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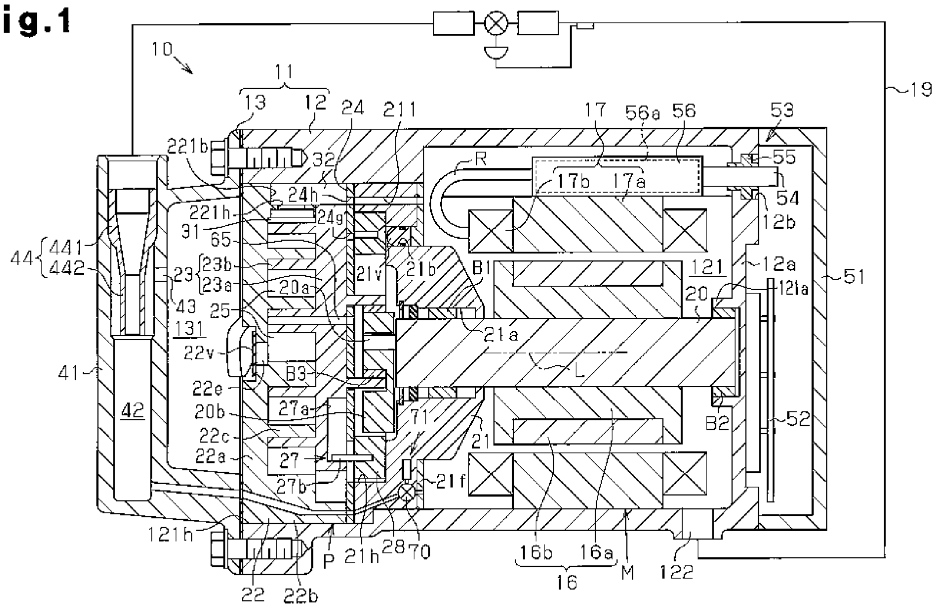
(54) **Scroll compressor with rotation restriction mechanism**

(57) A scroll compressor includes a rotation shaft, a fixed scroll, a movable scroll, a compression chamber, a shaft support, a housing, a movable member arranged in the shaft support, and a rotation restriction mechanism configured to restrict rotation of the movable scroll. The rotation restriction mechanism includes pins, recesses into which the respective pins are loosely fitted, and the movable member. The movable member includes the pins or the recesses. A switching mechanism is configured to switch the movable member between a state in which movement of the movable member in a radial direction of the rotation shaft is restricted and a state in which the restriction is canceled and the movable member can move freely, which changes a movable range of the movable member in the radial direction so that an orbital radius of the movable scroll is changed.

Fig.1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a scroll compressor.

[0002] Generally, a scroll compressor includes a fixed scroll, which is fixed to a housing, and a movable scroll, which orbits with respect to the fixed scroll. The fixed scroll includes a fixed base plate and a fixed spiral wall projecting from the fixed base plate. The movable scroll includes a movable base plate and a movable spiral wall projecting from the movable base plate. The fixed spiral wall and the movable spiral wall are engaged with each other to define a compression chamber. The orbital movement of the movable scroll decreases the volume of the compression chamber and compresses refrigerant. Japanese Laid-Open Patent Publication No. 2010-14108 describes an example of such a scroll compressor.

[0003] In the scroll compressor, a large centrifugal force acts on the movable scroll especially when the rotation shaft rotates at a high speed. This increases the noise generated when the movable spiral wall comes into contact with the fixed spiral wall. When the movable spiral wall is spaced apart from the fixed spiral wall to avoid contact between the spiral walls, leakage of the refrigerant from the compression chamber increases when the rotation shaft rotates at a low speed. This lowers the compression performance.

SUMMARY OF THE INVENTION

[0004] It is an object of the present disclosure to provide a scroll compressor that can reduce noise caused by contact between the fixed spiral wall and the movable spiral wall when the rotation shaft rotates at a high speed and reduce leakage of refrigerant from the compression chamber when the rotation shaft rotates at a low speed.

[0005] To achieve the above object, one aspect of the present invention is a scroll compressor that includes a rotation shaft, a fixed scroll including a fixed spiral wall, and a movable scroll including a movable spiral wall engaged with the fixed spiral wall. The movable scroll orbits when the rotation shaft is rotated. A compression chamber is defined between the fixed spiral wall and the movable spiral wall. The compression chamber has a volume that is decreased when the movable scroll orbits, and refrigerant is compressed in the compression chamber when the volume is decreased. A shaft support supports the rotation shaft. The shaft support and the fixed scroll are arranged at opposite sides of the movable scroll. A housing accommodates the rotation shaft, the fixed scroll, the movable scroll, and the shaft support. A movable member is arranged in the shaft support. A rotation restriction mechanism is configured to restrict rotation of the movable scroll. The rotation restriction mechanism includes a plurality of pins, a plurality of recesses into which the respective pins are loosely fitted, and the movable member. The movable member includes one of the plurality of pins and the plurality of recesses. A switching mechanism is configured to switch the movable member between a state in which movement of the movable member in a radial direction of the rotation shaft is restricted and a state in which the restriction is canceled and the movable member can move freely, which changes a movable range of the movable member in the radial direction of the rotation shaft so that an orbital radius of the movable scroll is changed.

[0006] Other aspects and advantages of the present 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

[0007] 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 showing a scroll compressor of a first embodiment;
Fig. 2 is an enlarged cross-sectional view showing a rotation restriction mechanism of the scroll compressor of Fig. 1;
Fig. 3 is a cross-sectional view showing the scroll compressor of Fig. 1;
Fig. 4 is an enlarged cross-sectional view showing a rotation restriction mechanism of the first embodiment;
Fig. 5 is an enlarged cross-sectional view showing the rotation restriction mechanism of the second embodiment; and
Fig. 6 is an enlarged cross-sectional view showing the rotation restriction mechanism of a second embodiment.

DETAILED DESCRIPTION OF THE INVENTION

First Embodiment

[0008] Referring to Figs. 1 to 4, a first embodiment of a scroll compressor (hereinafter referred to as the compressor) will now be described. The compressor is installed in a vehicle and used with a vehicle air-conditioning device.

[0009] As shown in Fig. 1, the compressor 10 includes a housing 11 made of metal (aluminum in the present embodiment). The housing 11 includes a cylindrical motor housing member 12 and a cylindrical discharge housing member 13. The motor housing member 12 includes a closed end and an open end 121h (left end as viewed in Fig. 1). The discharge housing member 13, which has a closed end, is connected to the open end 121h of the motor housing member 12. The motor housing member 12 accommodates a compression unit P, which compresses refrigerant, and an electric motor M, which drives the compression unit P.

[0010] The motor housing member 12 includes an end wall 12a and a cylindrical shaft support portion 121a projecting from the central section of the end wall 12a. A shaft support 21 is fixed in the motor housing member 12 near the open end 121h. An insertion hole 21a extends through a central section of the shaft support 21.

[0011] The motor housing member 12 also accommodates a rotation shaft 20. The rotation shaft 20 includes two ends. One end, which faces toward the open end 121h of the motor housing member 12, is located in the insertion hole 21a of the shaft support 21 and supported by a bearing B1 to be rotatable relative to the shaft support 21. The other end of the rotation shaft 20 faces toward the end wall 12a of the motor housing member 12 and is supported by a bearing B2 to be rotatable relative to the shaft support portion 121a. The bearings B1 and B2 are plain bearings.

[0012] The motor housing member 12 includes a motor chamber 121 extending between the shaft support 21 and the end wall 12a. The motor chamber 121 accommodates the electric motor M that includes a rotor 16, which rotates integrally with the rotation shaft 20, and a stator 17, which surrounds the rotor 16 and is fixed to the inner surface of the motor housing member 12. The rotor 16 includes a rotor core 16a, which is fixed to the rotation shaft 20 and rotated integrally with the rotation shaft 20, and a plurality of permanent magnets 16b, which are embedded in the rotor core 16a. The stator 17 includes a stator core 17a, which is annular and fixed to the inner surface of the motor housing member 12, and coils 17b, which are wound around the teeth (not shown) of the stator core 17a. Leads R for U, V, and W phases (only one lead shown in Fig. 1) extend from the ends of the coils 17b that face toward the shaft support 21.

[0013] A fixed scroll 22 is arranged between the shaft support 21 and the open end 121h of the motor housing member 12. The fixed scroll 22 includes a circular base plate 22a, a cylindrically-formed peripheral wall 22b projecting from the periphery of the base plate 22a, and a fixed spiral wall 22c projecting from the base plate 22a at the inner side of the peripheral wall 22b.

[0014] An eccentric shaft 20a projects from the end face of the rotation shaft 20 that faces toward the open end 121 h. The eccentric shaft 20a is eccentric to the rotation axis L of the rotation shaft 20. The eccentric shaft 20a supports a bushing 20b. A movable scroll 23 is supported by the bushing 20b to be rotatable relative to the bushing 20b. A bearing B3 is arranged between the movable scroll 23 and the bushing 20b. The movable scroll 23 includes a circular base plate 23a and a movable spiral wall 23b projecting from the base plate 23a toward the base plate 22a of the fixed scroll 22.

[0015] The fixed spiral wall 22c of the fixed scroll 22 and the movable spiral wall 23b of the movable scroll 23 are engaged with each other. The fixed spiral wall 22c has a distal surface in contact with the base plate 23a of the movable scroll 23. The movable spiral wall 23b has a distal surface in contact with the base plate 22a of the fixed scroll 22. The base plate 22a and the fixed spiral wall 22c of the fixed scroll 22 and the base plate 23a and the movable spiral wall 23b of the movable scroll 23 define a compression chamber 25.

[0016] As shown in Fig. 2, the end surface of the shaft support 21 that faces the movable scroll 23 includes an accommodating recess 21 h. The accommodating recess 21h accommodates an annular movable member 28 surrounding the bushing 20b. A clearance C1 is formed between the movable member 28 and the shaft support 21 in the radial direction of the rotation shaft 20. Thus, the movable member 28 is movable in the radial direction of the rotation shaft 20 in the range of a distance corresponding to the clearance C1. In the following description, the terms "axial direction", "radial direction", and "circumferential direction" refer to the axial direction, the radial direction, and the circumferential direction of the rotation shaft 20, respectively.

[0017] A rotation restriction mechanism 27 is arranged between the base plate 23a of the movable scroll 23 and the shaft support 21. The rotation restriction mechanism 27 includes a plurality of circular holes 27a, which are recesses arranged in the outer circumferential portion of the end surface of the base plate 23a of the movable scroll 23, and a plurality of pins 27b (only one shown in Fig. 1), which project from the outer circumferential portion of the shaft support 21 and are loosely fitted into the circular holes 27a. The pins 27b are integrated with the movable member 28.

[0018] As shown in Figs. 2 and 3, the shaft support 21 includes a plurality of cylindrical valve chambers 21 b extending in the axial direction. The valve chambers 21b are arranged in intervals in the circumferential direction. Each valve chamber 21b has one end facing toward the movable scroll 23 that opens in the accommodating recess 21h and another end facing away from the movable scroll 23 that is closed by a cover 21f, which has the form of a circular plate. The cover 21f is coupled to the end surface of the shaft support 21 that faces toward the end wall 12a of the motor housing member 12.

[0019] Each valve chamber 21b accommodates a cylindrical valve body 21v. Each valve body 21v has a semispherical distal end that faces toward the movable scroll 23. An annular seal 21s is arranged in the outer surface of each valve body 21v. The seal 21s seals the gap between the valve body 21v and the valve chamber 21b and divides the valve chamber 21 b into a primary void K1 and a secondary void K2. The primary void K1 is located between the movable scroll 23 and the secondary void K2.

[0020] As shown in Fig. 2, the shaft support 21 incorporates an electromagnetic switching valve 70. In addition, the shaft support 21 includes a branch passage 71 extending from the switching valve 70 to the valve chambers 21 b. The branch passage 71 includes a main passage 71a, which is in communication with the switching valve 70, and an annular passage 71 b, which extends in the circumferential direction and communicates the main passage 71a and the secondary voids K2 of the valve chambers 21b.

[0021] The end surface of the movable member 28 that faces away from the movable scroll 23 includes circular fitting recesses 28k at positions corresponding to the valve chambers 21b. The surface of each fitting recess 28k is tapered so that the diameter of the fitting recess 28k increases from the side that faces toward the movable scroll 23 to the end surface that faces away from the movable scroll 23. The movable member 28 also includes communication passages 28r that extend in the axial direction and are in communication with the corresponding fitting recesses 28k.

[0022] An annular, flat seat member 24 is arranged between the movable scroll 23 and the movable member 28. The seat member 24 includes a peripheral portion held between the fixed scroll 22 and the shaft support 21. The seat member 24 is fixed positioned relative to the motor housing member 12. The seat member 24 includes communication holes 24g that communicate the corresponding communication passages 28r and a gap between the seat member 24 and the movable scroll 23.

[0023] As shown in Fig. 1, when the rotation shaft 20 is driven by the electric motor M and rotated, the movable scroll 23, which is coupled to the rotation shaft 20 by the eccentric shaft 20a, orbits about the axis of the fixed scroll 22 (the rotation axis L of the rotation shaft 20) without rotating. The rotation restriction mechanism 27 prevents rotation of the movable scroll 23 while permitting the orbital motion. The orbital motion of the movable scroll 23 reduces the volume of the compression chamber 25. Thus, the fixed scroll 22 and the movable scroll 23 form a compression unit P that draws in and discharges refrigerant.

[0024] The peripheral wall 22b of the fixed scroll 22 and the outermost portion in the movable spiral wall 23b of the movable scroll 23 define a suction chamber 31 that is in communication with the compression chamber 25. The peripheral wall 22b of the fixed scroll 22 has an outer surface including a recess 221 b. The area surrounded by the recess 221 b and the inner surface of the motor housing member 12 forms a suction passage 32 that is connected to the suction chamber 31 through a through hole 221 h in the peripheral wall 22b of the fixed scroll 22. A through hole 211, which extends through the peripheral portions of the shaft support 21 and the cover 21f, and a through hole 24h, which extends through the peripheral portion of the seat member 24, connect the suction passage 32 to the motor chamber 121.

[0025] The motor housing member 12 includes a suction port 122 connected to an external refrigerant circuit 19. Refrigerant (gas) is drawn into the motor chamber 121 from the external refrigerant circuit 19 through the suction port 122. The refrigerant in the motor chamber 121 is then sent to the compression chamber 25 through the through hole 211, the through hole 24h, the suction passage 32, the through hole 221 h, and the suction chamber 31. Accordingly, the motor chamber 121, the through hole 211, the through hole 24h, the suction passage 32, the through hole 221h, and the suction chamber 31 form a suction pressure region.

[0026] The refrigerant in the compression chamber 25 is compressed by the orbiting motion (discharging motion) of the movable scroll 23, forced through a discharge valve 22v of a discharge port 22e, and discharged into a discharge chamber 131 of the discharge housing member 13.

[0027] A chamber-forming wall 41 is formed integrally with the discharge housing member 13. An oil-separating chamber 42 is formed between the discharge housing member 13 and the chamber-forming wall 41. The oil-separating chamber 42 is in communication with the discharge chamber 131 through a discharge port 43 formed in the discharge housing member 13. The refrigerant in the discharge chamber 131 is sent to the oil-separating chamber 42 through the discharge port 43.

[0028] The oil-separating chamber 42 accommodates an oil-separating cylinder 44. The oil-separating cylinder 44 includes a large diameter portion 441, which is fitted in the oil-separating chamber 42, and a small diameter portion 442, which has a smaller diameter than the oil-separating chamber 42 and is located under the large diameter portion 441. Refrigerant flows into the oil-separating chamber 42 through the discharge port 43, swirls around the small diameter portion 442, and then flows into the oil-separating cylinder 44 from a lower opening in the small diameter portion 442. The refrigerant further flows from the oil-separating cylinder 44 to the external refrigerant circuit 19 and then returns to the motor chamber 121. Lubricating oil is separated from the refrigerant when the refrigerant swirls around the small diameter portion 442. The separated lubricating oil falls into the lower portion of the oil-separating chamber 42. Accordingly, the discharge port 22e, the discharge chamber 131, the discharge port 43, and the oil-separating chamber 42 form a discharge pressure region.

[0029] An inverter cover 51 made of metal (aluminum in the present embodiment) is fixed to the end wall 12a of the motor housing member 12. The inverter cover 51 and the end wall 12a of the motor housing member 12 define a chamber that accommodates a motor driving circuit 52 fixed to the outer surface of the end wall 12a. Thus, in the present embodiment, the compression unit P, the electric motor M, and the motor driving circuit 52 are arranged in this order in the axial direction.

[0030] The end wall 12a of the motor housing member 12 includes a through hole 12b that receives a sealing terminal 53. The sealing terminal 53 includes three sets of a metal terminal 54 and a glass insulator 55 (only one set shown in Fig. 1). The metal terminals 54 extend through the motor housing member 12 to electrically connect the electric motor M to the motor driving circuit 52. Each glass insulator 55 fixes the corresponding metal terminal 54 to the end wall 12a and insulates the metal terminal 54 from the end wall 12a. Each metal terminal 54 has a first end connected to the motor driving circuit 52 by a cable (not shown) and a second end extending into the motor housing member 12.

[0031] An insulative resin cluster block 56 is fixed to the outer surface of the stator core 17a. The cluster block 56 accommodates three connection terminals 56a (only one shown in the Fig. 1). The connection terminals 56a electrically connect the leads R to the metal terminals 54. The motor driving circuit 52 supplies power to the coils 17b through the metal terminals 54, the connection terminals 56a, and the leads R. This integrally rotates the rotor 16 and the rotation shaft 20.

[0032] As shown in Fig. 2, an annular seal 61, which is in contact with the surface of the rotation shaft 20, divides the insertion hole 21a of the shaft support 21 into a back pressure chamber 62 and an accommodating chamber 63. The back pressure chamber 62 is located between the seal 61 and the movable scroll 23. The accommodating chamber 63 accommodates the bearing B1. A snap ring 64 is fitted to a section of the insertion hole 21a of the shaft support 21 that is located in the back pressure chamber 62. The snap ring 64 restricts movement of the seal 61 into the back pressure chamber 62.

[0033] The movable scroll 23 and the seat member 24 include a first oil passage 65 extending through the movable spiral wall 23b and the base plate 23a near the center of the movable scroll 23. The first oil passage 65 has an end that opens to the compression chamber 25 and another end that opens to the back pressure chamber 62. Some of the refrigerant compressed in the compression chamber 25 is supplied to the back pressure chamber 62 through the first oil passage 65. The refrigerant supplied to the back pressure chamber 62 flows through the inner side of the seat member 24 into the circular holes 27a. The pressure of the refrigerant supplied into the back pressure chamber 62 and the circular holes 27a presses the movable scroll 23 toward the fixed scroll 22. Thus, in the present embodiment, the circular holes 27a and the back pressure chamber 62 form a back pressure region located between the movable scroll 23 and the movable member 28 in the motor housing member 12. The back pressure region applies force to the movable scroll 23, and the force presses the movable scroll 23 against the fixed scroll 22.

[0034] When refrigerant enters the gap between the seat member 24 and the movable scroll 23, the refrigerant flows to the primary voids K1 of the valve chambers 21b through the corresponding communication holes 24g and the communication passages 28r. The primary voids K1 function as part of the back pressure region due to the pressure of the refrigerant flowing into the primary voids K1.

[0035] The switching valve 70 is in communication with the oil-separating chamber 42 through the second oil passage 68, which extends through the shaft support 21, the seat member 24, the fixed scroll 22, and the discharge housing member 13. Further, the switching valve 70 is in communication with the motor chamber 121 through a communication passage 69 formed in the shaft support 21 and the cover 21f. The switching valve 70 operates so that the secondary voids K2 of the valve chambers 21b are in communication with the second oil passage 68 through the branch passage 71 when the compressor 10 operates at a high rotation speed and so that the secondary voids K2 are in communication with the communication passage 69 through the branch passage 71 when the compressor 10 operates at a low rotation speed. In other words, the switching valve 70 switches between a state in which the secondary voids K2 are in communication with a suction pressure region and a state in which the secondary voids K2 are in communication with a discharge pressure region. The suction pressure region is a low pressure region, the pressure of which is lower than that of the primary voids K1. The primary voids K1 are part of the back pressure region. The discharge pressure region is a high pressure region, the pressure of which is higher than that of the primary voids K1.

[0036] The operation of the first embodiment will now be described.

[0037] As shown in Fig. 4, when the compressor 10 operates at a high rotation speed, the switching valve 70 brings the secondary voids K2 of the valve chambers 21b into communication with the second oil passage 68 through the branch passage 71. This allows the lubricating oil flowing in the second oil passage 68 from the oil-separating chamber 42 to be sent into the secondary voids K2 of the valve chambers 21b through the switching valve 70 and the branch passage 71. Consequently, the secondary voids K2 become part of the discharge pressure region.

[0038] The difference between the pressure in the primary voids K1 and the pressure in the secondary voids K2 moves the valve bodies 21v toward the movable scroll 23. The distal end of each valve body 21v that faces toward the movable scroll 23 is guided by the surface of the corresponding fitting recess 28k into the fitting recess 28k. Accordingly, the movable member 28 is pressed by the valve bodies 21v toward the movable scroll 23 and received by the seat member 24. Thus, the movable member 28 is held between the valve bodies 21v and the seat member 24. This restricts movement of the movable member in the radial direction. Further, the engagement between the valve bodies 21v and the respective fitting recesses 28k also restricts the radial movement of the movable member 28 and changes the movable range of the movable member 28 in the radial direction. Thus, the orbital radius of the movable scroll 23 is decreased compared to when the restriction of the movable member 28 is canceled and the movable member 28 can move freely. As a result, the movable spiral wall 23b does not contact the fixed spiral wall 22c when the compressor 10 operates at a high rotation speed. This reduces noise that would be caused by contact between the fixed spiral wall 22c and the movable spiral wall 23b during high speed rotation.

[0039] As shown in Fig. 2, when the compressor 10 operates at a low rotation speed, the switching valve 70 brings the secondary voids K2 of the valve chambers 21 b into communication with the communication passage 69 through the branch passage 71. This allows the refrigerant in the valve chambers 21b to flow into the motor chamber 121 through the branch passage 71, the switching valve 70, and the communication passage 69. Consequently, the secondary voids K2 become part of the suction pressure region.

[0040] The difference in the pressure in the primary voids K1 and the pressure in the secondary voids K2 moves the valve bodies 21v away from the movable scroll 23. This releases the movable member 28 from the valve bodies 21v and the seat member 24 and disengages the valve bodies 21v from the fitting recesses 28k thereby allowing the movable member 28 to move freely. As a result, the movable range of the movable member 28 in the radial direction is changed. Thus, the orbital radius of the movable scroll 23 is increased compared to when the radial movement of the movable member 28 is restricted. As a result, the movable spiral wall 23b is in contact with the fixed spiral wall 22c when the compressor 10 operates at low rotation speed. This suppresses leakage of refrigerant from the compression chamber 25 during low speed rotation. In the present embodiment, the valve chamber 21b, the valve body 21v, the primary void K1, the secondary void K2, the branch passage 71, and the switching valve 70 form a switching mechanism.

[0041] The orbital radius of the movable scroll 23 is increased or decreased when the bushing 20b slides or swings to move in the radial direction relative to the eccentric shaft 20a and thereby permit radial movement of the movable scroll 23.

[0042] The advantage of the first embodiment will now be described.

(1) The movable member 28 is arranged in the shaft support 21. In addition, the pins 27b, the circular holes 27a, and the movable member 28 form the rotation restriction mechanism 27. The movable member 28 is switched between a state in which the radial movement of the movable member 28 is restricted and a state in which the restriction is canceled and the movable member 28 can move freely. This allows the movable range of the movable member 28 and the orbital radius of the movable scroll 23 to be changed. When the compressor 10 operates at high rotation speed, the radial movement of the movable member 28 is restricted to reduce the movable range of the movable member 28 in the radial direction. Thus, the orbital radius of the movable scroll 23 is decreased so that the movable spiral wall 23b does not contact the fixed spiral wall 22c. This reduces noise that would be caused by contact between the fixed spiral wall 22c and the movable spiral wall 23b during high speed rotation. Further, when the compressor 10 operates at low rotation speed, the restriction of the movable member 28 is canceled so that the movable member can move freely. This increases the movable range of the movable member 28 in the radial direction and allows the orbital radius of the movable scroll 23 to be increased. Thus, the movable spiral wall 23b contacts the fixed spiral wall 22c. This suppresses leakage of refrigerant from the compression chamber 25 during low speed rotation.

(2) The shaft support 21 includes the valve chambers 21 b, each accommodating the corresponding valve body 21v that presses the movable member 28 toward the movable scroll 23. Thus, the radial movement of the movable member 28 can be restricted by moving the valve bodies 21v toward the movable scroll 23 so that the valve bodies 21v press the movable member 28 toward the movable scroll 23.

(3) The shaft support 21 includes the switching valve 70, which switches between a state in which the secondary voids K2 are in communication with the suction pressure region having a lower pressure than the primary voids K1, which function as the back pressure region, and a state in which the secondary voids K2 are in communication with the discharge pressure region having a higher pressure than the primary voids K1. When the switching valve 70 brings the secondary voids K2 into communication with the discharge pressure region, the difference between the pressure in the primary voids K1 and the pressure in the secondary voids K2 moves the valve bodies 21v toward the movable scroll 23. Accordingly, the valve bodies 21v press the movable member 28 toward the movable scroll 23 and easily restrict the radial movement of the movable member 28. Further, when the switching valve 70 brings the secondary voids K2 into communication with the suction pressure region, the difference between the pressure in the primary voids K1 and the pressure in the secondary voids K2 moves the valve bodies 21v away from the movable scroll 23. Thus, the valve bodies 21v no longer press the movable member 28 against the movable scroll 23, and the restriction of the radial movement of the rotation shaft 20 is easily cancelled.

(4) The movable member 28 includes the communication passages 28r that communicate the back pressure region and the primary voids K1. This ensures that the primary voids K1 function as part of the back pressure region and contrasts to a structure in which the movable member 28 does not include the communication passages 28r. Consequently, when the secondary voids K2 become part of the discharge pressure region due to actuation of the switching valve 70, the difference between the pressure in the primary voids K1 and the pressure in sec-

ondary voids K2 is ensured to move the valve bodies 21v toward the movable scroll 23. Further, when the secondary voids K2 become part of the suction pressure region due to actuation of the switching valve 70, the difference between the pressure in the primary voids K1 and the pressure in the secondary voids K2 is ensured to move the valve bodies 21v away from the movable scroll 23.

(5) The shaft support 21 includes a plurality of valve chambers 21b separated from one another in the circumferential direction. The shaft support 21 also includes the branch passage 71 extending from the switching valve 70 to the valve chambers 21b. This facilitates restriction of the radial movement of the movable member 28 and contrasts to a structure in which the shaft support 21 includes only one valve chamber 21b and the radial movement of the movable member 28 is restricted by only one valve body 21v.

(6) The movable member 28 includes the fitting recesses 28k to which the corresponding valve bodies 21v can be fitted. When the switching valve 70 brings the secondary voids K2 into communication with the discharge pressure region and the difference between the pressure in the primary voids K1 and the pressure in the secondary voids K2 moves the valve bodies 21v toward the movable scroll 23, the valve bodies 21v are fitted to the corresponding fitting recesses 28k. This further facilitates the restriction of radial movement of the movable member 28.

(7) The seat member 24 is arranged between the movable scroll 23 and the movable member 28. The seat member 24 is fixed to the motor housing member 12 and receives the movable member 28 that is pressed toward the movable scroll 23 by the valve bodies 21v. This facilitates the restriction of radial movement of the movable member 28 compared to a structure in which the radial movement of the movable member 28 is restricted by holding the movable member 28 between the valve bodies 21v and the movable scroll 23, for example.

(8) Each valve body 21v includes the semispherical distal end that faces toward the movable scroll 23. In addition, the surface of each fitting recess 28k is tapered so that the diameter of the fitting recess 28k increases from the side that faces toward the movable scroll 23 to the end surface that faces away from the movable scroll 23. Thus, when the difference in the pressure in the primary voids K1 and the pressure in the secondary voids K2 moves the valve bodies 21v toward the movable scroll 23, the distal end of each valve body 21v is guided by the surface of the corresponding fitting recess 28k and inserted into the fitting recess 28k. This facilitates the engagement between the valve body 21v and the fitting recess 28k.

Second Embodiment

[0043] Referring to Figs. 5 and 6, the second embodiment will now be described. Same reference numerals are given to those components that are the same as the corresponding components of the first embodiment. Such components will not be described in detail.

[0044] As shown in Fig. 5, the end surface of the movable member 28 that faces away from the movable scroll 23 includes a conical projection 81. The conical projection 81 includes a conical projection surface 81a that surrounds the bushing 20b and has a diameter that decreases as the movable scroll 23 becomes farther. Further, an annular seal 28s is arranged in the outer circumferential surface of the movable member 28. The seal 28s has an outer surface that is located radially outward from the outer circumferential surface of the movable member 28. Accordingly, a clearance C2 is formed between the movable member 28 and the shaft support 21 in the radial direction. The seal 28s can be elastically deformed to allow the movable member 28 to move in the radial direction in the range of the distance of the clearance C2.

[0045] Further, the accommodating recess 21 h accommodates a tip seal 29 arranged on the end surface of the movable member 28 that faces away from the movable scroll 23. The tip seal 29 seals the gap between the shaft support 21 and the movable member 28. In addition, the end surface of the movable member 28 that faces away from the movable scroll 23 includes an accommodating groove 28g that can accommodate the tip seal 29. The accommodating recess 21h is divided into a primary void K1 and a secondary void K2. The primary void K1 is located between the movable scroll 23 and the secondary void K2, and the secondary void K2 is located between the seal 28s and the tip seal 29.

[0046] The shaft support 21 includes a communication flow passage 83 that communicates the switching valve 70 and the secondary void K2. The primary void K1 is in communication with the first oil passage 65, which is in communication with the back pressure chamber 62. Thus, in the second embodiment, the primary void K1 functions as part of the back pressure region.

[0047] The shaft support 21 includes a conical recess 82 on the side that faces the movable member 28. The conical recess 82 includes a conical recess surface 82a that surrounds the bushing 20b and has a diameter that decreases as the movable member 28 becomes farther. The conical projection 81 is movable toward and away from the conical recess 82.

[0048] The operation of the second embodiment will now be described.

[0049] As shown in Fig. 6, when the compressor 10 operates at a high rotation speed, the switching valve 70 brings the secondary void K2 into communication with the communication passage 69 through the communication flow passage 83. This allows the refrigerant in the secondary void K2 to flow into the motor chamber 121 through the communication flow passage 83, the switching valve 70, and the communication passage 69. Consequently, the secondary void K2 becomes part of the suction pressure region.

[0050] The difference between the pressure in the primary void K1 and the pressure in the secondary void K2 moves the movable member 28 away from the movable scroll 23. This moves the conical projection 81 toward the conical recess 82 and brings the conical projection surface 81a and conical recess surface 82a into contact with each other. Thus, the conical projection 81 is fitted into the conical recess 82 and thereby restricts the radial movement of the movable member 28. This changes the movable range of the movable member 28 in the radial direction. The orbital radius of the movable scroll 23 is decreased compared to when the movable member 28 is not restricted and freely movable. As a result, when the compressor 10 is operating at a high rotation speed, the movable spiral wall 23b is not in contact with the fixed spiral wall 22c. This reduces noise that would be caused by contact between the fixed spiral wall 22c and the movable spiral wall 23b during high speed rotation.

[0051] As shown in Fig. 5, when the compressor 10 operates at a low rotation speed, the switching valve 70 brings the secondary void K2 into communication with the second oil passage 68 through the communication flow passage 83. This allows the lubricating oil flowing in the second oil passage 68 from the oil-separating chamber 42 to flow into the secondary void K2 through the switching valve 70 and the communication flow passage 83. Consequently, the secondary void K2 becomes part of the discharge pressure region.

[0052] The difference between the pressure in the primary void K1 and the pressure in the secondary void K2 moves the movable member 28 toward the movable scroll 23. This moves the conical projection 81 away from the conical recess 82 and allows the movable member 28 to move freely. Thus, the movable range of the movable member 28 in the radial direction is changed. The orbital radius of the movable scroll 23 is increased compared to when the radial movement of the movable member 28 is restricted. As a result, when the compressor 10 operates at a low rotation speed, the movable spiral wall 23b is in contact with the fixed spiral wall 22c. This suppresses leakage of refrigerant from the compression chamber 25 during low speed rotation. In the present embodiment, the conical projection 81, the conical recess 82, the primary void K1, the secondary void K2, the communication passage 69, and the switching valve 70 form a switching mechanism.

[0053] Accordingly, the second embodiment has the following advantages in addition to advantage (1) of the first embodiment.

[0054] (9) The second embodiment does not require the valve chambers 21b or the valve bodies 21v of the first embodiment and has a simple structure.

[0055] 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 present invention may be embodied in the following forms.

[0056] In the first embodiment, the movable member 28 does not have to include the fitting recesses 28k. Instead, the valve bodies 21v may be pressed against the end surface of the movable member 28 that faces away from the movable scroll 23 to restrict radial movement of the movable member 28 with the friction produced between the valve bodies 21v and the movable member 28.

[0057] In the first embodiment, the communication passages 28r may be omitted. In this case, the primary voids K1 can still become the back pressure region due to the refrigerant flowing into the primary voids K1 from the back pressure chamber 62 through the gap between the movable member 28 and the shaft support 21.

[0058] In the first embodiment, the number of the valve chambers 21b is not limited.

[0059] In the first embodiment, the seat member 24 may be omitted. The radial movement of the movable member 28 may be restricted by holding the movable member 28 between the valve bodies 21v and the movable scroll 23, for example.

[0060] In the first embodiment, the shape of the valve body 21v is not limited. For example, the valve body 21v may be spherical.

[0061] In the first embodiment, the surface of the fitting recesses 28k may extend in the axial direction, for example.

[0062] In the above embodiment, the secondary void K2 does not have to be in communication with the suction pressure region or the discharge pressure region as long as the secondary void K2 is in communication with a low pressure region that has a lower pressure than the back pressure region or a high pressure region that has a higher pressure than the back pressure region.

[0063] The bushing 20b may be fixed to the eccentric shaft 20a, and the radial movement of the movable scroll 23 may be permitted by a gap between the movable scroll 23 and the bearing B3 or a gap between the bushing 20b and the bearing B3.

[0064] In the above embodiments, the secondary void K2 receives lubricating oil from the oil-separating chamber 42 through the second oil passage 68. However, the secondary void K2 may be in communication with the discharge chamber 131 so that refrigerant having the discharge pressure is delivered to the secondary void K2.

[0065] The movable scroll 23 may include a plurality of pins that are integrated with the movable scroll 23, and the movable member 28 may include a plurality of circular holes into which the respective pins are loosely fitted.

[0066] The present invention may be embodied in a scroll compressor that is directly driven by a driving source such as an engine, instead of being driven by the electric motor M.

[0067] 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.

Claims

1. A scroll compressor comprising:

   a rotation shaft (20);
   a fixed scroll (22) including a fixed spiral wall (22c);
   a movable scroll (23) including a movable spiral wall (23b) engaged with the fixed spiral wall (22c), wherein the movable scroll (23) orbits when the rotation shaft (20) is rotated;
   a compression chamber (25) defined between the fixed spiral wall (22c) and the movable spiral wall (23b), wherein the compression chamber (25) has a volume that is decreased when the movable scroll (23) orbits, and refrigerant is compressed in the compression chamber (25) when the volume is decreased;
   a shaft support (21) that supports the rotation shaft (20), wherein the shaft support (21) and the fixed scroll (22) are arranged at opposite sides of the movable scroll (23);
   a housing (11) that accommodates the rotation shaft (20), the fixed scroll (22), the movable scroll (23), and the shaft support (21);
   a movable member (28) arranged in the shaft support (21);
   a rotation restriction mechanism (27) configured to restrict rotation of the movable scroll (23), wherein the rotation restriction mechanism (27) includes a plurality of pins (27b), a plurality of recesses (27a) into which the respective pins (27b) are loosely fitted, and the movable member (28), and wherein the movable member (28) includes one of the plurality of pins (27b) and the plurality of recesses (27a); and
   a switching mechanism configured to switch the movable member (28) between a state in which movement of the movable member (28) in a radial direction of the rotation shaft (20) is restricted and a state in which the restriction is canceled and the movable member (28) can move freely, which changes a movable range of the movable member (28) in the radial direction of the rotation shaft (20) so that an orbital radius of the movable scroll (23) is changed.

2. The scroll compressor according to claim 1, wherein the switching mechanism includes a valve chamber (21 b), which is arranged in the shaft support (21), and a valve body (21v), which is accommodated in the valve chamber (21b), and
   the valve body (21v) presses the movable member (28) toward the movable scroll (23).

3. The scroll compressor according to claim 2, wherein the valve chamber (21 b) includes a primary void (K1) and a secondary void (K2),
   the primary void (K1) is located between the secondary void (K2) and the movable scroll (23), and
   the switching mechanism includes a switching valve (70) configured to switch between a state in which the secondary void (K2) is in communication with a low pressure region, the pressure of which is lower than that of the primary void (K1), and a state in which the secondary void (K2) is in communication with a high pressure region, the pressure of which is higher than that of the primary void (K1).

4. The scroll compressor according to claim 3, further comprising a back pressure region (62) located between the movable scroll (23) and the movable member (28) and configured to apply force to the movable scroll (23) so that the movable scroll (23) is pressed toward the fixed scroll (22), wherein
   the movable member (28) includes a communication passage (28r) that communicates the back pressure region (62) and the primary void (K1).

5. The scroll compressor according to claim 3 or claim 4, wherein
   the valve chamber (21 b) is one of a plurality of valve chambers (21 b) that are arranged in the shaft support (21) in intervals in a circumferential direction of the rotation shaft (20), and
   the switching mechanism includes a passage (71) that extends in the shaft support (21) from the switching valve (70) to the valve chambers (21 b).

6. The scroll compressor according to any one of claims 2 to 5, wherein the movable member (28) includes a fitting recess (28k) to which the valve body (21v) can be fitted.

7. The scroll compressor according to any one of claims 2 to 6, further comprising a seat member (24) fixed to the housing (11) and arranged between the movable scroll (23) and the movable member (28), wherein the seat member (24) receives the movable member (28) that is pressed toward the movable scroll (23) by the valve body (21v).

8. The scroll compressor according to claim 1, wherein the switching mechanism includes
   a primary void (K1) and a secondary void (K2) arranged in the shaft support (21), wherein the primary void (K1) is located between the movable scroll (23) and the secondary void (K2),
   a conical recess (82) arranged in the shaft support (21),
   a conical projection (81) that is arranged in the movable member (28) and movable toward and away from the conical recess (82), and

a switching valve (70) that switches between a state in which the secondary void (K2) is in communication with a low pressure region, the pressure of which is lower than that of the primary void (K1), and a state in which the secondary void (K2) is in communication with a high pressure region, the pressure of which is higher than that of the primary void (K1).

Fig.1

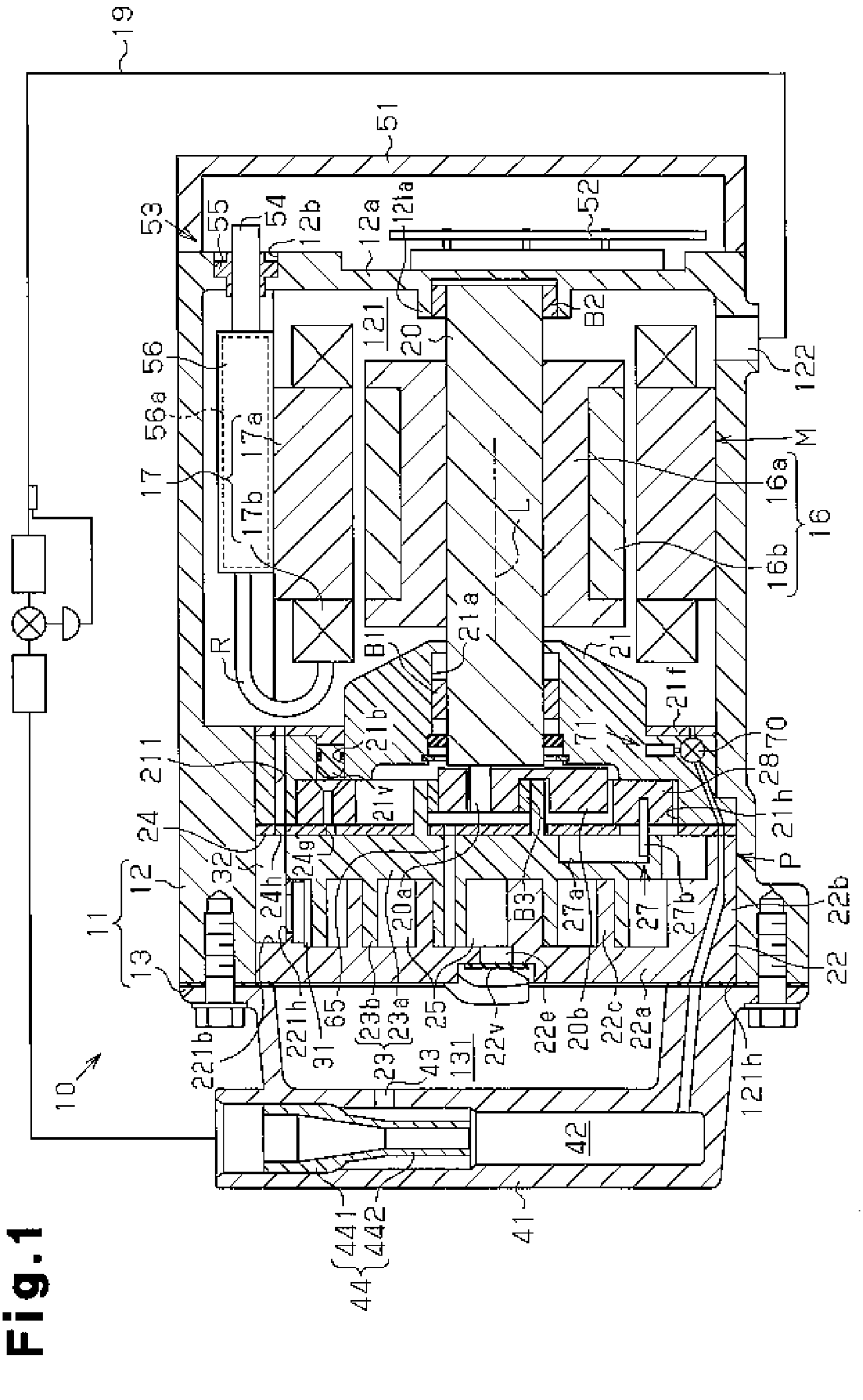
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Fig.2

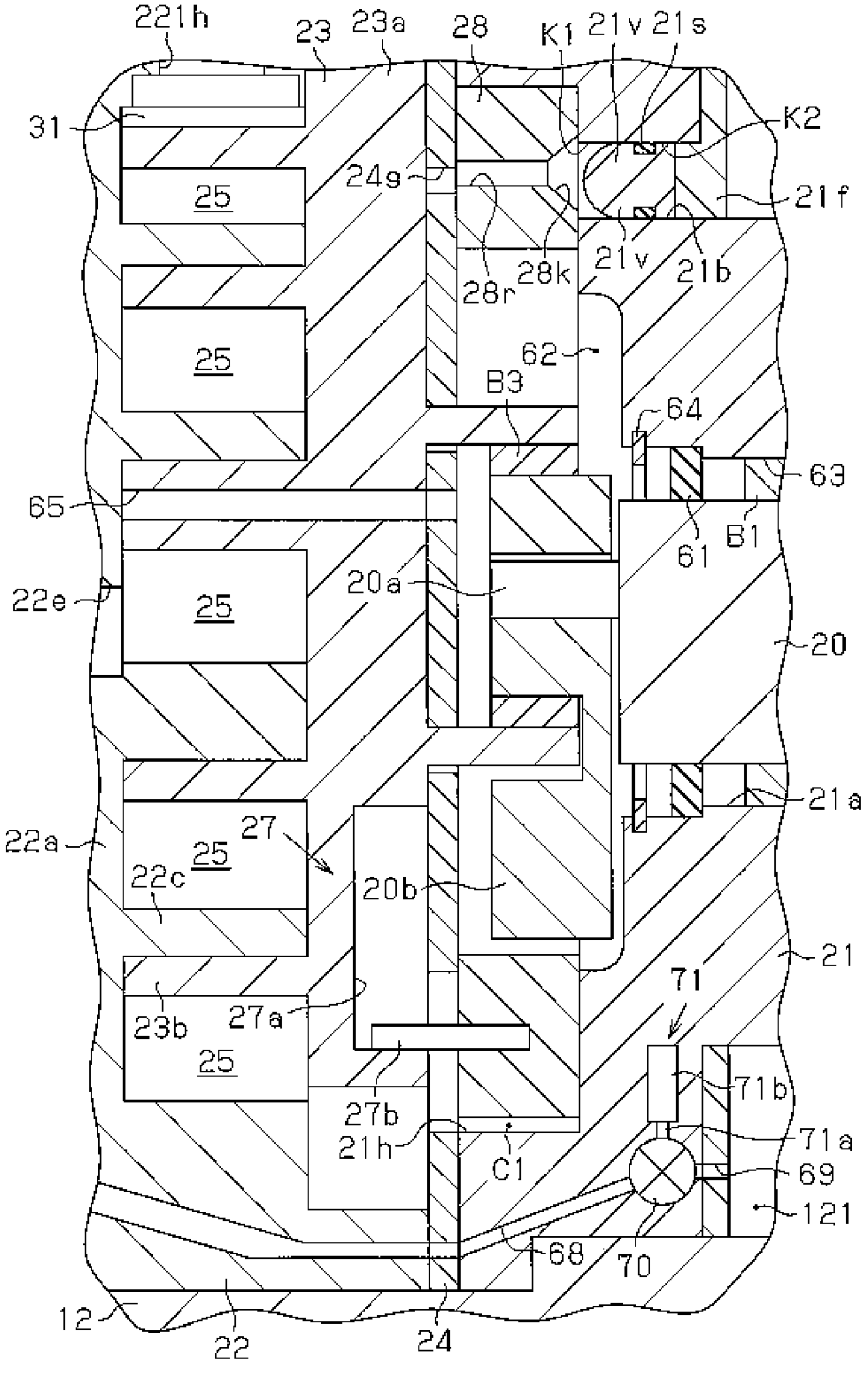
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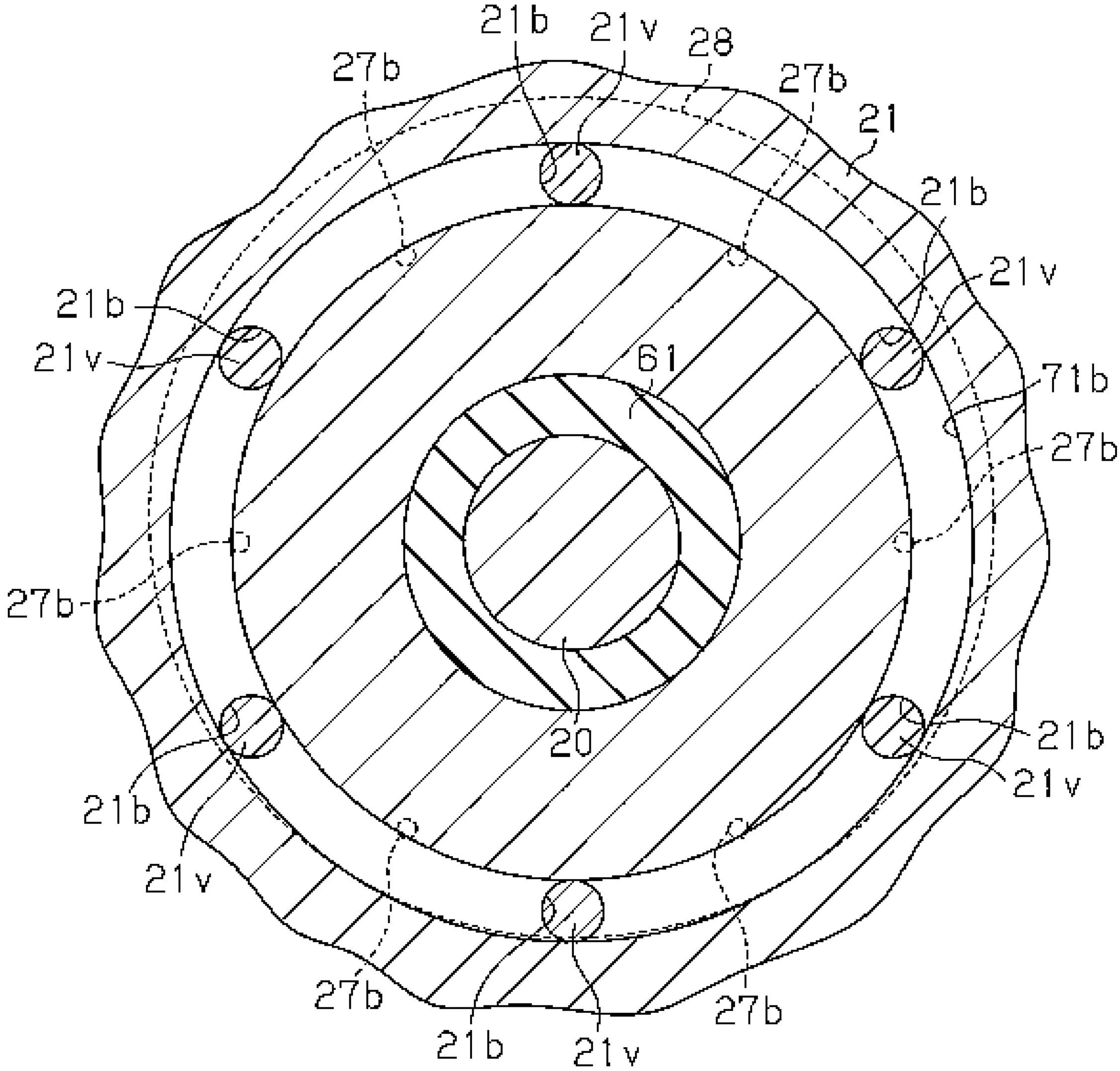
Fig.3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27b
21b
21v

Fig.4

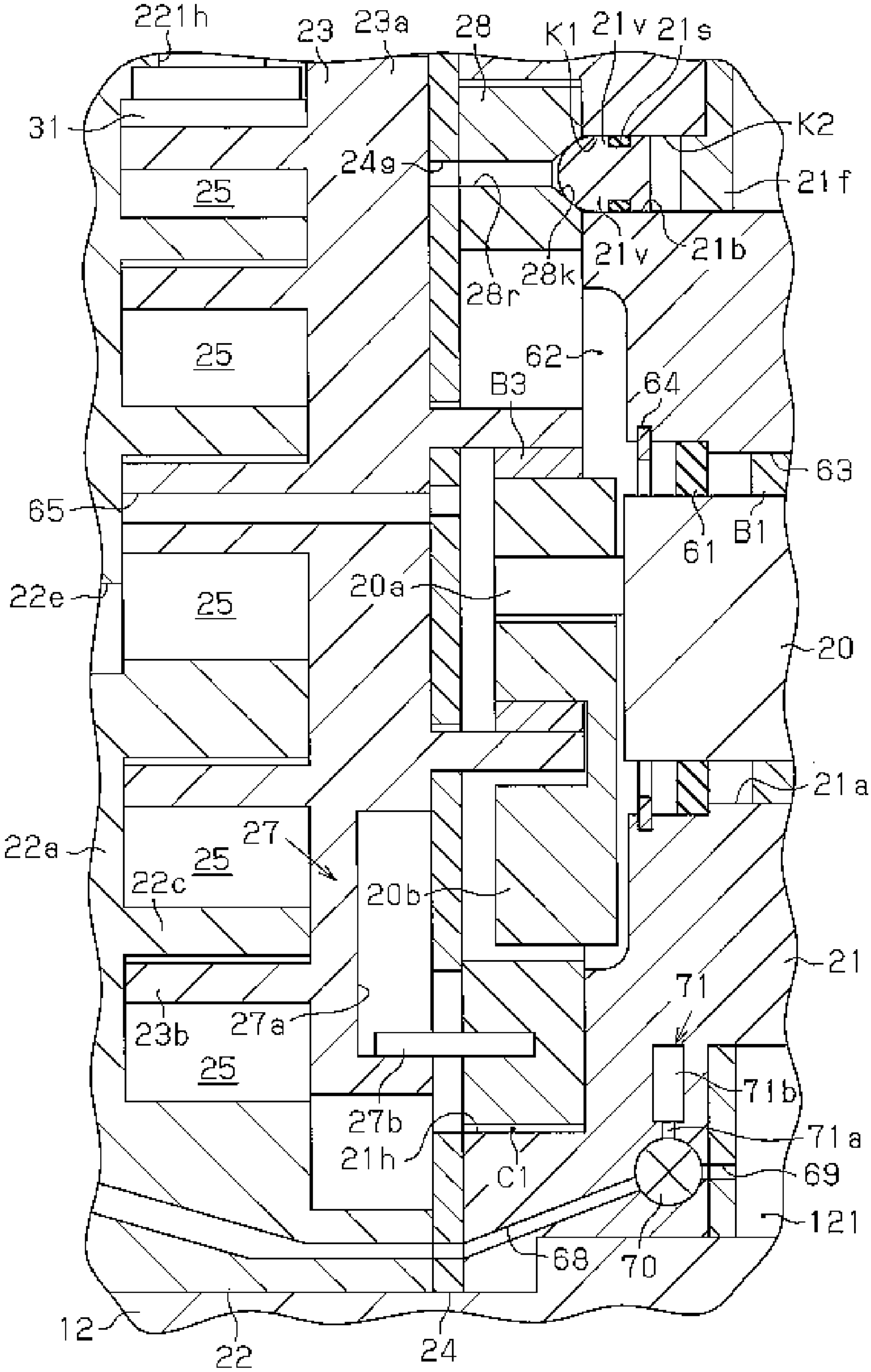
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Fig.5

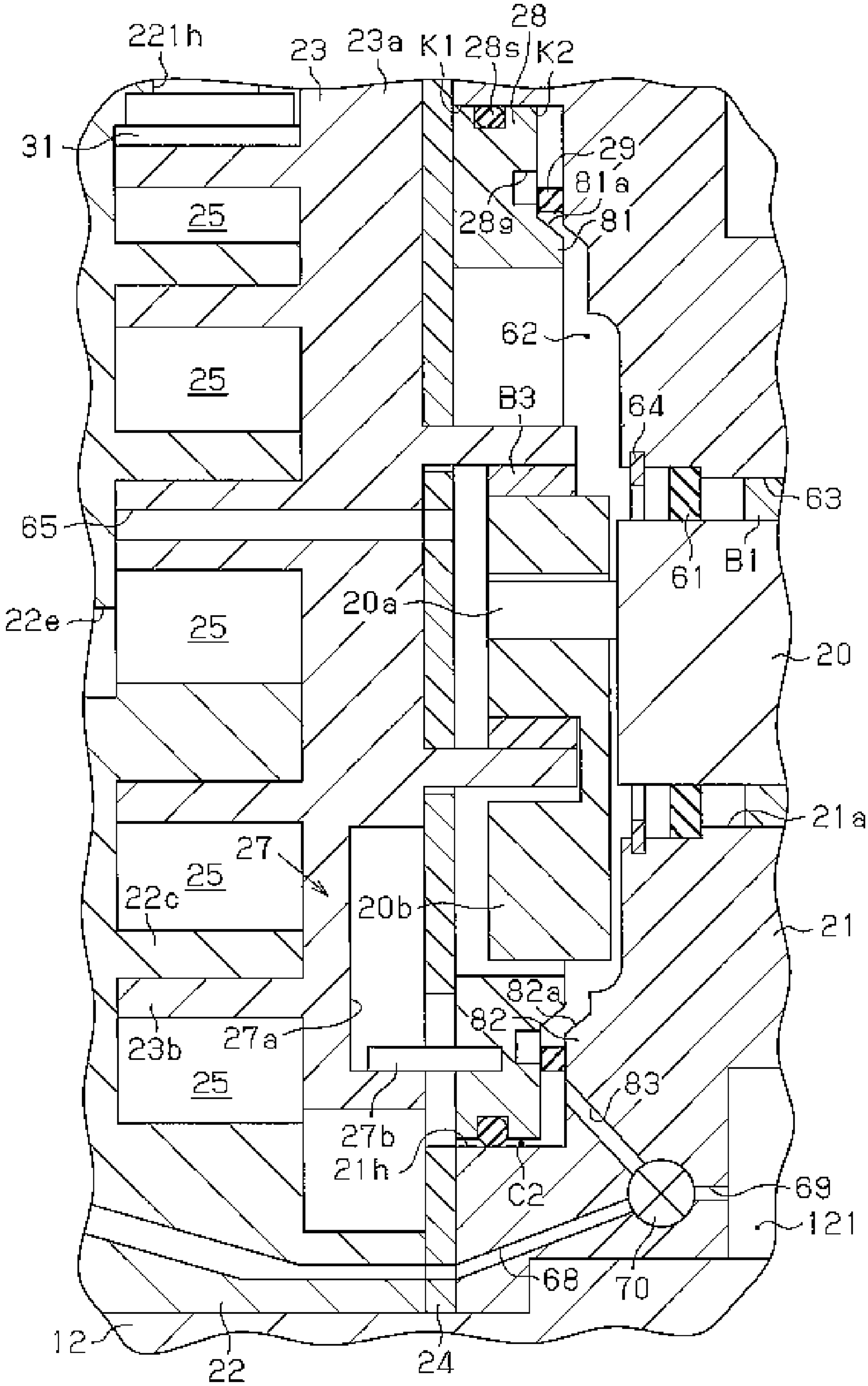
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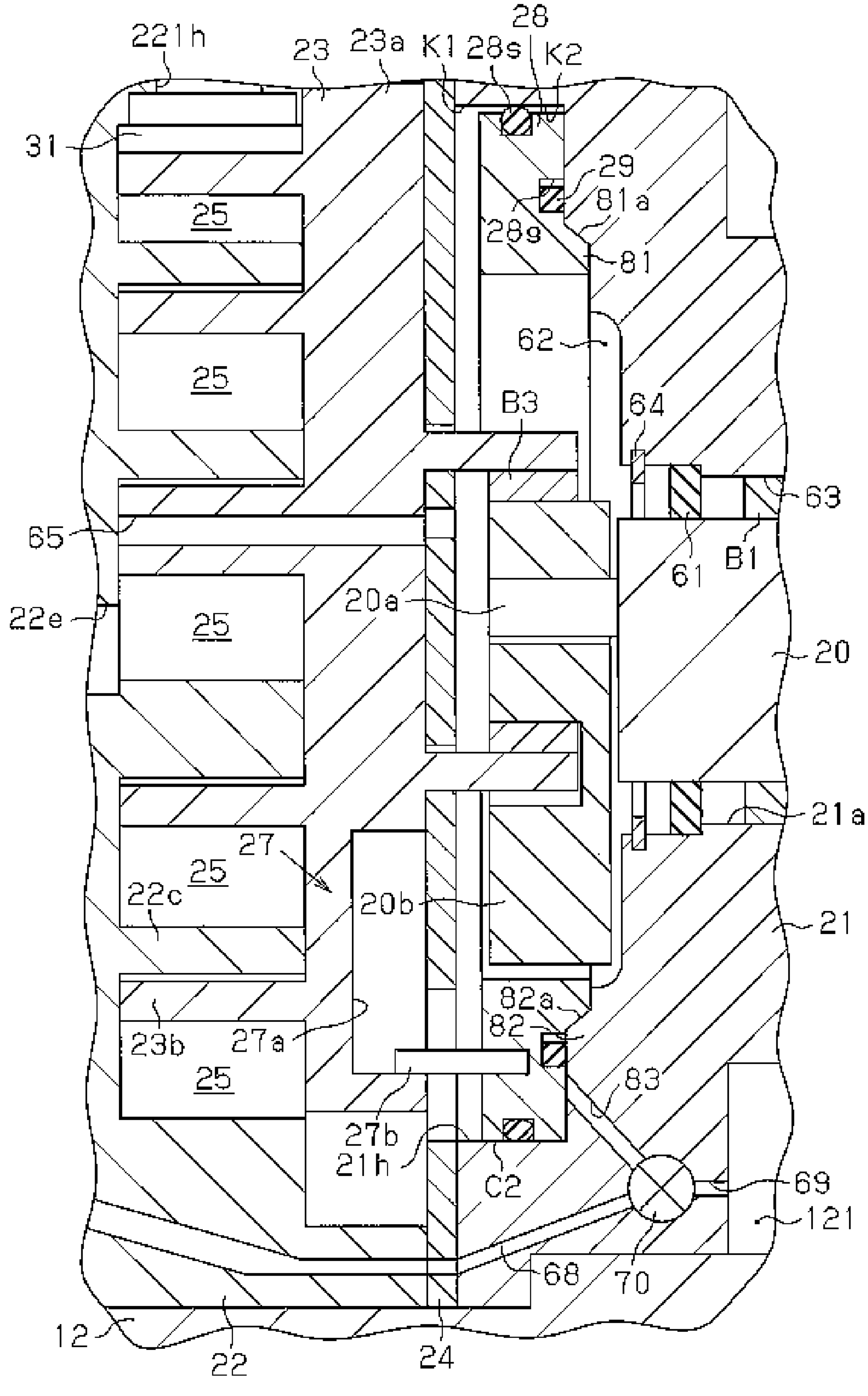
Fig.6



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REFERENCES CITED IN THE DESCRIPTION

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