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(54) **Flow path switching valve**

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## Description

### Background of the Invention

#### Field of the Invention

**[0001]** The present invention relates to a flow path switching valve for switching a flow path of a refrigerant used in a refrigeration cycle of an air conditioner or the like.

#### Description of the related art

**[0002]** Conventionally, in the air conditioner, by switching the flow path of the refrigerant of the refrigeration cycle, air cooling and heating operations are switched. In such a refrigeration cycle, a compressor, two heat exchangers for a condenser and an evaporator, and a flow path switching valve for switching the flow path of the refrigerant disposed in the compressor and two heat exchangers are used.

**[0003]** For example, such a flow path switching valve is disclosed in JP, A, 2009-68695 (Patent document 1). In this flow path switching valve, a piston main body formed by joining two pistons and a main valve body is received in a tubular valve housing (valve main body), and the main valve body is slid relative to a valve seat in the valve housing in an axial direction to switch the flow path of the refrigerant passing through a plurality of pipes. When switching the flow path, a differential pressure between a pressure of the refrigerant in a main valve chamber between two pistons and a pressure of the refrigerant of a sub valve chamber outside of the pistons moves the piston main body.

**[0004]** Further, in the flow path switching valve disclosed in the patent document 1, when the piston main body is moved, a second valve body (ball) disposed at the piston is in contact with the valve seat provided at an end cap of the valve housing, and by blocking an exhaust pipe provided at the valve seat, the pressures of the main valve chamber at a high pressure side and of the sub valve chamber at a low pressure side are equalized to reduce the differential pressure acting on a packing of the piston. In this way, even when a super high pressure refrigerant such as CO<sub>2</sub> is used, durability of the piston is maintained.

**[0005]** [Patent Document 1] JP, A, 2009-68695

**[0006]** In the flow path switching valve of the patent document 1, a circular slope portion is provided around a packing of the piston. A sectional shape of the slope portion is gradually closer to an inner wall of the valve housing as the slope portion extends to an end of the valve housing. Then, while the main valve chamber is in a high pressure, and the sub valve chamber is in a low pressure, when the pressures of the main valve chamber and the sub valve chamber are equalized after the second valve body blocks the exhaust pipe, the high pressure refrigerant at the main valve chamber leaks into the

sub valve chamber from a space between the slope portion of the packing and the inner wall of the valve housing. Therefore, there is a problem that it is difficult to smoothly equalize the pressure between the main valve chamber and the sub valve chamber. This also applies for the valves shown in US-2976701 and US-4966194.

**[0007]** An object of the present invention is to solve the above-described problem, and to surely equalize the pressure between the main valve chamber and the sub valve chamber after the main valve body is moved, and improve the durability of the piston, in the flow path switching valve receiving two pistons and the main valve body in a joint manner in the tubular valve housing for switching the flow path of the refrigerant passing through a plurality of pipes by sliding the main valve body relative to the valve seat due to the differential pressure of the refrigerant between the main valve chamber inside the piston and the sub valve chamber outside the piston.

#### Summary of the Invention

**[0008]** In order to attain the object, according to the present invention, there is provided a flow path switching valve for switching a flow of a refrigerant receiving two pistons joined together in a tubular valve housing disposed on an axial line of the valve housing, said two pistons partitioning the valve housing into a center main valve chamber to which a high pressure pipe is connected and two sub valve chambers at both sides of the main valve chamber, wherein a main valve seat connected to a low pressure pipe and two switching pipes is disposed in the main valve chamber, and a main valve body slidable in the axial direction relative to the main valve seat is connected to the piston, wherein by introducing a high pressure refrigerant into any one of the two sub valve chambers, and by reducing a pressure of the other sub valve chamber, the piston and the main valve body are moved to the sub valve chamber side due to a differential pressure between the sub valve chamber of which pressure is reduced and the main valve chamber, whereby with a concave portion of the valve body, the low pressure pipe alternatively communicates with any one of the two switching pipes, and the other switching pipe communicates with the high pressure pipe via the main valve chamber to switch the flow of the refrigerant, wherein sub valve seats projected toward the main valve chamber and in which an exhaust path for the refrigerant is opened in the valve housing are formed at both ends of the valve housing, wherein a pressure equalizing path for communicating the main valve chamber with the sub valve chamber is formed on the axial line corresponding to the sub valve seat, and a sub valve is arranged in the pressure equalizing path for switching open/close of the pressure equalizing path by moving the sub valve in an axial line direction relative to the pressure equalizing path, and

wherein when the piston finishes moving to the sub valve chamber of which pressure is reduced, the sub valve of the piston closes an opening of the sub valve seat at the sub valve chamber side, and the sub valve seat abuts on the sub valve to open the pressure equalizing path, thereby the pressures between the sub valve chamber of which pressure is reduced and the main valve chamber is equalized via the pressure equalizing path.

**[0009]** Preferably, the piston includes a packing contacting an inner wall of the valve housing, and a sloped portion extending circularly at the center of the valve housing is formed on an outer periphery of the packing. Further, a sectional shape of the sloped portion is gradually closer to the inner wall of the valve housing as the sloped portion extends toward the center of the valve housing.

#### Effect of the invention

**[0010]** According to the flow path switching valve of the present invention, when the piston finishes moving to the sub valve chamber of which pressure is reduced, the sub valve of the piston closes the opening of the sub valve seat at the sub valve chamber side. Therefore, the reduction of the pressure in the sub valve chamber is stopped, and the sub valve seat abuts on the sub valve to open the pressure equalizing path, thereby the refrigerant flows from the main valve chamber to the sub valve chamber via the pressure equalizing path. Thus, the differential pressure between the main valve chamber and the sub valve chamber is equalized smoothly. Thus, because a pressure load acting on a sealing member of the piston is eliminated when the piston is not moved, a creep deformation of the sealing member is prevented. Further, a stress deformation of a member composing the piston is prevented. Accordingly, the flow path switching valve of the present invention is particularly suitable for a super high pressure refrigerant such as CO<sub>2</sub> refrigerant.

**[0011]** According to the preferable flow path switching valve of the present invention, in addition to the effect described above, when the pressure of the sub valve chamber is reduced, the high pressure refrigerant at the main valve chamber presses the sloped portion of the packing of the piston positioned between the pressure-reduced sub valve chamber and the high pressure main valve chamber toward the inner wall of the valve housing. Therefore, this packing can surely seal the pressure-reduced sub valve chamber and the main valve chamber, and the piston and the main valve body is surely moved.

**[0012]** These and other objects, features, and advantages of the present invention will become more apparent upon reading of the following detailed description along with the accompanied drawings.

#### Brief Description of the Drawings

**[0013]**

Fig. 1 is a schematic view showing a flow path switching valve, a pilot valve, and a refrigeration cycle according to an embodiment of the present invention; Fig. 2 is a main part sectional view of the flow path switching valve according to the embodiment;

Figs. 3A, 3B are a main part operation explanatory view of the flow path switching valve according to the embodiment;

Fig. 4 is a main part sectional view of the pilot valve according to the embodiment;

Figs. 5A, 5B are a timing chart showing a driving example of the pilot valve according to the embodiment; and

Fig. 6 is a main part sectional view showing another example of a piston of the flow path switching valve according to the embodiment.

#### Detailed Description of the Preferred Embodiments

**[0014]** Next, an embodiment of the present invention will be explained. Fig. 1 is a schematic view showing a flow path switching valve, a pilot valve, and a refrigeration cycle according to the embodiment. A flow path switching valve 10 of this embodiment is a four way switching valve.

This flow path switching valve 10 is connected to a pilot valve 20 with a pipe. In the flow path switching valve 10, a valve housing 1 is a tubular shape, and composed of a cylindrical cylinder 11 and two disk-shaped caps 12, 12. The caps 12, 12 are attached to the cylinder 11 by welding or the like so as to close ends of the cylinder 11. A center axis of the cylinder 11 and the caps 12, 12 is an axis line L1 of the valve housing 1. Thin circular concavities 121 are formed at the cylinder 11 side of the caps 12, 12.

**[0015]** Two pistons 2, 2 disposed on the axis line L of the valve housing 1 and joined together with a joining member 3 are received in the valve housing 1. In this way, an inside of the valve housing 1 composed of an inside of the cylinder 11 and circular concavities 121, 121 of the caps 12, 12 is partitioned by the two pistons 2, 2 into a center main valve chamber 11A and two sub valve chambers 12A, 12A disposed at both sides of the main valve chamber 11A.

**[0016]** A main valve seat 4 is disposed at the center of the main valve chamber 11A, and a main valve body 5 sliding in the axis line L1 direction of the valve housing 1 is disposed on the main valve seat 4. E port 4a, S port 4b, and C port 4c arranged in a straight line in the axis line L1 direction of the valve housing 1 are formed in the main valve seat 4. E joint pipe 13a, S joint pipe 13b, C joint pipe 13c are respectively attached to E port 4a, S port 4b, and C port 4c. Further, D port 11a is formed at a position facing the main valve seat 4 disposed at the center of the cylinder 11. D joint pipe 13d is attached to D port 11a. Incidentally, E joint pipe 13a and C joint pipe 13c correspond to a switching pipe, S joint pipe 13b corresponds to a low pressure pipe, and D joint pipe 13d corresponds to a high pressure pipe. In this way, the main

valve chamber 11A is connected to D joint pipe 13d as the high pressure pipe, and the main valve seat 4 is connected to the low pressure pipe and two switching pipes.

**[0017]** A valve body fitting hole 3a is formed at the center of the joining member 3, and transparent holes 3b, 3c are formed at both sides of the valve body fitting hole 3a. The main valve body 5 is fitted into the valve body fitting hole 3a, and held with a little play in the axial line L direction relative to the joining member 3. When the pistons 2, 2 are moved, the main valve body 5 is slid on the main valve seat 4 together with the joining member 3 and stopped at one of predetermined left or right positions.

**[0018]** The main valve body 5 is made by insert-molding a bowl-shaped metal plate 51 with a resin-made member 52. A main valve concavity 5A is formed on an inside of the metal plate 51. The main valve body 5 communicates the S port 4b and the E port 4a via the main valve concavity 5A at a left end position shown in Fig. 1. At this time, the C port 4c is communicated with the D port 11a mainly via the transparent hole 3c in the main valve chamber 11A. Further, the main valve body 5 communicates the S port 4b and the C port 4c via the main valve concavity 5A at a right end position in Fig. 1. At this time, the E port 4a is communicated with the D port 11a mainly via the transparent hole 3b in the main valve chamber 11A.

**[0019]** The S joint pipe 13b is connected to an inlet of a compressor 30 via a low pressure pipe 14a, and the D joint pipe 13d is connected to an outlet of the compressor 30 via a high pressure pipe 14b. The C joint pipe 13c is connected to an indoor unit 50 via a pipe 14c, and the E joint pipe 13a is connected to an outdoor unit 40 via a pipe 14d. The outdoor unit 40 and the indoor unit 50 are connected to each other with a pipe 14e via a throttle unit 60. The refrigeration cycle is formed by a route composed of the C joint pipe 13c, the outdoor unit 40, the throttle unit 60, the indoor unit 50, and the E joint pipe 13a, and by a route composed of the S joint pipe 13b, the compressor 30, and the D joint pipe 13d.

**[0020]** Then, the pilot valve 20 switches the position of the main valve body 5 of the flow path switching valve 10 as described later. The high pressure refrigerant compressed by the compressor 30 flows from the D joint pipe 13d via the D port 11a to the main valve chamber 11A, and in a cooling operation of Fig. 1, the high pressure refrigerant flows from the C port 4c to the outdoor unit 40. Further, in a heating operation when the main valve body 5 is switched, the high pressure refrigerant flows from the E port 4a to the indoor unit 50. Namely, in the cooling operation, the refrigerant discharged from the compressor 30 is circulated from the C joint pipe 13c via the outdoor unit 40, the throttle unit 60, the indoor unit 50, to the E joint pipe 13a. The outdoor unit 40 works as a condenser, and the indoor unit 50 works as an evaporator to cool the air. Further, in the heating operation, the refrigerant is circulated inversely. The indoor unit 50 works as the condenser, and the outdoor unit 40 works as the evaporator to heat the air.

**[0021]** A sub valve seat 122 projected toward an inside of the cylinder 11 at the center of the circular concavity 121 (on the axial line L1) is formed on each of caps 12, 12. Further, an exhaust path 12a penetrating from a side of the cap 12 to an end 122a of the sub valve seat 122 is formed on each of caps 12, 12. Guiding pipes 15f, 15g are respectively connected to the exhaust paths 12a, 12a.

**[0022]** In Fig. 1, the pilot valve 20 includes two electromagnetic actuators. This pilot valve 20 has a block-shaped valve housing 61, and two plunger cases 62, 62 are air-tightly fixed to the valve housing 61. Further, adsorbers 63, 63 are air-tightly fixed to ends of the plunger cases 62, 62. Further, a plunger 65 is disposed in the plunger cases 12, 12. Electromagnet coils 72, 72 wound around bobbins 71, 71 are disposed on outer peripheries of the adsorbers 63, 63 and the plunger cases 62, 62. When the electromagnet coils 72, 72 are excited, an inner end wall of the adsorber 63 becomes a magnetic adsorption surface relative to the plunger 65.

**[0023]** A high pressure joint pipe 64d, a low pressure joint pipe 64b, and two switching joint pipes 64a, 64c are attached to the valve housing 61. The high pressure joint pipe 64d is connected to the D joint pipe 13d of the four way switching valve 10 by a guiding pipe 14f, and the low pressure joint pipe 64b is connected to the S joint pipe 13b of the four way switching valve 10 by a guiding pipe 14g. Further, the switching joint pipes 64a, 64c are respectively connected to guiding pipes 15f, 15g of the four way switching valve 10. Incidentally, the high pressure joint pipe 64d, the low pressure joint pipe 64b, the switching joint pipes 64a, 64c, and the guiding pipes 14f, 14g, 14h, 14i can be made by the same material.

**[0024]** Fig. 4 is a sectional view showing in detail a main part of the pilot valve 20. A cylindrical pilot valve chamber 61A is formed in the valve housing 61. The plunger cases 62, 62 are fitted into both ends of the pilot valve chamber 61A coaxially with an axial line L2. The plunger cases 62, 62 are a cylindrical shape. Further, a pilot valve seat 66 is attached between the plunger cases 62, 62 in the pilot valve chamber 61A. A pilot valve body 67 sliding in an axial line L2 direction is provided on the pilot valve seat 66. A pilot switching port 61a, a pilot low pressure port 61b, and a pilot switching port 61c are arranged in a line in the axial line L2 direction in the pilot valve seat 66. The switching joint pipe 64a, the low pressure joint pipe 64b, and the switching joint pipe 64c are respectively attached to the pilot switching port 61a, the pilot low pressure port 61b, and the pilot switching port 61c. Further, a pilot high pressure port 61d is formed at a position opposite to the pilot valve seat 66 in the middle of the valve housing 61. The high pressure joint pipe 64d is attached to the pilot high pressure port 61d.

**[0025]** The plunger 65 is disposed in the plunger cases 62, 62 in a manner penetrating the pilot valve chamber 61A. The plunger 65 is in a substantially cylindrical shape, and includes a small diameter portion 651 at the center side, and large diameter portions 652, 652 on both sides

of the small diameter portion 651, and aligned with inner walls of the plunger cases 62, 62. Further, the plunger 65 includes a D-cut surface 65a which is partially cut parallel to the axial line L2. This D-cut surface 65a faces the pilot valve seat 66. A valve body holding hole 65b is drilled from the D-cut surface 65a in the center of the small diameter portion 651. A communicating hole 65c is formed opposite to the D-cut surface 65a from the valve body holding hole 65b. The pilot valve body 67 and a coil spring 68 are disposed in the valve body holding hole 65b.

**[0026]** A pilot concavity 67a is formed on the pilot valve body 67 at the pilot valve seat 66 side. The pilot valve body 67 makes the pilot switching port 61a and the pilot low pressure port 61b communicate with each other via the pilot concavity 67a at a left end position in Fig. 4. At this time, the pilot switching port 61c communicates with the pilot high pressure port 61d via the pilot valve chamber 61A and a circumference of the small diameter portion 651. Further, the pilot valve body 67 makes the pilot switching port 61c and the pilot low pressure port 61b communicate with each other via the pilot concavity 67a at a right end position in Fig. 4. At this time, the pilot switching port 61a communicates with the pilot high pressure port 61d via the pilot valve chamber 61A and a circumference of the small diameter portion 651.

**[0027]** In this manner, in the pilot valve 20, by energizing the electromagnet coil 72, the plunger 65 is adsorbed onto the adsorber 63 to move the pilot valve body 67 straight along the axial line L2. Thus, by switching a condition that the high pressure refrigerant is supplied to the left side sub valve chamber 12A of the four way switching valve 10 from the pilot switching port 61a, and the pressure of the right side sub valve chamber 12A is reduced, and a condition that the high pressure refrigerant is supplied to the right side sub valve chamber 12A of the four way switching valve 10 from the pilot switching port 61c, and the pressure of the left side sub valve chamber 12A is reduced, the flow path of the refrigeration cycle is switched.

**[0028]** Incidentally, the pilot valve body 67 is pressed onto a pilot valve seat 66 by the coil spring 68, thereby a sealing property between the pilot valve body 67 and the pilot valve seat 66 is increased. Further, the pilot valve seat 66 is a metallic member, and the pilot valve body 67 is a resin-made member. Therefore, due to a plastic property of the pilot valve body 67, the sealing property between the pilot valve body 67 and the pilot valve seat 66 is further increased. This high sealing property is effective, in particular, when the super high pressure CO<sub>2</sub> is used as the refrigerant.

**[0029]** Figs. 5A, 5B are a timing chart showing an example of an energizing control to the two electromagnet coils 72, 72. In Fig. 1, the left side electromagnet coil 72 is defined as "coil A", and the right side electromagnet coil 72 is defined as "coil B". As shown in Fig. 5A, when the coil A is energized (ON), the coil B is not energized (OFF). Thereby, the pilot valve body 67 is moved to the left side position (the coil A side). Then, the pilot high

pressure port 61d and the pilot switching port 61c communicate with each other, and the pilot switching port 61a and the pilot low pressure port 61b communicate with each other. Then, even when the coil A is not energized (OFF), the position of the pilot valve body 67 is maintained. Next, while the coil A is not energized, when the coil B is energized (ON), the pilot valve body 67 is moved to the right side position (the coil B side). Then, the pilot high pressure port 61d and the pilot switching port 61a communicate with each other, and the pilot switching port 61c and the pilot low pressure port 61b communicate with each other. Then, even when the coil B is not energized (OFF), the position of the pilot valve body 67 is maintained. Incidentally, as shown in Fig. 5B, after the electromagnet coil 72 is energized to switch the position of the pilot valve body 67, a holding voltage may be applied to the electromagnet coil 72 until the next switching is occurred.

**[0030]** According to the pilot valve 20 of this embodiment, the plunger 65 holding the pilot valve body 67 is disposed in the two plunger cases 62, 62 attached to the valve housing 61. The pilot valve body 67 is slidable on the pilot valve seat 66 connected to a plurality of joint pipes together with the plunger 65 in the axial line L2 direction. The adsorbers 63, 63 are air-tightly fixed to the ends of the plunger cases 62, 62. The electromagnet coils 72, 72 are respectively provided on the outer peripheries of the adsorbers 63, 63 and the plunger cases 62, 62. When any one of the electromagnet coils 72, 72 is energized and the other is not energized, the plunger 65 is adsorbed onto the adsorber 63, thereby the flow paths of the refrigerant in the pipes are switched with the pilot valve body 67.

**[0031]** The pilot valve 20 of this embodiment is superior to, for example, a pilot valve disclosed in JP, A, H08-170865. According to this conventional pilot valve, a pilot valve body is moved to one side by energizing an electromagnetic actuator, and the pilot valve body is moved to the other side by not energizing the electromagnetic actuator, and by a biasing force of a spring. Therefore, because of a high differential pressure of the refrigerant acting on the pilot valve body, when the pilot valve body is moved, a large driving force of the electromagnetic actuator and a large spring force are needed. Further, the spring force blocks the driving force of the electromagnetic actuator, and an efficiency of the adsorbing force is reduced.

**[0032]** On the contrary, according to the pilot valve 20 of this embodiment, the spring is not used, and two facing electromagnet actuators are provided. By switching the two electromagnet actuators reciprocally, the pilot valve body on which high differential pressure acts can be moved without an efficiency reduction due to the spring force, and with small-sized low-cost electromagnetic actuators. Further, when the differential pressure is generated on the pilot valve body, because when the coil is not energized (OFF), the position of the pilot valve body is maintained, a latching mechanism is realized to im-

prove the energy-saving property. Further, according to the conventional pilot valve, when the adsorption force is reduced with a low voltage, a magnetic noise is generated due to a balance between the electromagnetic force and the spring force. However, according to the pilot valve 20 of this embodiment, because the spring is not used, the magnetic noise is reduced.

**[0033]** In this manner, the high pressure refrigerant flowing into the pilot valve 20 from the high pressure joint pipe 64d flows out from the switching joint pipe 64a or 64c. This high pressure refrigerant is supplied to the left or right side sub valve chamber 12A in the four way switching valve 10. At this time, the right or left side sub valve chamber 12A of the flow path switching valve 10 communicates with the low pressure side via the low pressure joint pipe 64b. In this manner, owing to the pilot valve 20, in the four way switching valve 10, one sub valve chamber is in high pressure, and the other sub valve chamber is in low pressure. Incidentally, the high pressure refrigerant is always supplied to the main valve chamber 11A. Therefore, the differential pressure between the low pressure at the sub valve chamber 12A and the high pressure at the main valve chamber 11A acts on the piston 2 at the low pressure sub valve chamber side, and mainly due to this differential pressure, the piston 2 and the main valve body 5 is moved to the low pressure sub valve chamber 12A side to switch the position of the main valve body 5.

**[0034]** Here, in Fig. 1, pistons 2, 2 are mirror symmetrical. Hereinafter, a detailed structure of the right side piston 2 will be explained with reference to Fig. 2. The piston 2 includes a fixed disk 21 fixed to the joining member 3, a flat spring 22, a packing 23, a circular stopper plate 24, a sub valve 25, and a coil spring 26. They are coaxially disposed relative to the axial line L1.

**[0035]** The flat spring 22 is made of an elastically deformable thin metal plate, and integrally includes a circular disk portion 221 and a sloped biasing portion 222. An outer diameter of the disk portion 221 is substantially the same as the fixed disk 21. The sloped biasing portion 222 is formed in a ring shape, and disposed on a whole outer edge of the disk portion 221. The sloped biasing portion 222 is extended from the outer edge of the disk portion 221 toward the center of the cylinder 11 (valve housing 1). Namely, as the sloped biasing portion 222 is extended toward the center of the valve housing 1, a sectional shape of the sloped biasing portion 222 is closer to an inner wall of the valve housing 1. The sloped biasing portion 222 is sloped relative to both the axial line L1 direction and a radial direction.

**[0036]** The packing 23 is made of synthetic resin, and integrally includes a circular disk portion 231 and a sloped portion 232. An outer diameter of the disk portion 231 is substantially the same as the fixed disk 21. The sloped portion 232 is formed in a ring shape, and disposed on a whole outer edge of the disk portion 231. The sloped portion 232 is extended from the outer edge of the disk portion 231 toward the center of the cylinder 11 (valve

housing 1). Namely, as the sloped portion 232 is extended toward the center of the valve housing 1, a sectional shape of the sloped portion 232 is closer to an inner wall of the valve housing 1. The sloped biasing portion 232 is sloped relative to both the axial line L1 direction and the radial direction.

**[0037]** Thus, the flat spring 22 and the packing 23 are formed in the substantially same shape, and the flat spring 22 is disposed inside of the packing 23. By holding the disk portion 221 and the disk portion 231 between the fixed disk 21 and the stopper plate 24, the flat spring 22 and the packing 23 are fixed. The elastically deformable flat spring 22 is slid on the inner wall of the valve housing 1 at an end of the sloped biasing portion 222 away from the disk portion 221 via the sloped portion 232 of the packing 23. Further, an elastically restoring force is generated by the flat spring 22 for biasing the sloped portion 232 of the packing 23 away from the inner wall of the valve housing 1 toward the inner wall of the valve housing 1. Further, in a state that the flat spring 22 is assembled in the valve housing 1 (cylinder 11), the end of the sloped biasing portion 222 away from the disk portion 221 pushes the sloped portion 232 of the packing 23 toward the inner wall of the valve housing 1. Thereby, the packing 23 surely seals the piston 2 on an inner circumference of the cylinder 11 with regard to the high pressure refrigerant in the main valve chamber 11A.

**[0038]** In the each piston 2, circular holes 21a, 22a, 23a, and 24a are respectively formed on the centers of the fixed disk 21, the flat spring 22, the packing 23, and the stopper plate 24. Further, a circular hole 3d is formed at the fixed disk 21 side of the joining member 3, and the circular hole 3d of the joining member 3 communicates with the transparent hole 3b (transparent hole 3c at the right side) via a path 3e. Among them, diameters of the hole 3d of the joining member 3, the hole 21a of the fixed disk 21, the hole 22a of the flat spring 22, and the hole 23a of the packing 23 are substantially the same, and a diameter of the hole 24a of the stopper plate 24 is smaller than them. A pressure equalizing path is composed of these holes 21a, 22a, 23a, 24a, and 3d. The sub valve 25 is disposed with a gap on outer peripheries of the holes 21a, 22a, 23a, 24a, and 3d.

**[0039]** The sub valve 25 is composed of a cylindrical large diameter portion 251, a cylindrical small diameter portion 252, and a cylindrical boss portion 253. The large diameter portion 251 is inserted into the holes 21a, 22a, 23a, and the small diameter portion 252 is inserted into the hole 24a. Further, the coil spring 26 is fitted into the boss portion 253 in the hole 3d of the joining member 3. The sub valve 25 is pushed toward the cap 12 by the coil spring 26. A step end wall 25a is formed between the large diameter portion 251 and the small diameter portion 252.

**[0040]** An operation of the sub valve 25 is described below. When the low pressure is introduced into one sub valve chamber 12A, and the differential pressure is generated between the main valve chamber 11A and the one

sub valve chamber, the whole piston 2 including the sub valve 25 is moved toward the low pressure sub valve chamber (cap 12). Then, when the stopper plate 24 abuts on the cap 12, the piston 2 is stopped. In a process of movement of the piston 2, firstly, an end (small diameter portion 252) of the sub valve 25 contacts the sub valve seat 122. At this time, the exhaust path 12a disposed on the sub valve chamber 12A is closed. Even after the end of the sub valve 25 contacts the sub valve seat 122, the piston 2 is still moved because the differential pressure between the main valve chamber 11A and the sub valve chamber 12A overcomes the biasing force of the coil spring 26. The piston 2 keeps on moving until the stopper plate 24 abuts on the cap 12. In this moving interval, a gap is always generated between the step end wall 25a of the sub valve 25 and the stopper plate 24. Therefore, the refrigerant flows from the main valve chamber 11A to the sub valve chamber 12A via the gap to equalize the pressure. When the pressure in the main valve chamber 11A and the pressure in the 12A are equalized, the piston 2 is stopped at a position where the biasing force of the coil spring 26 and a frictional force between the piston 2 and the inner periphery of the cylinder 11 stay in balance. Incidentally, when the pressure of the opposite sub valve chamber 12A is reduced from this condition, and the piston 2 is removed from the cap 12, due to the biasing force of the coil spring 26, while the sub valve 25 still contacts the sub valve seat 122, the stopper plate 24 abuts on the step end wall 25a. Then, the piston 2 including the sub valve 25 is moved.

**[0041]** Figs. 3A and 3B are an explanatory view for explaining an operation of the sub valve 25 and the pressure equalizing path composed of the holes 21a, 22a, 23a, 24a, 3d. Fig. 3A shows a condition that the sub valve 25 is separated from the sub valve seat 122, and corresponds to a process that the main valve body 5 is moved to the right side in Fig. 1, or a process that the main valve body 5 is moved to the left side from the center of the valve housing 1. At this time, the step end wall 25a of the sub valve 25 abuts on the stopper plate 24, and closes the path between the hole 24a of the stopper plate 24 and the hole 23a of the packing 23 and the hole 21a of the fixed disk 21. Namely, the pressure equalizing path is in a closed condition.

**[0042]** Fig. 3B corresponds to a condition shown in Fig. 2 where the sub valve 25 abuts on the sub valve seat 122. At this time, the small diameter portion 252 of the sub valve 25 closes the exhaust path 12a of the sub valve seat 122, and the stopper plate 24 is separated from the step end wall 25a of the sub valve 25. Thereby, the hole 24a of the stopper plate 24, the hole 23a of the packing 23, the hole 21a of the fixed disk 21, and the hole 3d of the joining member 3 communicate with each other. Namely, the pressure equalizing path is in an open state. Thereby, as shown by a dotted arrow in Fig. 3B, the high pressure refrigerant in the main valve chamber 11A flows into the sub valve chamber 12A via the transparent hole 3b (Fig. 2) of the joining member 3, the path 3e, the hole

3d, the hole 21a of the fixed disk 21, the hole 22a of the flat spring 22, the hole 23a of the packing 23, and the hole 24a of the stopper plate 24. Then, because the exhaust path 12a of the sub valve seat 122 is closed, the pressure in the main valve chamber 11A and the pressure in the sub valve chamber 12A are equalized, and the flow of this refrigerant is stopped.

**[0043]** In this manner, the pressure in the main valve chamber 11A and the pressure in the sub valve chamber 12A are rapidly equalized via the pressure equalizing path. Therefore, a condition where the refrigerant pressure does not affect the packing 23 rapidly comes. According to this embodiment, as the sloped portion 232 of the packing 23 is extended from the outer edge of the disk portion 231 toward the center of the cylinder 11, and the sectional shape of the sloped portion 232 is closer to an inner wall of the valve housing 1. Therefore, the high pressure of the main valve chamber 11A is surely maintained.

**[0044]** Fig. 6 shows another embodiment of the piston, the same elements in Fig. 2 are identified with the same reference numerals, and duplicated explanation is omitted. In this piston 2', a disk-shaped stopper plate 27 is fixed to the joining member 3, and a ring-shaped packing 28 sliding on an inner wall of the cylinder 11 is fitted into an outer periphery of the stopper plate 27. Further, a large hole 27a corresponding to the large diameter portion 251 of the sub valve 25, and a small hole 27b corresponding to the small diameter portion 252 are formed on the center of the stopper plate 27. The sub valve 25 is disposed with a gap in the large hole 27a and the small hole 27b. The large hole 27a and the small hole 27b compose the pressure equalizing path. When the sub valve 25 abuts on the sub valve seat 122, and the stopper plate 27 is moved to abut on the cap 12, during this movement, an end wall between the large hole 27a and the small hole 27b is separated from the step end wall 25a of the sub valve 25 to open the pressure equalizing path. Further, from this condition, when the stopper plate 27 is removed from the cap 12, the stopper plate 27 abuts on the step end wall 25a to close the pressure equalizing path. These operations of the sub valve 25 and the pressure equalizing path are the same as the above described embodiment.

**[0045]** The above described embodiment is particularly efficient when the refrigerant (liquid) is the carbon dioxide which is used in high pressure. However, various refrigerant such as HCFC (Hydrochlorofluorocarbon) or HFC (hydrofluorocarbon) may be used. Further, according to the present invention, a ball shaped valve may be used as the sub valve 25. Further, a flat spring may be used instead of the coil spring 26.

**[0046]** Although the present invention has been fully described by way of example with reference to the accompanying drawings, it is to be understood that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the

present invention hereinafter defined, they should be construed as being included therein.

## Claims

1. A flow path switching valve (10) for switching a flow of a refrigerant receiving two pistons (2, 2) joined together in a tubular valve housing (1) disposed on an axial line of the valve housing, said two pistons (2) partitioning the valve housing (1) into a center main valve chamber (11a) to which a high pressure pipe is connected and two sub valve chambers (12A, 12A) at both sides of the main valve chamber, wherein a main valve seat (4) connected to a low pressure pipe and two switching pipes is disposed in the main valve chamber (1), and a main valve body (5) slidable in the axial direction relative to the main valve seat (4) is connected to the piston (2), wherein by introducing a high pressure refrigerant into any one of the two sub valve chambers (12A), and by reducing a pressure of the other sub valve chamber, the piston (2) and the main valve body (5) are moved to the sub valve chamber (12A) side due to a differential pressure between the sub valve chamber (12A) of which pressure is reduced and the main valve chamber (11A), whereby with a concave portion (5A) of the valve body (5), the low pressure pipe alternatively communicates with any one of the two switching pipes, and the other switching pipe communicates with the high pressure pipe via the main valve chamber (11A) to switch the flow of the refrigerant,

### characterized in that

sub valve seats (122) projected toward the main valve chamber (11A) and in which an exhaust path for the refrigerant is opened in the valve housing (1) are formed at both ends of the valve housing, a pressure equalizing path for communicating the main valve chamber (11A) with the sub valve chamber (12A) is formed on the axial line corresponding to the sub valve seat (122), and a sub valve (25) arranged in the pressure equalizing path for switching open/close of the pressure equalizing path by moving the sub valve (25) in an axial line direction relative to the pressure equalizing path, and when the piston finishes moving to the sub valve chamber (12A) of which pressure is reduced, the sub valve (25) of the piston (2) closes an opening of the sub valve seat (122) at the sub valve chamber side, and the sub valve seat (122) abuts on the sub valve (25) to open the pressure equalizing path, thereby the pressures between the sub valve chamber (12A) of which pressure is reduced and the main valve chamber (11A) is equalized via the pressure equalizing path.

2. The flow path switching valve as claimed in claim 1,

wherein the piston (2) includes a packing (23) contacting an inner wall of the valve housing, and a sloped portion (122) extending circularly at the center of the valve housing is formed on an outer periphery of the packing, and wherein a sectional shape of the sloped portion (222) is gradually closer to the inner wall of the valve housing as the sloped portion extends toward the center of the valve housing (1).

## Patentansprüche

1. Strömungspfadumschaltventil (10) zum Umschalten einer Strömung eines Kältemittels, das zwei Kolben (2, 2) aufnimmt, die in einem rohrförmigen Ventilgehäuse (1) auf einer axialen Linie des Ventilgehäuses angeordnet miteinander verbunden sind, wobei die zwei Kolben das Ventilgehäuse (1) in eine mittlere Hauptventilkammer (11A), mit welcher ein Hochdruckrohr verbunden ist, und zwei Nebenventilkammern (12A, 12A) an beiden Seiten der Hauptventilkammer teilen, wobei ein Hauptventilsitz (4), der mit einem Niederdruckrohr und zwei Umschaltröhren verbunden ist, in der Hauptventilkammer (11A) angeordnet ist, und ein Hauptventilkörper (5), der in der Axialrichtung relativ zu dem Hauptventilsitz (4) verschiebbar ist, mit dem Kolben (2) verbunden ist, wobei durch Einführen eines Hochdruckkältemittels in irgendeine der zwei Nebenventilkammern (12A) und durch Reduzieren eines Druckes der anderen Nebenventilkammer der Kolben (2) und der Hauptventilkörper (5) infolge eines Differenzdruckes zwischen der Nebenventilkammer (12A), von welcher Druck reduziert wird, und der Hauptventilkammer zu der Seite der Nebenventilkammer (12A) bewegt werden, wodurch mit einem konkaven Abschnitt (5A) des Ventilkörpers (5) das Niederdruckrohr wahlweise mit irgendeinem der zwei Umschaltröhre in Verbindung steht, und das andere Umschaltröhr über die Hauptventilkammer (11A) mit dem Hochdruckrohr in Verbindung steht, um die Strömung des Kältemittels umzuschalten,

### dadurch gekennzeichnet, dass

Nebenventilsitze (122), die in Richtung zu der Hauptventilkammer (11A) vorstehen und in welchen ein Auslasspfad für das Kältemittel in dem Ventilgehäuse (1) geöffnet ist, an beiden Enden des Ventilgehäuses ausgebildet sind, ein Druckausgleichspfad zum Verbinden der Hauptventilkammer (11A) mit der Nebenventilkammer (12A) auf der axialen Linie ausgebildet ist, die mit dem Nebenventilsitz (122) korrespondiert, und ein Nebenventil (25) in dem Druckausgleichspfad zum Öffnen/Schließen-Umschalten des Druckausgleichspfades durch Bewegen des Nebenventils

(25) in einer Richtung der axialen Linie relativ zu dem Druckausgleichspfad angeordnet ist, und wenn der Kolben das Bewegen zu der Nebenventilkammer (12A), von welcher Druck reduziert wird, beendet, das Nebenventil (25) des Kolbens (2) eine Öffnung des Nebenventilsitzes (122) an der Seite der Nebenventilkammer schließt, und der Nebenventilsitz (122) an dem Nebenventil (25) anliegt, um den Druckausgleichspfad zu öffnen, wodurch die Drücke zwischen der Nebenventilkammer (12A), von welcher Druck reduziert wird, und der Hauptventilkammer (11A) über den Druckausgleichspfad ausgeglichen werden.

2. Strömungspfadumschaltventil nach Anspruch 1, wobei der Kolben (2) eine Dichtung (23) aufweist, die eine Innenwand des Ventilgehäuses kontaktiert, und ein schräger Abschnitt (222), der sich in der Mitte des Ventilgehäuses kreisförmig erstreckt, an einem Außenumfang der Dichtung ausgebildet ist, und wobei eine Querschnittsform des schrägen Abschnitts (222) allmählich näher an der Innenwand des Ventilgehäuses ist, wie sich der schräge Abschnitt in Richtung zu der Mitte des Ventilgehäuses (1) erstreckt.

## Revendications

1. Vanne de commutation de trajectoire d'écoulement (10) pour commuter un écoulement d'un réfrigérant recevant deux pistons (2, 2) assemblés dans un boîtier de valve tubulaire (1) disposé sur une ligne axiale du boîtier de vanne, lesdits deux pistons (2) divisant le boîtier de vanne (1) en une chambre de vanne principale centrale (11 A) à laquelle un tuyau haute pression est raccordé et en deux chambres de vanne auxiliaire (12A, 12A) des deux côtés de la chambre de vanne principale, dans laquelle un siège de vanne principale (4) raccordé à un tuyau basse pression et à deux tuyaux de commutation est disposé dans la chambre de vanne principale (1) et un corps de vanne principale (5) pouvant coulisser dans la direction axiale par rapport au siège de vanne principale (4) est raccordé au piston (2), dans laquelle en introduisant un réfrigérant haute pression dans l'une quelconque des deux chambres de vanne auxiliaire (12A) et en réduisant une pression de l'autre chambre de vanne auxiliaire, le piston (2) et le corps de vanne principale (5) sont déplacés du côté de la chambre de vanne auxiliaire (12A) en raison d'une pression différentielle entre la chambre de vanne auxiliaire (12A) dont la pression est réduite et la chambre de vanne principale (11A), moyennant quoi avec une partie concave (5A) du corps de vanne (5), le tuyau basse pression communique de manière alternée avec l'un quelconque

des deux tuyaux de commutation et l'autre tuyau de commutation communique avec le tuyau haute pression via la chambre de vanne principale (11A) afin de commuter l'écoulement du réfrigérant,

**caractérisée en ce que :**

les sièges de vanne auxiliaire (122) en saillie vers la chambre de vanne principale (11A) et dans lesquels une trajectoire d'échappement pour le réfrigérant est ouverte dans le boîtier de vanne (1), sont formés aux deux extrémités du boîtier de vanne, une trajectoire d'égalisation de pression pour faire communiquer la chambre de vanne principale (11A) avec la chambre de vanne auxiliaire (12A) est formée sur la ligne axiale correspondant au siège de vanne auxiliaire (122) et une vanne auxiliaire (25) est agencée dans la trajectoire d'égalisation de pression pour ouvrir/fermer par commutation la trajectoire d'égalisation de pression en déplaçant la vanne auxiliaire (25) dans une direction de ligne axiale par rapport à la trajectoire d'égalisation de pression, et lorsque le piston a fini de se déplacer vers la chambre de vanne auxiliaire (12A) dont la pression est réduite, la vanne auxiliaire (25) du piston (2) ferme une ouverture du siège de vanne auxiliaire (122) du côté de la chambre de vanne auxiliaire, et le siège de vanne auxiliaire (122) vient en butée sur la vanne auxiliaire (25) pour ouvrir la trajectoire d'égalisation de pression, ainsi les pressions entre la chambre de vanne auxiliaire (12A) dont la pression est réduite et la chambre de vanne principale (11A) sont égalisées via la trajectoire d'égalisation de pression.

2. Vanne de commutation de trajectoire d'écoulement selon la revendication 1, dans laquelle le piston (2) comprend une garniture d'étanchéité (23) en contact avec une paroi interne du boîtier de vanne, et une partie inclinée (222) s'étendant de manière circulaire au niveau du centre du boîtier de vanne est formée sur une périphérie externe de la garniture d'étanchéité, et dans laquelle une forme transversale de la partie inclinée (222) est progressivement plus proche de la paroi interne du boîtier de vanne au fur et à mesure que la partie inclinée s'étend vers le centre du boîtier de vanne (1).

FIG. 1

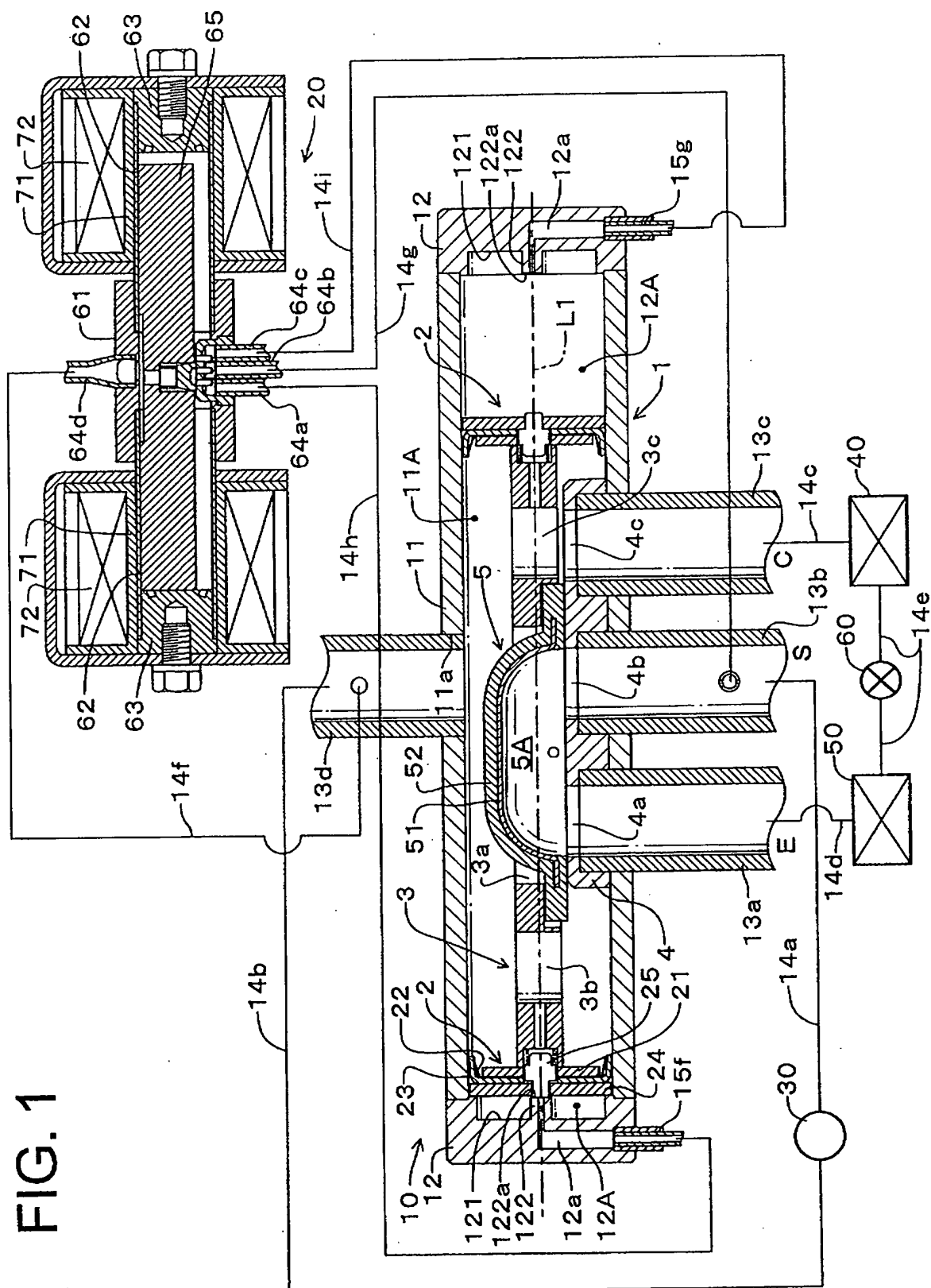


FIG. 2

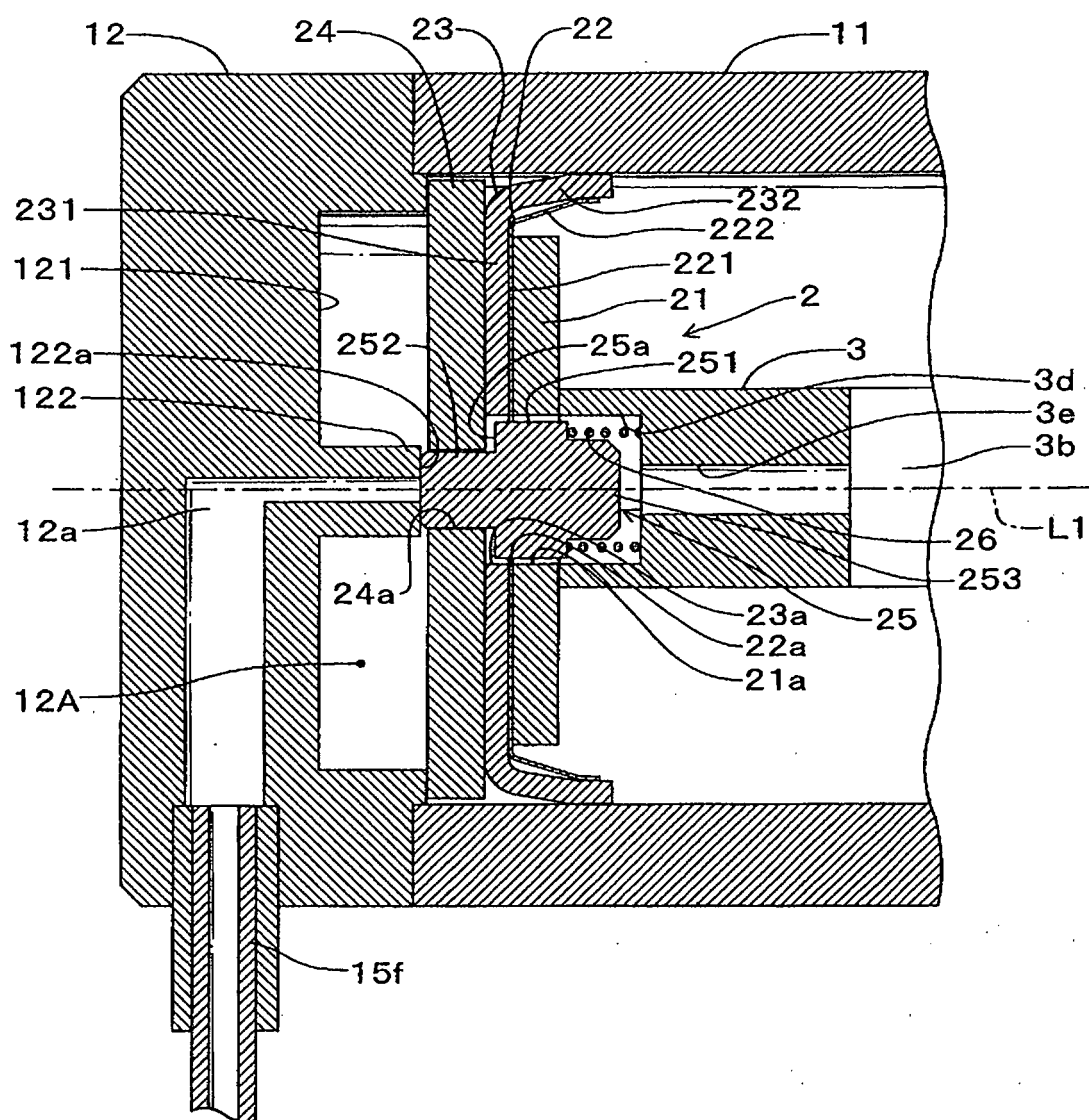


FIG. 3A

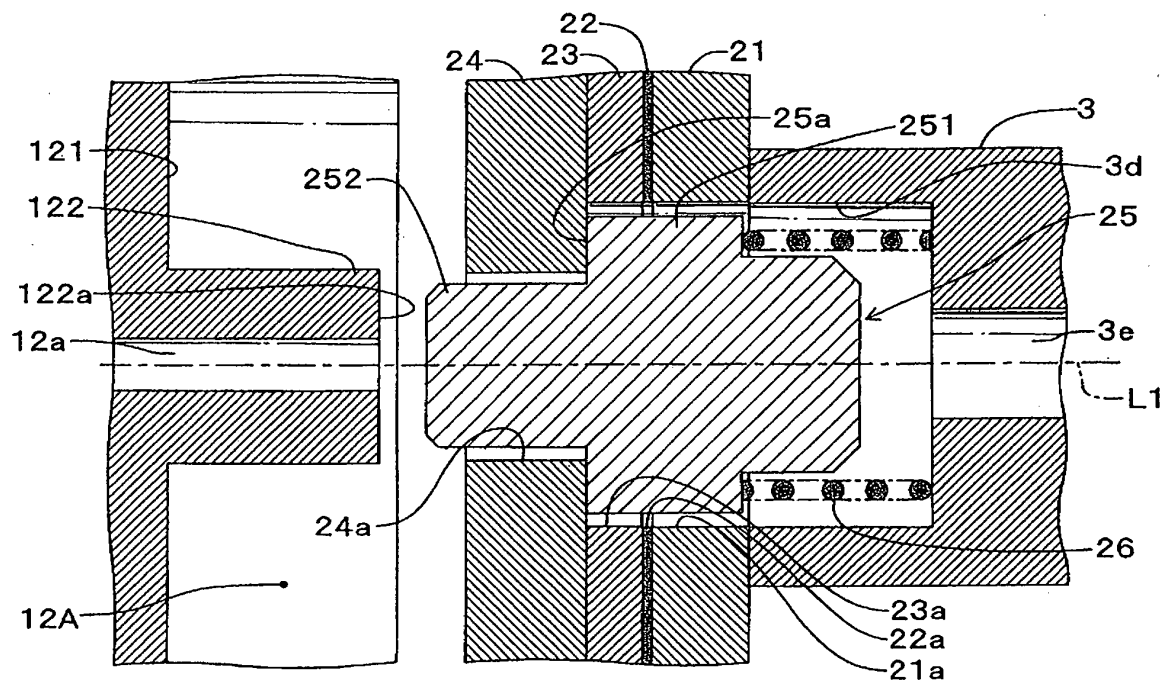


FIG. 3B

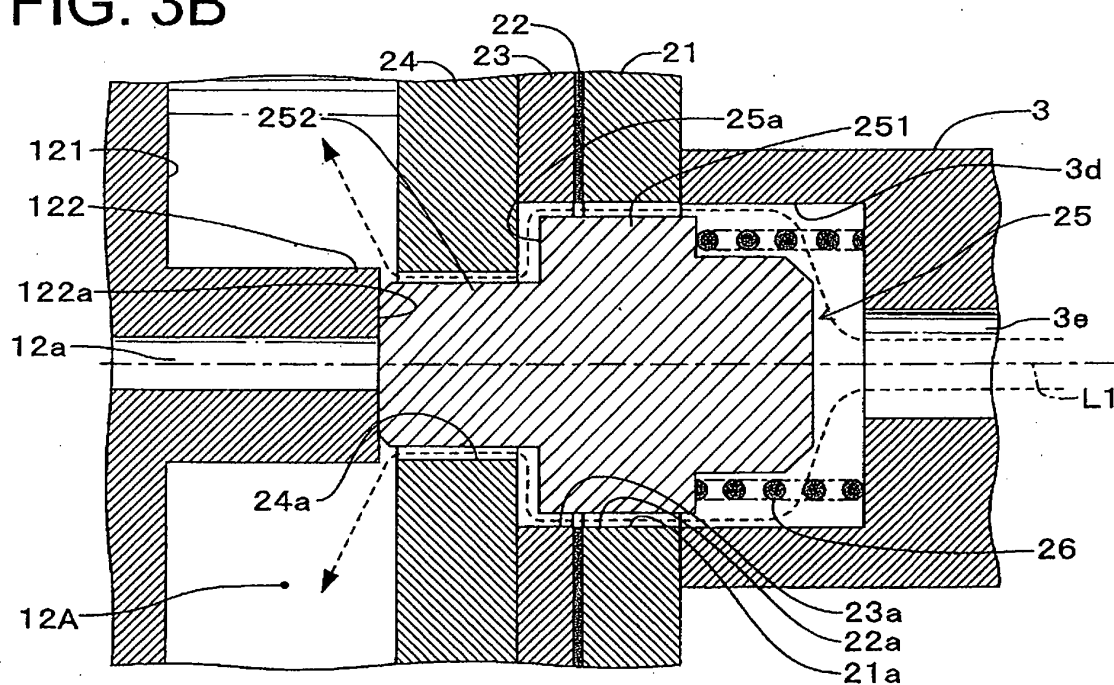


FIG. 4

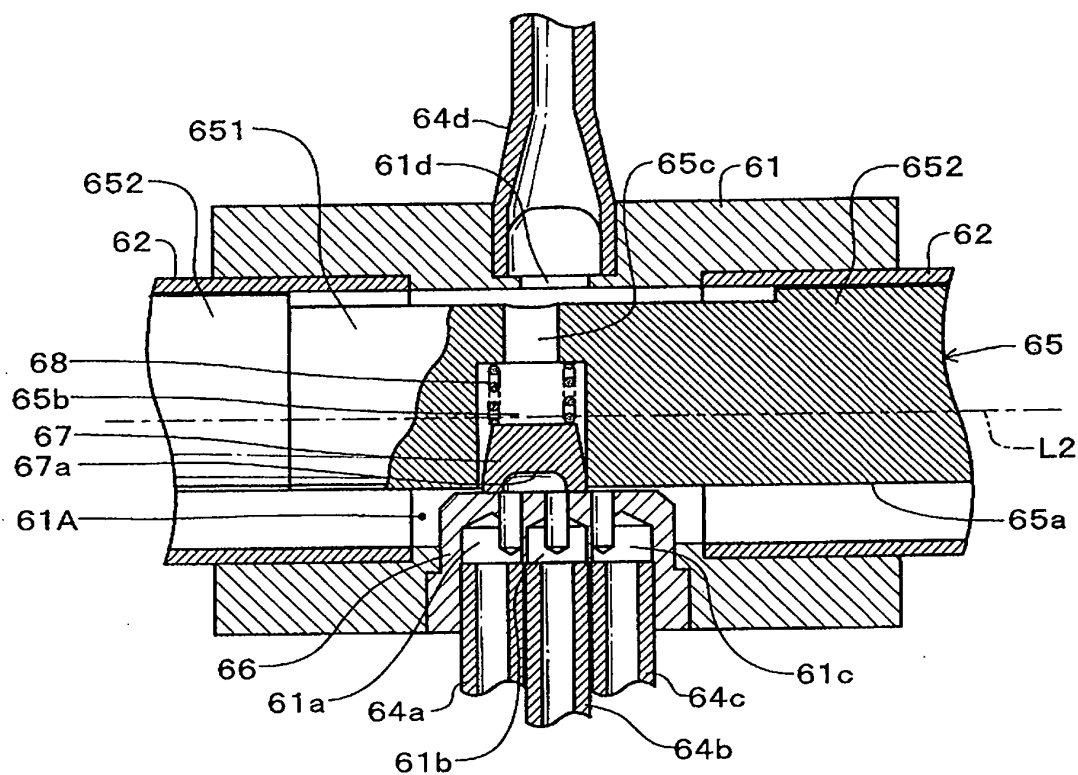


FIG. 5A

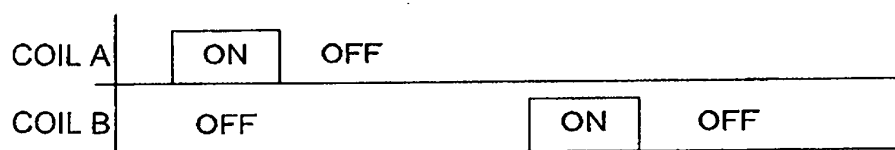


FIG. 5B

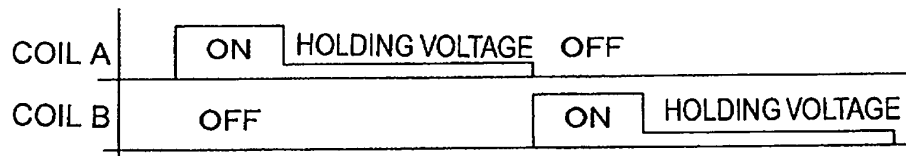
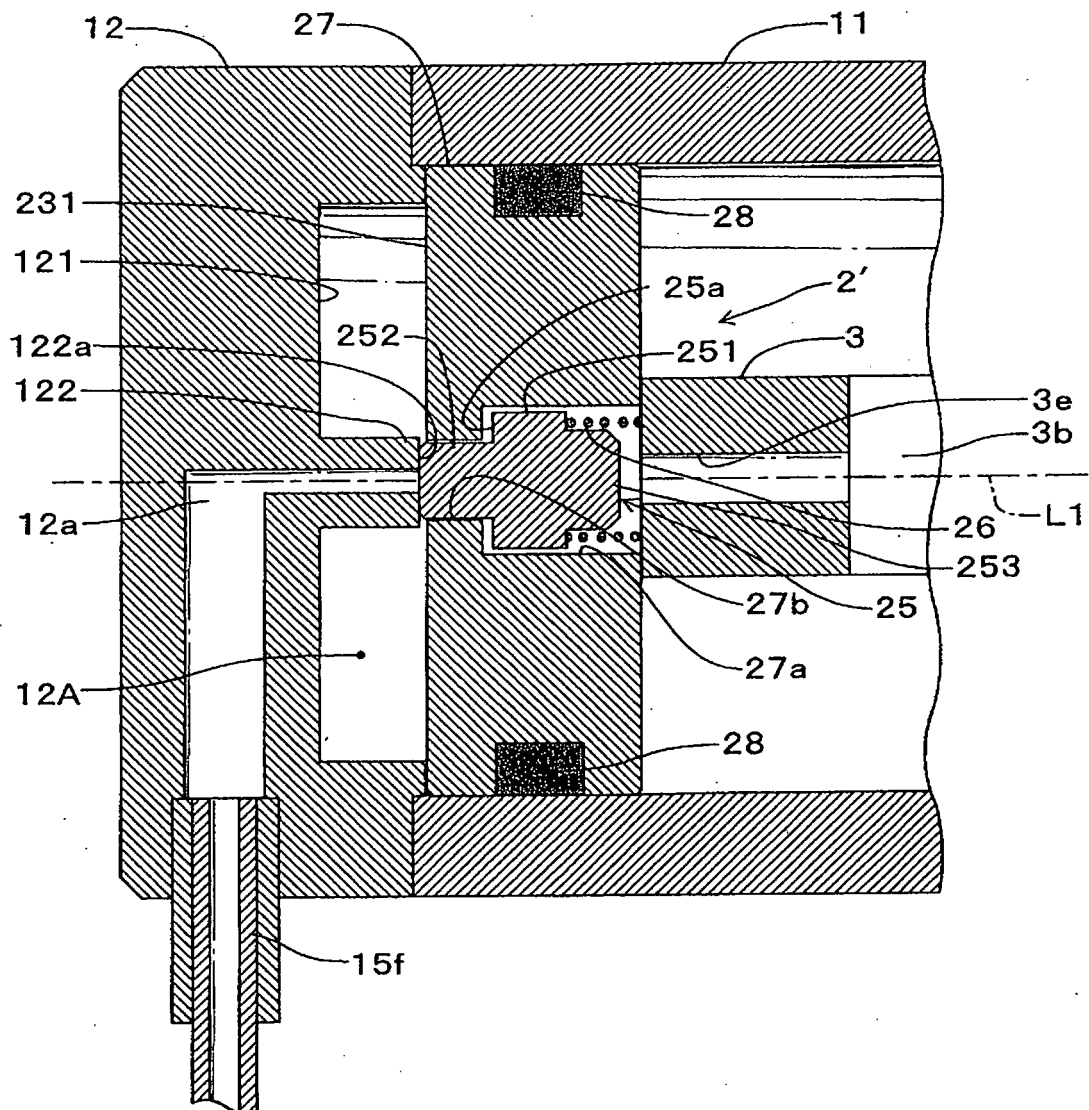


FIG. 6



**REFERENCES CITED IN THE DESCRIPTION**

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