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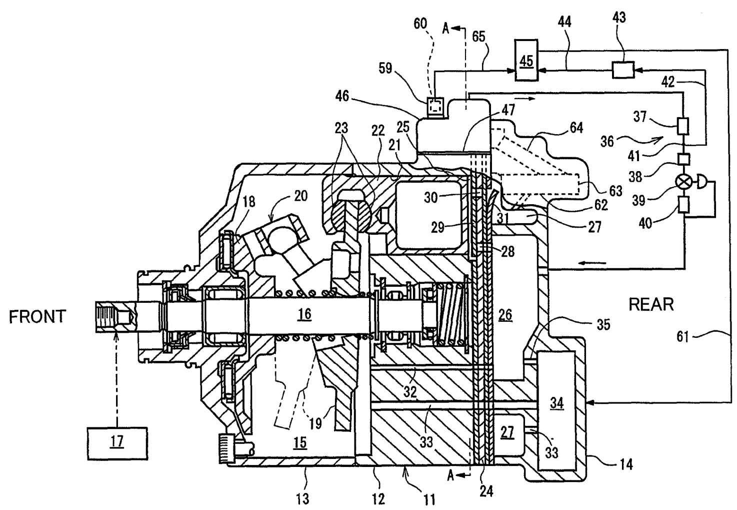
(54) **Variable displacement compressor**

(57) A variable displacement compressor comprises a flange, a movable body, and a detection sensor. The flange is joined to a housing and forms a flange passage for connecting a refrigerant passage and an external refrigerant circuit. The movable body is movably disposed in the flange, is movable according to a flow rate of refrigerant gas in the flange passage, and has a magnet. The detection sensor is fixed to or in the flange for detecting magnetic flux density of the magnet. The flow rate of the refrigerant gas is detected based on the magnetic flux density detected by the detection sensor. The flange is attachable to and detachable from the housing in a state where the flange is provided with the movable body and the detection sensor.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a variable displacement compressor which includes a body movable in response to a change of flow rate of refrigerant gas and which detects magnetic flux density of a magnet in the body, thereby detecting the flow rate of refrigerant.

[0002] There has been known a variable displacement compressor (hereinafter referred to merely as compressor) in which the inclination angle of a swash plate is varied by adjusting the opening degree of a displacement control valve, thus the displacement of the compressor being changed.

[0003] In a conventional compressor, however, a flow rate changing command is merely sent in controlling and changing the displacement, and actual displacement cannot be known. As the displacement is changed, the power of the compressor is varied, but it is estimated by a calculated value based on a flow rate command value.

[0004] Thus, the actual displacement is different from the calculated value until the displacement reaches the commanded value after the flow rate changing command has been sent. Especially, when the compressor compresses gas at start-up of a vehicle engine, the above difference is increased. Thus, it takes a longer time for the vehicle interior temperature to reach desired level, and a greater load acts on the vehicle engine. Namely, appropriate control is hard to perform under this situation (cf. Japanese Patent Application Publication No. 2002-332962).

[0005] If the flow rate of the refrigerant gas in the compressor is accurately detected, the actual displacement and the actual power of the compressor can be known, which is very useful. For the above purpose, an electric flow meter which is disclosed in Japanese Utility Model Application Publication No. 63-177715 may be used for detecting the flow rate of the refrigerant gas.

[0006] Japanese Utility Model Application Publication No. 63-177715 discloses in FIG. 1 thereof an electric flow meter or an area flow meter including a main body, a float (or a movable body), and a guide which is provided to the main body above the float. A magnet is fixed to the float through a rod which is provided on the upper surface of the float. As the float is moved vertically, the magnet is moved vertically in the guide. The magnetic field of the magnet is formed perpendicularly to the film of a Hall element (or a detection sensor) which is provided adjacent to the outer wall of the guide. The magnet is moved in parallel with the film of the Hall element. The Hall element is connected to a controller.

[0007] Japanese Utility Model Application Publication No. 63-177715 also discloses in FIG. 2 thereof an electric flow meter including a differential-pressure detector which is connected to high-pressure and low-pressure introducing passages which are provided on the front and back sides of an orifice in a flow passage, respectively. The inside of the detector is divided into two spaces hermetically by a bellophragm (or a movable body). Pressures in the flow passage on the front and back sides of the orifice are introduced through the introducing passages into the divided two space on both sides of the bellophragm, and a magnet which is provided on the bellophragm is moved by the differential pressure therebetween. A Hall element (or a detection sensor) is provided perpendicularly to the direction in which the magnet is moved, and the magnetic pole of the magnet faces the Hall element. The Hall element is connected to a controller.

[0008] Even in the case of applying the electric flow meter of Japanese Utility Model Application Publication No. 63-177715 to a compressor, dimensional accuracy of elements for detecting flow rate varies. Thus, accuracy of detecting flow rate is varied in each compressor. For enhancing accuracy of flow rate detection, sufficient refrigerant gas may be made to flow in the compressor having the electric flow meter, and then the positions of the magnet and the Hall element may be adjusted and the Hall element may be calibrated.

[0009] When the electric flow meter of Japanese Utility Model Application Publication No. 63-177715 is applied merely to a compressor, however, refrigerant gas is made to flow in the compressor and the elements for detecting flow rate are adjusted and calibrated in a state where the movable body and the detection sensor are installed in the housing of the compressor. Such processes are troublesome and cannot be automated. In actual production site for mass-producing compressors, a process of making refrigerant gas flow in each compressor increases cost and production time. Thus, the process is impossible to carry out in the actual production site.

[0010] The present invention which is made in view of the above problems is directed to a variable displacement compressor including elements for detecting flow rate which are adjusted and calibrated easier than conventional ones.

SUMMARY OF THE INVENTION

[0011] An aspect in accordance with the present invention provides a variable displacement compressor which comprises a housing, a refrigerant passage, a piston, a swash plate, a flange, a movable body, and a detection sensor. A housing has a cylinder bore and a crank chamber. The refrigerant passage is formed in the housing and includes a suction-pressure region and a discharge-pressure region. The piston is disposed in the cylinder bore. The swash plate is disposed in the crank chamber. An inclination angle of the swash plate is controlled according to differential pressure between a pressure in the crank chamber and a pressure in the cylinder bore across the piston, and the pressure in the crank chamber is adjusted through a supply passage for supplying the pressure in the discharge-pressure region to the crank chamber and a bleed passage for releasing the pressure in the crank chamber to the suction-pressure region. The flange is joined to the housing and forms a flange passage for connecting the refrigerant passage and an external refrigerant circuit. The movable body is movably disposed in the flange, is movable according to a flow rate of refrigerant gas in the flange passage, and has a magnet. The detection sensor is fixed to or in the flange for detecting magnetic flux density of the magnet. The flow rate of the refrigerant gas is detected based on the magnetic flux density detected by the detection sensor, and the flange is attachable to and detachable from the housing in a state where the flange is provided with the movable body and the detection sensor.

[0012] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

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

FIG. 2 is a cross-sectional view taken along the line A-A in FIG. 1;

FIG. 3 is a partially enlarged cross-sectional view of a flow meter of the first preferred embodiment when a spool is located its uppermost position;

FIG. 4 is a partially enlarged cross-sectional view of a flow meter of the first preferred embodiment when the spool is located its lowermost position;

FIG. 5 is views showing adjustment and calibration of the flow meter; and

FIG. 6 is a partially enlarged cross-sectional view of a flow meter of a second preferred embodiment according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] The following will describe a variable displacement compressor (hereinafter referred to merely as compressor) of a first preferred embodiment according to the present invention with reference to FIGS. 1 through 5. FIG. 1 shows a schematic view of the compressor. Referring to FIG. 1, the compressor has a housing 11 including a cylinder block 12, a front housing 13 and a rear housing 14. The front housing 13 is joined to the front end of the cylinder block 12. The rear housing 14 is joined to the rear end of the cylinder block 12. In FIG. 1, the left and right sides correspond to the front and rear sides, respectively.

[0015] The cylinder block 12 and the front housing 13 cooperate to define a crank chamber 15 in the housing 11. A drive shaft 16 is rotatably disposed in the crank chamber 15. The drive shaft 16 is operatively connected to an engine 17 which is mounted in a vehicle for rotation with the engine 17. In the first preferred embodiment, the power of the engine 17 is constantly transmitted to the drive shaft 16. In other words, the compressor is of a clutchless type.

[0016] A lug plate 18 is fixed on the drive shaft 16 for rotation therewith in the crank chamber 15. A swash plate 19 is accommodated in the crank chamber 15. The swash plate 19 is provided and supported on the drive shaft 16 with an inclination angle so that the swash plate 19 is inclinable relative to the axis of the drive shaft 16 and also slidable relative to the drive shaft 16. A hinge mechanism 20 is disposed between the lug plate 18 and the swash plate 19, allowing the swash plate 19 to rotate with the lug plate 18 and the drive shaft 16 and to incline relative to the axis of the drive shaft 16. The inclination angle of the swash plate 19 is controlled by a displacement control valve 34 which will be described later.

[0017] A plurality of cylinder bores 21 are formed in the cylinder block 12 (only one being shown in FIG. 1). A single-headed piston 22 is reciprocally disposed in each of the cylinder bores 21. Each piston 22 is engaged with the outer peripheral portion of the swash plate 19 through a pair of shoes 23. Thus, the rotation of the swash plate 19 by the rotation of the drive shaft 16 is converted into reciprocating movement of the pistons 22 through the shoes 23.

[0018] A valve-port assembly 24 is interposed between the cylinder block 12 and the rear housing 14, and compression chambers 25 are defined in the cylinder bores 8 on the back side (the right side in FIG. 1) thereof by the pistons 22 and the valve-port assembly 24. A suction chamber 26 as a suction-pressure region of the compressor and a discharge chamber 27 as a discharge-pressure region of the compressor are defined in the rear housing 14.

[0019] As the piston 22 moves from its top dead center toward its bottom dead center, refrigerant gas in the suction chamber 26 is drawn into the compression chamber 25 through a suction port 28 and a suction valve 29 which are formed in the valve-port assembly 24. As the piston 22 moves from its bottom dead center toward its top dead center, the refrigerant drawn in the compression chamber 25 is compressed to a predetermined pressure and discharged into the discharge chamber 27 through a discharge port 30 and a discharge valve 31 which are formed in the valve-port assembly 24.

[0020] A bleed passage 32 which connects the crank chamber 15 to the suction chamber 26 are formed in the cylinder block 12 and the valve-port assembly 24 for releasing the pressure in the crank chamber 15 to the suction chamber 26. A supply passage 33 which connects the discharge chamber 27 to the crank chamber 15 is formed in the rear housing 14, the valve-port assembly 24 and the cylinder block 12 for supplying the pressure in the discharge chamber 27 to the crank chamber 15. The displacement control valve 34 is arranged in the supply passage 33 in the rear housing 14.

[0021] The displacement control valve 34 is connected to the suction chamber 26 through a first pressure-introducing passage 35, and the opening degree of the displacement control valve 34 is adjusted based on the pressure in the suction chamber 26. The pressure in the crank chamber 15 depends on the balance between the amount of high-pressure refrigerant gas introduced from the discharge chamber 27 into the crank chamber 15 through the supply passage 33 and the amount of the refrigerant gas flowing out from the crank chamber 15 into the suction chamber 26 through the bleed passage 32. The balance is controlled by adjusting the opening degree of the displacement control valve 34 of the displacement control valve 34. The difference between the pressure in the cylinder bore 21 and the pressure in the crank chamber 15 across the piston 22 is changed in response to a change of the pressure in the crank chamber 15, thereby varying the inclination angle of the swash plate 19 relative to the drive shaft 16. Thus, the compressor changes the stroke of the piston 22 and hence its displacement.

[0022] As the pressure in the crank chamber 15 falls, the inclination angle of the swash plate 19 is increased thereby to increase the displacement of the compressor. The swash plate 19 indicated by the two-dot chain line in FIG. 1 is inclined at its maximum inclination angle in contact with the lug plate 18. On the other hand, as the pressure in the crank chamber 15 rises, the inclination angle of the swash plate 19 is decreased thereby to reduce the displacement of the compressor. The swash plate 19 indicated by the solid line in FIG. 1 is inclined at its minimum inclination angle.

[0023] The refrigerant circuit (or refrigeration cycle) of a vehicle air-conditioner includes the compressor and an external refrigerant circuit 36 which connects the discharge chamber 27 to the suction chamber 26. Carbon dioxide or chlorofluorocarbon is used as refrigerant. The external refrigerant circuit 36 includes a condenser 37, a receiver tank 38, an expansion valve 39 and an evaporator 40 which are arranged in this order as viewed from the discharge chamber 27 toward the suction chamber 26. A pressure sensor 41 is arranged in the refrigerant passage which connects the condenser 37 to the receiver tank 38 and adapted to send out electrical detection signals to an amplifier 45 through a connecting line 42, a data inputting means 43 and a connecting line 44. The amplifier 45 transmits a displacement-changing command signal to the displacement control valve 34 through a connection line 61 for controlling the displacement control valve 34. The amplifier 45 stores therein data concerning the flow rate of the refrigerant gas which is sent from a magnetic sensor 60 which will be described later, various information such as vehicle interior temperature provided from the data inputting means 43, and data of the pressure of the refrigerant gas transmitted from the pressure sensor 41. Further, the amplifier 45 is connected to an engine controller (not shown).

[0024] A flow meter which is shown in detail in FIGS. 2 through 4 is provided on the upper surface of the cylinder block 12. More specifically, the flow meter is provided to a flange 46 which is joined to the upper surface of the cylinder block 12. The flange 46 includes a movable body or a spool 53 which is disposed in the flange 46, a coil spring 56 as an urging member for urging the spool 53, and the magnetic sensor 60 which is fixed to the surface of the flange 46.

[0025] The flange 46 is formed of a metal and detachably joined to the cylinder block 12 by bolts (not shown). A gasket 47 as a heat insulating member is interposed between the flange 46 and the cylinder block 12. The gasket 47 is formed of a heat insulating material such as rubber or resin so that heat of the housing 11 is hard to transmit to the flange 46.

[0026] A flange passage is formed in the flange 46 when the flange 46 is joined to the cylinder block 12. As shown in FIG. 2, the flange passage includes high-pressure and low-pressure spaces 48a and 48b which is connected to each other through a throttle 52 which is formed by a partition 46a of the flange 46, a flow passage 51 which is in communication with the low-pressure space 48b, an accommodation chamber 49 which is in communication with the low-pressure space 48b, and a communication passage 50 which connects the high-pressure space 48a to the accommodation chamber 49. The high-pressure and low-pressure spaces 48a and 48b are located upstream of and downstream of the throttle 52, respectively. The spool 53 is disposed in the accommodation chamber 49 so as to slide therein for a predetermined distance.

[0027] Still referring to FIG. 2, the spool 53 is formed in a cylindrical shape having an upper large-diameter portion 54 and a lower small-diameter portion 55. A clearance is formed between the lower small-diameter portion 55 and the inner wall of the accommodation chamber 49, and the coil spring 56 is provided in the clearance for urging the spool 53 upward. The coil spring 56 has a predetermined spring constant so that the spool 53 is located at any predetermined position when the spool 53 receives differential pressure which will be described later. A magnet 57 is embedded in the upper large-diameter portion 54 of the spool 53. The outer diameter of the upper large-diameter portion 54 substantially corresponds to the inner diameter of the accommodation chamber 49, and a minute clearance is formed between the upper large-diameter portion 54 of the spool 53 and the accommodation chamber 49 with such a width that allows sliding movement of the spool 53. An engaging member 58 having a hole is mounted to the lower end of the accommodation chamber 49 for supporting the lower ends of the lower small-diameter portion 55 and the coil spring 56 and preventing the spool 53 and the coil spring 56 from falling out of the accommodation chamber 49. The upper end surface of the upper large-diameter portion 54 is a pressure receiving surface which receives the pressure in the high-pressure space 48a, and the lower end surface of the lower small-diameter portion 55 is a pressure receiving surface which receives the pressure in the low-pressure space 48b.

[0028] The magnetic sensor 60 as a detection sensor is fixed to the upper surface of the flange 46 through a mounting member 59 in facing relation to the magnet 57 of the spool 53 for detecting magnetic flux density of the magnet 57. The magnetic sensor 60 is spaced at a predetermined clearance from the flange 46 for preventing the heat of the housing 11 from being transmitted directly to the magnetic sensor 60. Further, the mounting member 59 is formed of a heat insulating material such as rubber or resin for preventing heat of the flange 46 from being transmitted to the magnetic sensor 60 therethrough.

[0029] The magnetic sensor 60 is connected to the amplifier 45 through a connecting line 65. The amplifier 45 recognizes that the differential pressure between the high-pressure and low-pressure spaces 48a and 48b is small based on the output from the magnetic sensor 60 when the magnet 57 is close to the magnetic sensor 60. The amplifier 45 recognizes that the differential pressure between the high-pressure and low-pressure spaces 48a and 48b is large based on the output from the magnetic sensor 60 when the magnet 57 is distant from the magnetic sensor 60. As shown in FIG. 1, the high-pressure space 48a formed in the flnage46 is in communication with the discharge chamber 27 through discharge passages 62 through 64 which are formed in the rear housing 14. Thus, high-pressure refrigerant gas is supplied from the discharge chamber 27 into the high-pressure space 48a. As shown in FIG. 2, holes 67 are formed in the cylinder block 12 for inserting therethrough bolts for joining the cylinder block 12 and the front and rear housings 13 and 14.

[0030] As constructed above, the high-pressure refrigerant gas which is supplied into the high-pressure space 48a flows into the low-pressure space 48b through the throttle 52 under a reduced pressure. The high-pressure refrigerant gas in the high-pressure space 48a is also introduced into the accommodation chamber 49 through the communication passage 50. The pressure of the high-pressure refrigerant gas in the high-pressure space 48a is received by the upper end surface of the upper large-diameter portion 54 while the pressure of the low-pressure refrigerant gas in the low-pressure space 48b is received by the lower end surface of the lower small-diameter portion 55, thus differential pressure therebetween acting on the spool 53. The spool 53 is moved vertically by the differential pressure, accordingly. When the displacement is changed by the displacement control valve 34, the amount of the refrigerant gas being discharged from the discharge chamber 27 is also changed. Thus, the differential pressure acting on the spool 53 is varied, and the spool 53 is moved upward or downward in response to the differential pressure. As the displacement is increased, the differential pressure is increased to move the spool 53 downward in FIG. 3. In FIG. 4, the spool 53 is located at its lowermost position when the displacement is maximum.

[0031] As the spool 53 is moved in response to the differential pressure, magnetic flux density of the magnet 57 with respect to the magnetic sensor 60 is changed. The flow rate of refrigerant gas is known based on the magnetic flux density which is detected by the magnetic sensor 60. The amplifier 45 calculates the current displacement of the compressor based on the data of the flow rate of refrigerant gas which is obtained from the magnetic sensor 60 and performs feedback control of the displacement control valve 34. Thus, the displacement of the compressor can be appropriately controlled. In addition, torque of the compressor can be calculated based on the data of the flow rate of refrigerant gas which is obtained from the magnetic sensor 60. Thus, the amplifier 45 performs feedback control of the engine controller in response to the flow rate. Thus, the vehicle engine speed can be appropriately controlled.

[0032] The following will describe adjustment and calibration of the flow meter of the compressor of the first preferred embodiment. In the first preferred embodiment, the flange 46 is provided with the spool 53, the coil spring 56, the engaging member 58, the magnetic sensor 60, and the mounting member 59. Thus, elements for detecting flow rate do not have to be adjusted and calibrated in a state where the flange 46 is mounted to the housing 11 of the compressor. For example, the flange 46 is detached from the compressor, and mounted to a regulator T for the flow meter as shown in FIG. 5. The regulator T forms a test passage which is similar to the flange passage of the compressor. Refrigerant gas required for adjustment and calibration is made to flow in the regulator T and the flange 46, and the output of the magnetic sensor 60 is confirmed according to the flow rate of the refrigerant gas. If the flow rate of refrigerant gas based on the output of the magnetic sensor 60 is different from the actual flow rate of the refrigerant gas flowing in the regulator T and the flange 46, adjustment and calibration are performed on the elements for detecting flow rate.

[0033] The adjustment includes adjusting the position of the magnetic sensor 60 with respect to the mounting member 59, adjusting the urging force of the coil spring 56, and adjusting the position of the magnet 57 with respect to the spool 53. The calibration includes calibrating the output of the magnetic sensor 60. In mass-producing compressors, the flange 46 does not have to be mounted to each compressor when the adjustment and the calibration are performed using the regulator T.

[0034] The compressor of the first preferred embodiment offers the following advantageous effects.

(1) The flange 46 is provided with the spool 53, the coil spring 56, the engaging member 58, the magnetic sensor 60 and the mounting member 59 which form the flow meter. When the flange 46 is handled independently of the housing 11 of the compressor, each element of the flow meter does not have to be adjusted and calibrated in a state where the flange 46 is mounted to the housing 11 of the compressor. Thus, the adjustment and the calibration of the elements of the flow meter of the compressor can be performed easier than those in the conventional compressor.

(2) In production process, the flange 46 which is provided with the elements for detecting flow rate is handled independently of the housing 11 of the compressor. Thus, the adjustment and the calibration of the elements for detecting flow rate can be automated.

(3) The gasket 47 which is formed of the heat insulating material is interposed between the flange 46 and the housing 11, so that the heat of the housing 11 is hard to transmit to the flange 46. As a result, adverse effects of heat on the magnetic sensor 60 is suppressed. In addition, the mounting member 59 which holds the magnetic sensor 60 is formed of the heat insulating material, and the magnetic sensor 60 is spaced at the predetermined clearance from the flange 46. Thus, heat transmission from the housing 11 to the magnetic sensor 60 is suppressed further.

[0035] The following will describe a compressor of a second preferred embodiment with reference to FIG. 6. The second preferred embodiment differs from the first preferred embodiment in structure of mounting the magnetic sensor to the flange. The basic structure of the second preferred embodiment is similar to that of the first preferred embodiment, and, therefore, the description for the identical components will not be reiterated.

[0036] Referring to FIG. 6, a flange 71 has a flange passage including a high-pressure chamber 72, a communication passage 74, a flow passage 75, and a branch passage 76 which is in communication with an accommodation chamber 73 which is formed in the flange 71 and connected to the communication passage 74. The flange 71 has a space 85 which is formed above the accommodation chamber 73, and a magnetic sensor 84 is disposed in the space 85 through a mounting member 83 which is formed of a heat insulating material. A C-ring 82 is disposed in the space 85 below the mounting member 83 for preventing the mounting member 83 and the magnetic sensor 84 from falling out of the space 85. A movable body or a spool 77 is disposed in the accommodation chamber 73 and has an upper small-diameter portion 78, a lower large-diameter portion 79, and a magnet 81. The spool 77 is urged by a coil spring 80 downwardly into the communication passage 74. When differential pressure does not act on the spool 77, the spool 77 is in contact with the lower portion of the inner wall of the communication passage 74. The amplifier recognizes that the differential pressure between the high-pressure chamber 72 and the flow passage 75 is large based on the output from the magnetic sensor 60 when the magnet 57 is close to the magnetic sensor 60. The amplifier recognizes that the differential pressure between the high-pressure chamber 72 and the flow passage 75 is small based on the output from the magnetic sensor 60 when the magnet 57 is distant from the magnetic sensor 60. The second preferred embodiment offers the same advantageous effects as the first

preferred embodiment.

[0037] The present invention is not limited to the first through fourth preferred embodiments described above, but it may be practiced in various alternative embodiments, as exemplified below.

[0038] In the first and second preferred embodiments described above, the movable body is slid or moved vertically. Alternatively, the movable body may be slid or moved in any direction such as width direction or longitudinal direction of the compressor. In such a case, the direction in which the movable body is slid or moved may be set as a direction corresponding to the position where the flange is mounted to the housing or may be set irrespective of the mounted position of the flange.

[0039] In the first and second preferred embodiments described above, the flow rate of refrigerant gas on the discharge side is detected. Alternatively, the flow rate of refrigerant gas on the suction side may be detected. For example, a flange is disposed between the suction chamber of the compressor and the external refrigerant circuit, and provided with a movable body, a magnetic sensor and the like for detecting the flow rate of refrigerant gas on the suction side.

[0040] In the first and second preferred embodiments described above, the throttle is provided in the flange passage, the differential pressure between pressures upstream of and downstream of the throttle is detected by the detection sensor. Alternatively, the detection sensor may be of a check valve type which function as a check valve to open close in response to resistance against fluid in the flange passage.

[0041] In the first and second preferred embodiments described above, the flange is formed of the metal. Alternatively, the flange may be formed of a heat insulating material such as resin or the like. In this case, heat is harder to transmit to the magnetic sensor than the case of using the metal flange. Thus, the materials for the gasket and the mounting member do not have to be limited to the heat insulating materials. Further, the gasket and the mounting member can be removed. In the case of removing the gasket and the mounting member, the magnetic sensor is mounted directly to the flange.

[0042] The first and second preferred embodiments described above show an example of a fixed throttle and an example of a variable throttle using the movable body, respectively. As long as a structure is provided so that the movable body is movable in response to differential pressure, the high-pressure chamber, the communication passage, the flow passage and the branch passage can be changed optionally.

[0043] In the first preferred embodiment described above, the displacement control valve is controlled based on the suction pressure which is introduced through the first pressure-introducing passage. The displacement control valve may be replaced by a control valve which is connected to the external refrigerant circuit through a second pressure-introducing passage and operable to control in response to control signals and differential pressure between two points, or by an ON/OFF electromagnetic valve which is operable to control a valve body by its electromagnetic force.

[0044] Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein but may be modified within the scope of the appended claims.

[0045] A variable displacement compressor comprises a flange, a movable body, and a detection sensor. The flange is joined to a housing and forms a flange passage for connecting a refrigerant passage and an external refrigerant circuit. The movable body is movably disposed in the flange, is movable according to a flow rate of refrigerant gas in the flange passage, and has a magnet. The detection sensor is fixed to or in the flange for detecting magnetic flux density of the magnet. The flow rate of the refrigerant gas is detected based on the magnetic flux density detected by the detection sensor. The flange is attachable to and detachable from the housing in a state where the flange is provided with the movable body and the detection sensor.

Claims

1. A variable displacement compressor comprising:

a housing (11) having a cylinder bore (21) and a crank chamber (15);
a refrigerant passage formed in the housing (11), the refrigerant passage including a suction-pressure region (26) and a discharge-pressure region (27);
a piston (22) disposed in the cylinder bore (21);
a swash plate (19) disposed in the crank chamber (15);
a flange (46, 71) joined to the housing (11), the flange (46, 71) forming a flange passage for connecting the refrigerant passage and an external refrigerant circuit (37);
a movable body (53, 77) movable according to a flow rate of refrigerant gas in the flange passage, the movable body (53, 77) having a magnet (57, 81); and
a detection sensor (60, 84) detecting magnetic flux density of the magnet (57, 81), wherein an inclination angle of the swash plate (19) is controlled according to differential pressure between a pressure in the crank chamber (15) and a pressure in the cylinder bore (21) across the piston (22), the pressure in the crank chamber (15) is adjusted through a supply passage (33) for supplying the pressure in the discharge-pressure region (27) to the crank chamber (15) and a bleed passage (32) for releasing the pressure in the crank chamber (15) to the suction-pressure region (26), and the flow rate of the refrigerant gas is detected based on the magnetic flux density detected by the detection sensor (60, 84),

characterized in that:

the movable body (53, 77) is movably disposed in the flange (46, 71);
in that the detection sensor (60, 84) is fixed to or in the flange (46, 71); and
in that the flange (46, 71) is attachable to and detachable from the housing (11) in a state where the flange (46, 71) is provided with the movable body (53, 77) and the detection sensor (60, 84).

2. The variable displacement compressor according to claim 1, wherein a heat insulating member (47) is provided between the flange (46, 71) and the housing (11).

3. The variable displacement compressor according to claim 2, wherein the heat insulating member (47) is a gasket (47) which is formed of a heat insulating material.

4. The variable displacement compressor according to any one of claims 1 through 3, wherein a throttle (52) is provided in the flange passage, and the movable body (53, 77) is movable by differential pressure between pressures in the flange passage upstream of and downstream of the throttle (52).

5. The variable displacement compressor according to claim 4, wherein the throttle (52) is formed by a partition (46a) of the flange (46, 71).

6. The variable displacement compressor according to any one of claims 1 through 5, wherein the flange passage includes an accommodation chamber (49, 73) for disposing the movable body (53, 77) therein.

7. The variable displacement compressor according to any one of claims 1 through 6, wherein the detection sensor (60, 84) is fixed to the flange (46, 71) through a mounting member (59) so that the detection sensor (60, 84) is spaced at a predetermined clearance from the flange (46, 71).

8. The variable displacement compressor according to claim 7, wherein the mounting member (59) is formed of a heat insulating material.

9. The variable displacement compressor according to any one claims 1 through 6, wherein the detection sensor (60, 84) is fixed in the flange (46, 71) through a mounting member (83).

10. The variable displacement compressor according to claim 9, wherein the mounting member (83) is formed of a heat insulating material.

11. The variable displacement compressor according to any one of claims 1 through 10, wherein the flange (46, 71) is formed of a heat insulating material.

FIG. 1

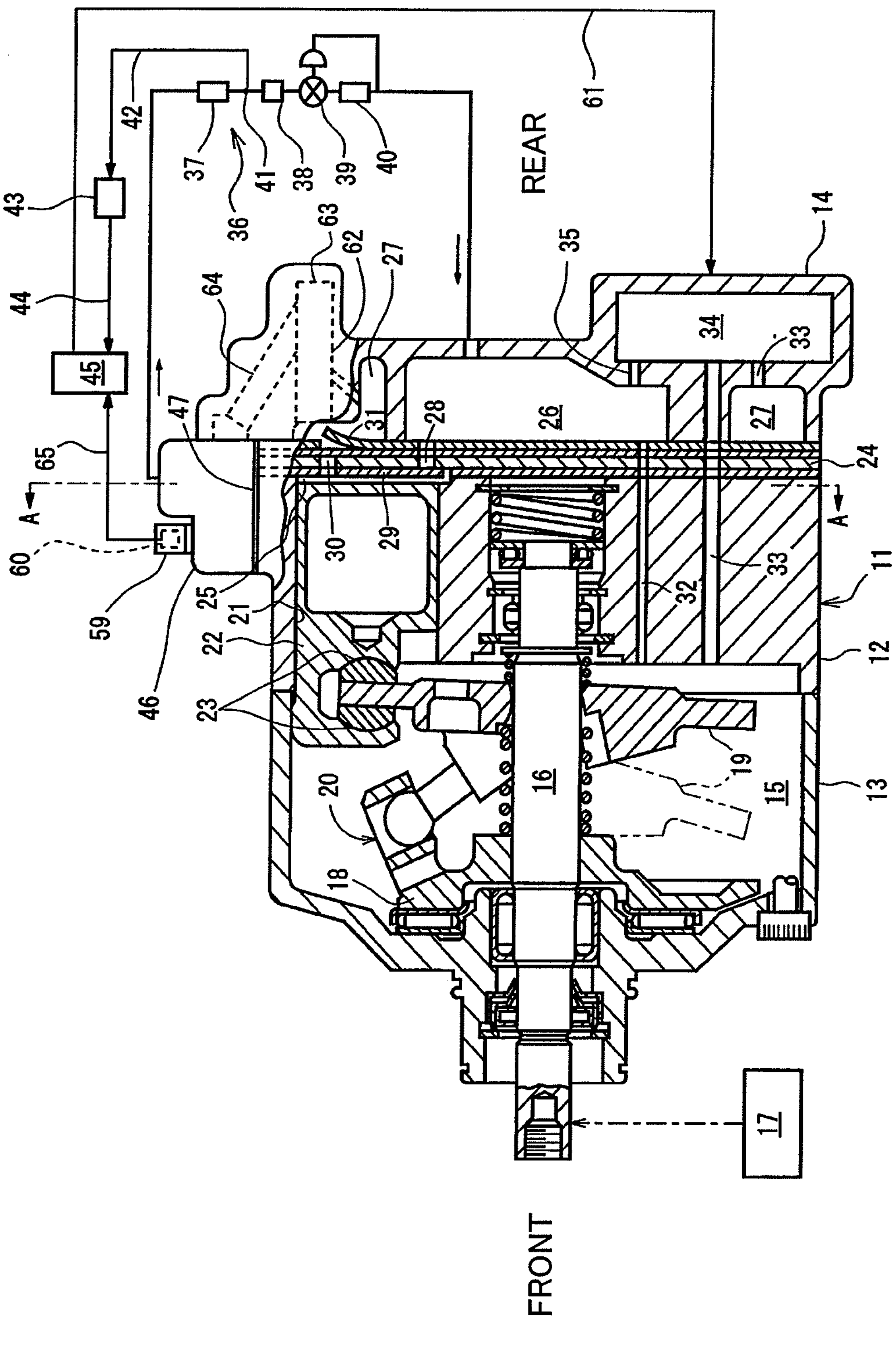
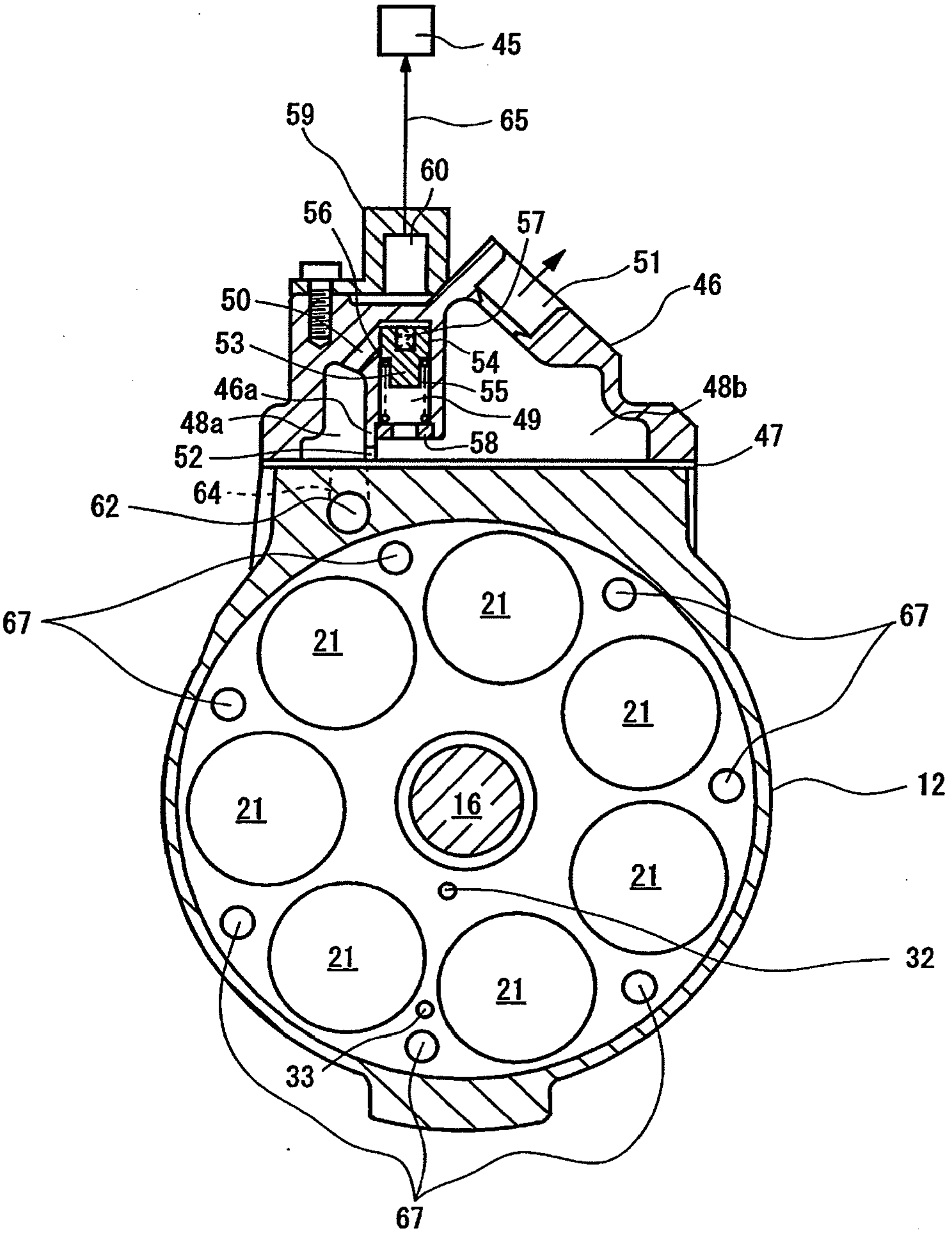


FIG. 2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46a
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48b
48a
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FIG. 3

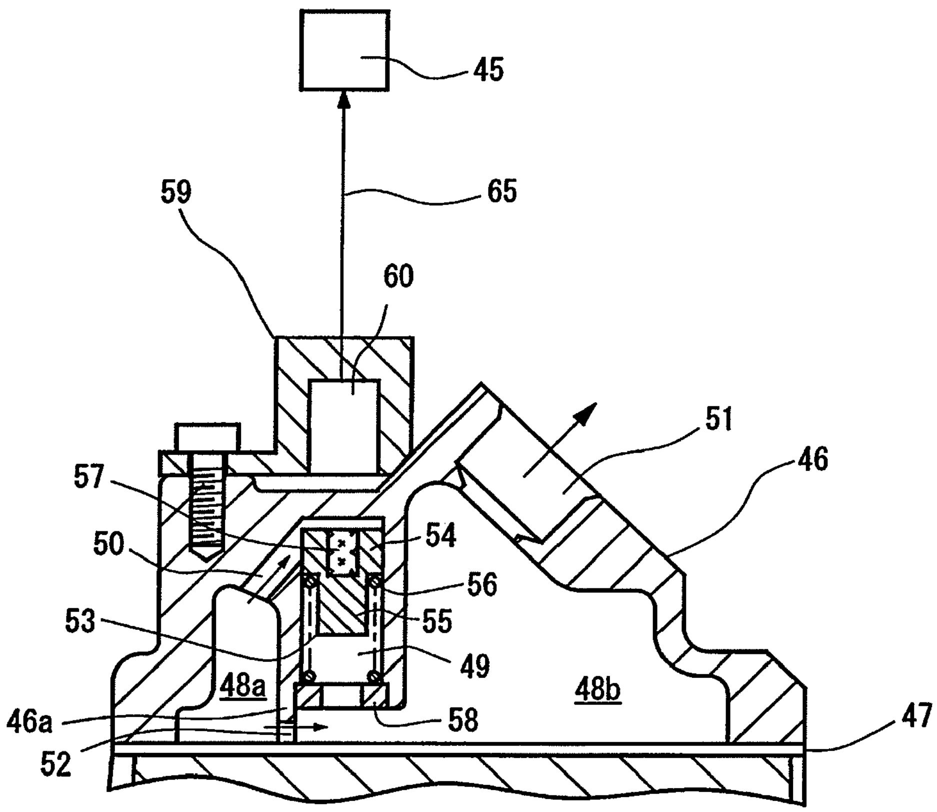

FIG. 4

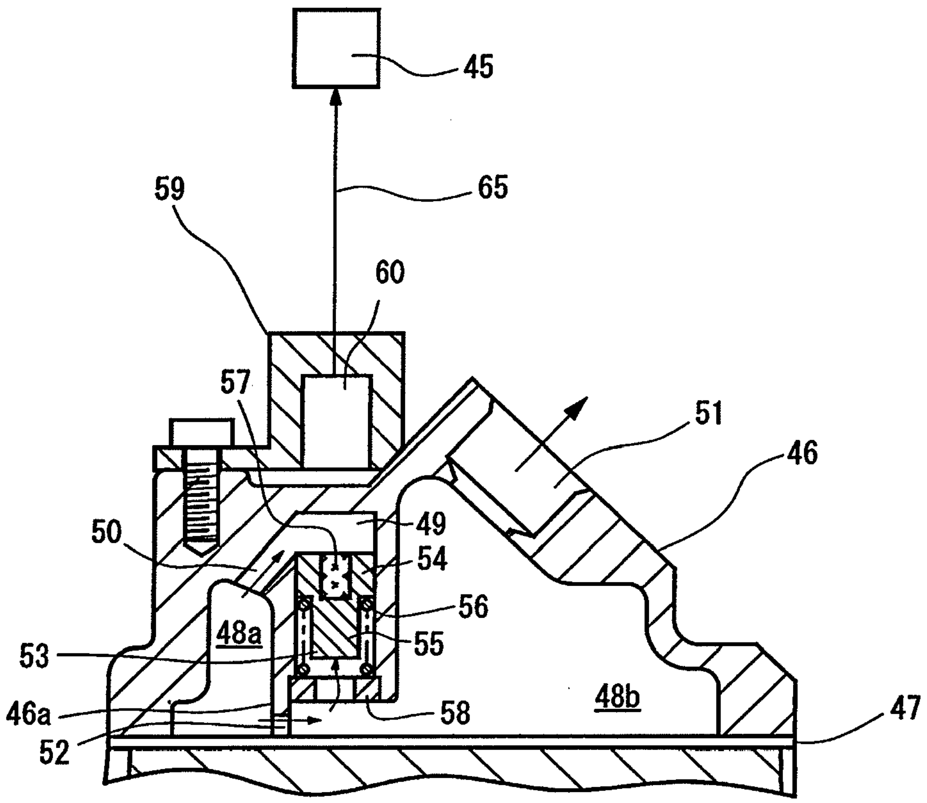

FIG. 5

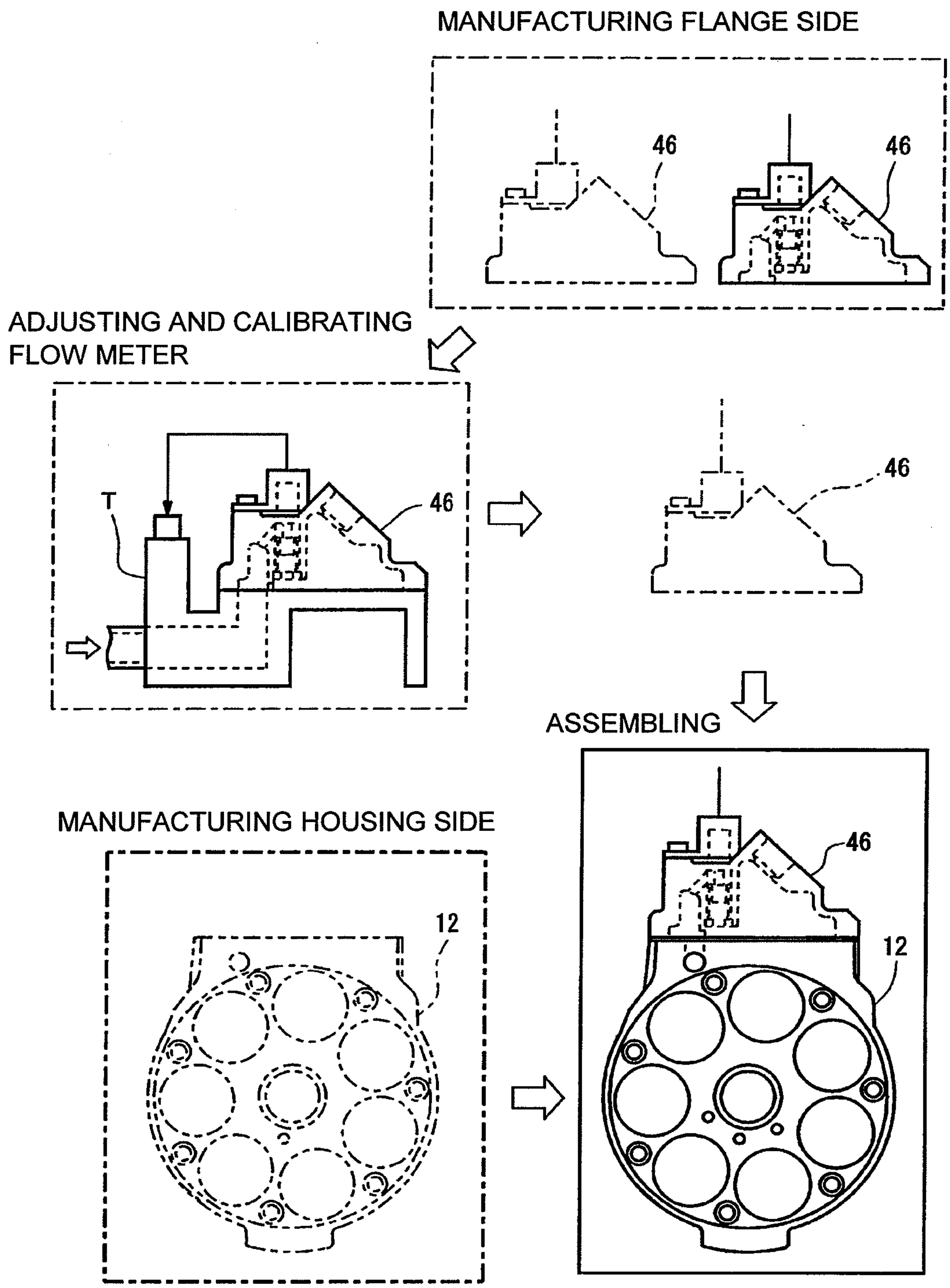
MANUFACTURING FLANGE SIDE
46
46
ADJUSTING AND CALIBRATING FLOW METER
T
46
46
ASSEMBLING
MANUFACTURING HOUSING SIDE
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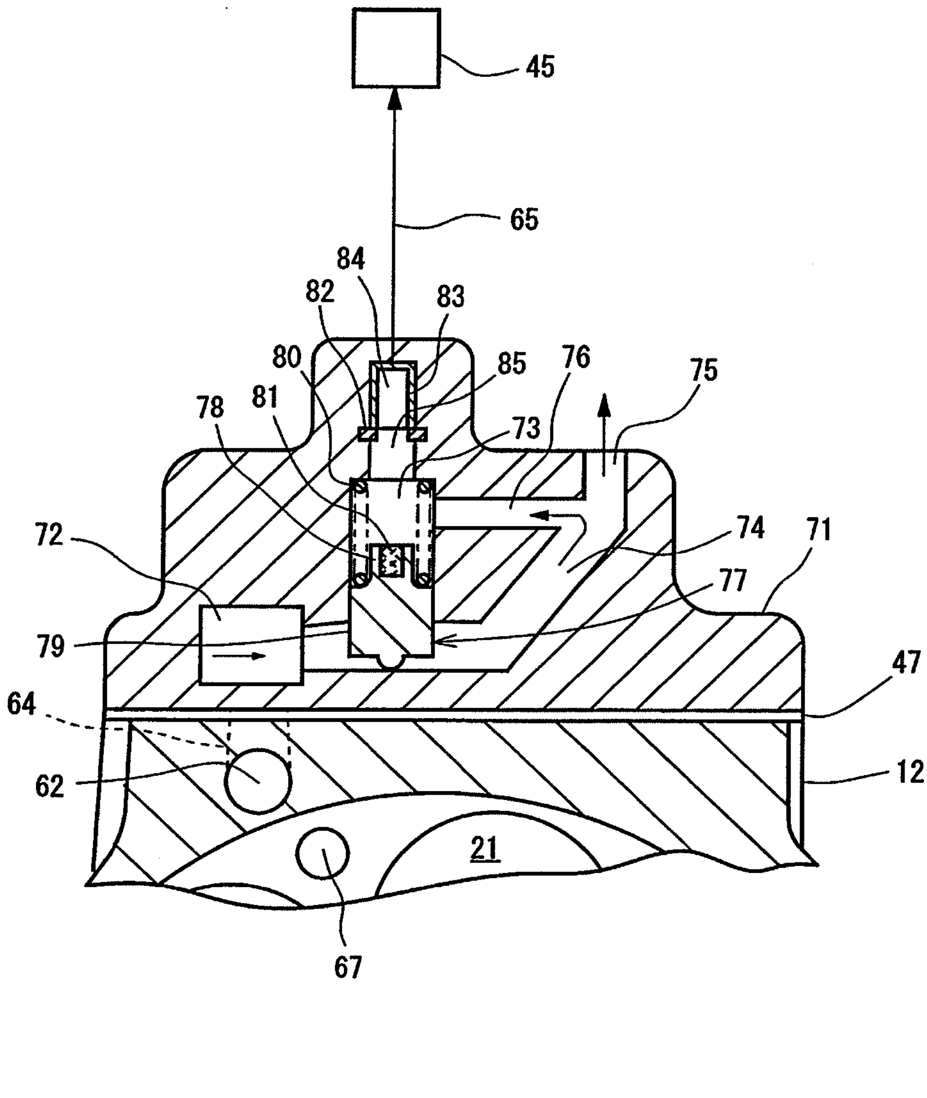
FIG. 6



REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2002332962 A **[0004]**
- JP 63177715 U **[0005] [0006] [0007] [0008] [0009]**