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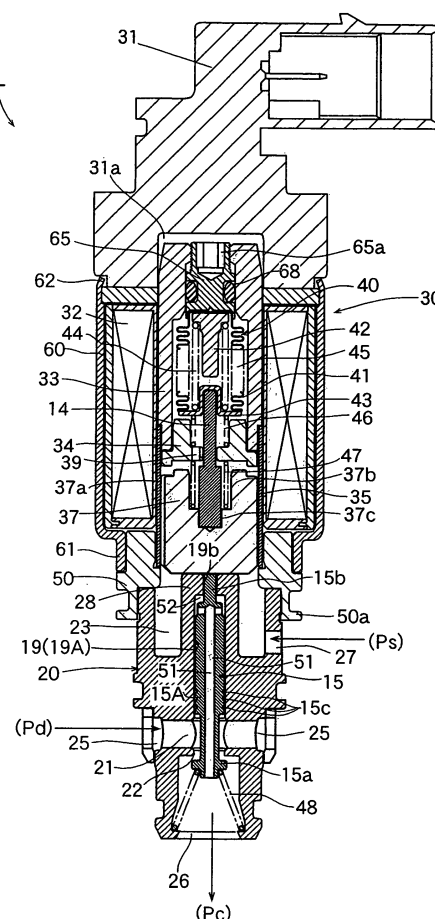
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(54) Control valve for variable capacity compressors

(57) There is provided a control valve for a variable capacity compressor, which is applicable to a compressor of large capacity. This control valve comprises a valve main body (20) equipped with a valve rod (15) having a valve body (15a), with a valve chamber (21) having a guide hole (19) in which the valve rod is enabled to slide and a valve aperture (22) for the valve body, with a cooling medium inlet port (25) disposed on an upstream side of the valve aperture for introducing a cooling medium from the compressor, and with a cooling medium outlet port (26) disposed on a downstream side of the valve aperture and communicated with a crank chamber; an electromagnetic actuator (30) for driving the valve rod to move in the direction of opening or closing the valve aperture; and a pressure sensitive moving member (40) for driving the valve rod to move in response to a sucking pressure of the compressor; which is characterized in that a contracted hole portion is formed at an upper portion of the guide hole, that a diametrically reduced rod portion (15b) to be inserted into the contracted hole portion (19b) is formed at an upper portion of the valve rod, and that the valve rod is provided with an equalizing hole (51) for introducing a cooling medium pressure of the cooling medium outlet port into an equalizing pressure introducing chamber (52).

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a control valve for a variable capacity compressor to be employed in an air conditioner for vehicle. In particular, the present invention relates to a control valve for a variable capacity compressor, which is applicable to a compressor of large capacity while making it possible to share the components employed in the conventional control valves.

2. Description of the Related Art

[0002] A control valve for a variable capacity compressor to be employed in an air conditioner for vehicle is generally constructed as follows. Namely, a cooling medium exhibiting a discharge pressure "Pd" is permitted to enter into the crank chamber of compressor from the discharge chamber of compressor so as to adjust the pressure "Pc" inside the crank chamber. In this case, the flow rate of cooling medium exhibiting a discharge pressure "Pd" to the crank chamber is restricted in such a manner that the quantity of supply (throttling volume) of cooling medium to the crank chamber can be controlled depending on the sucking pressure "Ps" of compressor. For this purpose, various proposals where an electromagnetic actuator (solenoid) is employed have been suggested or put into practice as seen from JP Patent Laid-open Publication (Kokai) No. 2002-303262 (2002).

[0003] FIG. 3 illustrates one example of such a conventional control valve for a variable capacity compressor. The control valve 5 shown herein comprises a valve rod 15' having a valve body 15a; a valve main body 20' provided with a valve chamber 21 having a valve seat (valve aperture) 22 with which the valve body 15a is enabled to retroactively contact, with a plurality of filter (25A)-attached cooling medium-inlet ports 25 for receiving a cooling medium of discharge pressure "Pd" from the compressor, these inlet ports 25 being disposed around the outer circumferential wall of the valve chamber 21 (i.e. an upstream side of the valve seat 22), and with a cooling medium outlet port 26 which is disposed on a downstream side of the valve seat 22 and communicated with a crank chamber of the compressor; an electromagnetic actuator 30.

[0004] This electromagnetic actuator 30 is equipped with a coil 32 having a connector 31 for electroexcitation, with a cylindrical stator 33 disposed on the inner peripheral side of the coil 32, with a sucking member 34 having U-shaped cross-section and press-inserted into a lower inner peripheral end portion of the stator 33, with a flange (35a) -attached pipe 35 which is coupled, through an upper edge portion thereof and by means of TIG welding, to a lower outer circumferential end portion (step portion) of the stator 33, with a plunger 37 slidably disposed so

as to enable it to move up and down inside the guide pipe 35 and placed below the sucking member 34, and with a cylindrical housing 60 with an opening in its bottom and disposed to cover the outer periphery of the coil 32.

[0005] Additionally, a hexagon socket head adjusting screw 65 is screwed on an upper portion of the stator 33. A pressure sensitive chamber 45 into which the sucking pressure "Ps" of compressor is to be introduced is formed between the adjusting screw 65 attached to the inner peripheral wall of stator 33 and the sucking member 34. In this pressure sensitive chamber 45, there is disposed, as a pressure sensitive driving member, a bellows main body 40 consisting of a bellows 41, a downwardly projected upper stopper 42, a reverse U-shaped lower stopper 43 and a compression coil spring 44. Further, a compression coil spring 46 for urging the bellows main body 40 to contract (in the direction to contract it toward the adjusting screw 65) is interposed between the bellows main body 40 and the sucking member 34. Further, a step-attached operating rod 14 piercing through the sucking member 34 is interposed between the reverse U-shaped lower stopper 43 of bellows main body 40 and a U-shaped portion 37c of plunger 37. Additionally, a valve-opening spring 47 made of a compression coil spring for urging the valve rod 15' downward (in the direction to open the valve) by way of the plunger 37 is interposed between the sucking member 34 and the U-shaped portion 37b of plunger 37.

[0006] On the other hand, a convex stopper 28 for regulating the lowermost descending position of the plunger 37 is projected upward from an upper central portion of the valve main body 20'. A guide hole 19 in which the valve rod 15 is slidably inserted is formed at a central portion of valve main body 20' over the valve chamber, this guide hole 19 being formed so as to pierce also through the convex stopper 28. A suction pressure cooling medium-introducing chamber 23 for enabling a cooling medium of suction pressure of the compressor to be introduced therein is formed between the plunger 37 and an upper outer periphery of the valve main body 20' (an outer peripheral wall of the convex stopper 28). A plurality of suction pressure cooling medium-introducing ports 27 are formed in the outer wall of the suction pressure-introducing chamber 23. A cooling medium of sucking pressure "Ps" that has been introduced into the suction pressure cooling medium -introducing chamber 23 from the cooling medium-introducing ports 27 is designed to be introduced into the pressure sensitive chamber 45 via longitudinal grooves 37a formed on the outer peripheral wall of plunger 37, via a through-hole 37d formed at a central axis of plunger 37 and via a through-hole 39 formed in the sucking member 34.

[0007] A valve-closing spring 48 made of a conical compression spring for urging the valve rod 15' upward is disposed at a lower portion (a cooling medium outlet port 26) of the valve main body 20'. By the effect of urging force of this valve-closing spring 48, an upper end portion of the valve rod 15' is always brought into press-contact

with the through-hole 37d portion of plunger 37.

[0008] A lower flange portion 35a of the pipe 35 is mounted, through an O-ring 57, on an upper end of the valve main body 20'. A flange (56a)-attached short cylindrical pipe holder 56 is interposed between the flange portion 35a and the coil 32. These flange portions 35a and 56a are both fixed to each other by means of the upper outer peripheral chamfering portion 29 of the valve main body 20'. An open bottom portion 61 of the housing 60 is press-inserted in an upper end portion of the pipe holder 56. An upper end portion 62 of the housing 60 is calked to the flange portion 31c of the connector 31. An O-ring 66 is interposed between the housing 60 and the connector 31. By the way, at a lower central portion of the connector 31, there is formed a recessed portion 31a in which a projected portion 31b to be engaged with the hexagonal hole of the adjusting screw 65 is formed. An upper portion of the stator 33 as well as an upper portion of the adjusting screw 65 is inserted into this recessed portion 31a.

[0009] In the control valve 5 constructed as described above, when the solenoid portion consisting of the coil 32, the stator 33 and the sucking member 34 is electro-excited, the plunger 37 is drawn toward the sucking member 34, forcing the valve rod 15' to move upward (in the valve-closing direction) by the urging force of the valve-closing spring 48. On the other hand, the cooling medium of suction pressure "Ps" that has been introduced into the suction pressure cooling medium-introducing ports 27 from the compressor is introduced from the suction pressure cooling medium-introducing chamber 23 into the pressure sensitive chamber 45 via longitudinal grooves 37a formed on the outer peripheral wall of plunger 37 and via a through-hole 39 formed in the sucking member 34. As a result, the bellows main body 40 (the interior thereof is kept in vacuum) is caused to displace, i.e. contract or expand depending on the pressure (the suction pressure "Ps") inside the pressure sensitive chamber 45 (when the suction pressure "Ps" is high, the bellows main body 40 is contracted, and when the suction pressure "Ps" is low, the bellows main body 40 is expanded). Then, this displacement is transmitted, via the operating rod 14 and the plunger 37, to the valve rod 15', thereby making it possible to adjust the magnitude of opening of valve (the effective cross-sectional area of passageway between the valve seat 22 and the valve body 15a). Namely, the magnitude of opening of valve will be determined depending on the sucking force of the plunger 37 to be effected by the solenoid portion consisting of the coil 32, the stator 33 and the sucking member 34, on the urging force of the bellows main body 40, and on the urging force of the valve-opening spring 47 and the valve-closing spring 48. Further, depending on this magnitude of opening of valve, the quantity (magnitude of restriction) of cooling medium of discharge pressure "Pd" that has been introduced from the discharge pressure cooling medium inlet port 25 into the valve chamber 21 and that will be delivered toward the outlet port 26,

i.e. toward the crank chamber can be adjusted, thus making it possible to control the pressure (cooling medium feeding pressure) "Pc" inside the crank chamber.

[0010] By the way, it has been tried by the present inventors to develop a control valve which is applicable to a compressor of large capacity while making it possible to share, in order to reduce the manufacturing cost, the components employed in the conventional control valves such as the aforementioned control valve 5 for a variable capacity compressor. However, there are following problems to be overcome in order to make the control valve applicable to a compressor of large capacity.

[0011] Namely, in order to make the control valve applicable to a compressor of large capacity, it is necessary to enlarge the valve aperture 22 so as to increase the flow rate of cooling medium to be fed to the crank chamber of compressor from the cooling medium outlet port 26. However, if the valve aperture 22 is enlarged, the cooling medium outlet port 26 side pressure (cooling medium feeding pressure "Pc" directed toward the crank chamber) acting on the valve rod 15' (valve body 15a) would be increased. In the case of the conventional control valve 5, a difference in pressure (Pc-Ps) between the cooling medium feeding pressure "Pc" and the suction pressure "Ps" (acting on a top surface of the valve rod 15') is so small that this difference is almost negligible in controlling the flow rate. However, when the flow rate of cooling medium is increased by enlarging the valve aperture 22 in order to make the valve applicable to a compressor of large capacity, the influence originating from this difference in pressure between the cooling medium feeding pressure "Pc" and the suction pressure "Ps" is increased, so that if the electromagnetic actuator 30 and the pressure sensitive driving member 40, each being the same in specifications, are employed (shared), the valve rod 15' (valve body 15a) is pushed upward (valve closing direction) due to this difference in pressure, thus giving bad influences on the control of cooling medium flow rate.

[0012] Further, in the case of control valve 5 described above, since the pressure of cooling medium to be introduced into the valve chamber 21 from the discharge pressure cooling medium inlet port 25 (discharge pressure "Pd") is higher than the pressure of cooling medium in the suction pressure cooling medium-introducing chamber 23 (suction pressure "Ps"), part of the cooling medium that has been introduced into the valve chamber 21 is enabled to leak into the suction pressure cooling medium-introducing chamber 23 through a slide-contacting interface between the valve rod 15' and the guide hole 19. As the quantity of this leakage due to this difference (Pd>Ps) is increased, the control of cooling medium would be badly affected. Therefore, it is desirable to minimize the quantity of this leakage due to this difference (Pd>Ps) as much as possible.

BRIEF SUMMARY OF THE INVENTION

[0013] The present invention has been made in view of the circumstances mentioned above and, therefore, an object of the present invention to provide a control valve for a variable capacity compressor, which is applicable to a compressor of large capacity while making it possible to share the components employed in other kinds of control valve.

[0014] With a view to achieving the aforementioned objects, there is provided, according to one aspect of the present invention, a control valve for a variable capacity compressor, which fundamentally comprises a valve main body equipped with a valve rod having a valve body, with a valve chamber having a guide hole in which the valve rod is enabled to slidably insert and a valve aperture with which the valve body can be retractively contacted, with a cooling medium inlet port disposed on an upstream side of the valve aperture for introducing a cooling medium of discharge pressure from the compressor, and with a cooling medium outlet port disposed on a downstream side of the valve aperture and communicated with a crank chamber of the compressor; an electromagnetic actuator for driving the valve rod to move in the direction of opening or closing the valve aperture; and a pressure sensitive moving member for driving the valve rod to move in the direction of opening or closing the valve aperture in response to a sucking pressure of the compressor.

[0015] Further, control valve is characterized in that a contracted hole portion is formed at an upper portion of the guide hole, that a diametrically reduced rod portion which can be slidably inserted into the contracted hole portion is formed at an upper portion of the valve rod, and that the valve rod is provided with an equalizing hole for introducing a cooling medium pressure of the cooling medium outlet port into an equalizing pressure introducing chamber which is interposed between an enlarged hole portion located below the contracted hole portion of the guide hole and a diametrically enlarged rod portion located below the diametrically reduced rod portion of the valve rod.

[0016] In a more preferable embodiment, the control valve for a variable capacity compressor comprises a valve main body equipped with a valve rod having a valve body, with a valve chamber having a guide hole in which the valve rod is enabled to slidably insert and a valve aperture with which the valve body can be retractively contacted, with a cooling medium inlet port disposed on an upstream side of the valve aperture for introducing a cooling medium of discharge pressure from the compressor, and with a cooling medium outlet port disposed on a downstream side of the valve aperture and communicated with a crank chamber of the compressor; an electromagnetic actuator constituted by a coil, a cylindrical stator disposed on the inner peripheral side of the coil, a sucking member secured to the stator, and a plunger disposed below the sucking member and enabled to slide

up and down; a pressure sensitive chamber which is formed on the inner peripheral side of the stator and over the sucking member and to which an inlet pressure is introduced therein from the compressor; a pressure sensitive driving member disposed in the pressure-sensitive chamber; and an operating rod interposed between a pressure sensitive driving member and the plunger; wherein the valve body is designed to be moved in the valve-closing direction as the plunger is moved close to the sucking member and in the valve-opening direction as the operating rod is pushed downward by the actuation of the pressure sensitive driving member; the control valve being further characterized in that a contracted hole portion is formed at an upper portion of the guide hole, that a diametrically reduced rod portion which can be slidably inserted into the contracted hole portion is formed at an upper portion of the valve rod, and that the valve rod is provided with an equalizing hole for introducing a cooling medium pressure of the cooling medium outlet port into an equalizing pressure introducing chamber which is interposed between an enlarged hole portion located below the contracted hole portion of the guide hole and a diametrically enlarged rod portion located below the diametrically reduced rod portion of the valve rod.

[0017] In a further preferable embodiment, the valve rod is provided with an annular groove on an outer circumferential portion thereof which is designed to be slidably contacted with the enlarged hole portion of guide hole.

[0018] In the control valve for a variable capacity compressor according to the present invention, the pressure of the cooling medium outlet port side acting on the valve body of valve rod (the pressure "Pc" to be fed to the crank chamber) is transmitted, via equalizing hole formed in the valve rod, into the equalizing pressure introducing chamber, enabling the pressure "Pc" to act so as to push the valve rod downward, i.e. to minimize (cancel) the pressure difference between the cooling medium feeding pressure "Pc" and the suction pressure "Ps". As a result, even if the valve aperture is enlarged to increase the flow rate of cooling medium in order to make the control valve applicable to a compressor of large capacity, it is possible to prevent the valve rod (valve body) from being pushed upward that might have been caused by the effect of pressure difference between the cooling medium feeding pressure "Pc" and the suction pressure "Ps", thus overcoming the problems involved in the control of valve. As a result, it is now possible to provide a control valve which is applicable to a compressor of large capacity while making it possible to share the components employed in other kinds of control valve.

[0019] Further, part of the cooling medium that has been introduced into the valve chamber from the discharge pressure cooling medium inlet port is enabled to enter into the equalizing pressure introducing chamber through a slide-contacting interface between the valve rod and the guide hole. In other words, since the leakage of cooling medium (from the discharge pressure "Pd" to

the suction pressure "Ps") in the conventional control valve can be substantially prevented and hence the discharge pressure "Pd" is allowed to pass toward the feeding pressure "Pc", there is no possibility that the pressure control can be badly affected. As a result, it is possible to enhance the accuracy of pressure control.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0020]

FIG. 1 is a longitudinal sectional view illustrating one embodiment of the control valve for a variable capacity compressor according to the present invention;

FIG. 2 is an enlarged longitudinal sectional view illustrating a main portion of the control valve shown in FIG. 1; and

FIG. 3 is a longitudinal sectional view illustrating one example of the control valve for a variable capacity compressor according to the prior art.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Next, a specific embodiment of the control valve for a variable capacity compressor according to the present invention will be explained in detail with reference to the drawings.

[0022] FIG. 1 shows a longitudinal sectional view illustrating one embodiment of the control valve for a variable capacity compressor according to the present invention.

[0023] The control valve 1 for a variable capacity compressor shown in FIG. 1 is designed such that it is applicable to a compressor of large capacity while making it possible to share the components such as the electromagnetic actuator 30, the pressure sensitive moving member (bellows main body) 40, etc. of the conventional control valve 5 for a variable capacity compressor which is shown in FIG. 3. In the following description, the parts or components which correspond to those of the conventional control valve 5 for a variable capacity compressor which is shown in FIG. 3 will be identified by the same reference numbers and the features which differ from those of the conventional control valve 5 will be mainly explained.

[0024] The control valve 1 shown in FIG. 1 comprises a valve main body 20 which is equipped with a valve rod 15 having a valve body 15a which is cross- or T-shaped in cross-section (to be explained hereinafter in more detail), with a valve chamber 21 provided with a valve seat (valve aperture) 22 with which the valve body 15a can be retractively contacted, with a plurality of cooling medium inlet ports 25 for introducing a cooling medium of discharge pressure "Pd" from the compressor into the outer peripheral portion of the valve chamber 21 (on the upstream side of the valve seat 22), and with a cooling medium outlet port 26 disposed below (downstream side

of) the valve seat 22 and communicated with the crank chamber of compressor; and an electromagnetic actuator 30.

[0025] The electromagnetic actuator 30 is equipped with an electromagnetic coil 32 having a connector 31 for electroexcitation, a step-attached cylindrical stator 33 disposed on the inner peripheral side of the electromagnetic coil 32, a sucking member 34 having U-shaped cross-section and press-inserted into a lower inner peripheral end portion of the stator 33, a plunger 37 slidably disposed to move up and down in a guide pipe 35 and located below the sucking member 34, the cylindrical guide pipe 35 for guiding the plunger 37, which is fixedly coupled, through a brazing which is applied to an upper inner peripheral end 35a, to a lower outer peripheral end portion of the stator 33, a step-attached cylindrical housing 60 disposed covering the outer peripheral portion of the coil 32, and a short cylindrical holder 50 interposed between an upper end portion of the valve main body 20 and the coil 32.

[0026] A lower end portion of the pipe 35 is fitted inside the holder 50 and fixedly coupled thereto by means of brazing. A lower diametrically contracted portion 61 of the housing 60 is externally inserted over an outer peripheral portion of holder 50. An upper end portion 62 of the housing 60 is calked to nearly an upper end portion of the coil 32. At a lower end portion of the holder 50, there is integrally formed a thin wall flanged cylindrical portion 50a which is externally fitted on an upper outer peripheral wall of the valve main body 20. The holder 50 is fixed to the valve main body 20 through the peel-calking work of the cylindrical portion 50a.

[0027] Additionally, a hexagon socket head adjusting screw 65 is screwed on an upper portion of the stator 33. A pressure sensitive chamber 45 into which the sucking pressure "Ps" of compressor is to be introduced is formed between the adjusting screw 65 attached to the inner peripheral wall of stator 33 and the sucking member 34. In this pressure sensitive chamber 45, there are disposed, as a pressure sensitive driving member, a bellows main body 40 consisting of a bellows 41, a downwardly projected upper stopper 42, a reverse U-shaped lower stopper 43 and a compression coil spring 44. Further, a compression coil spring 46 for urging the bellows main body 40 to contract (in the direction to contract it toward the adjusting screw 65) is interposed between the bellows main body 40 and the sucking member 34. Further, a step-attached operating rod 14 piercing through the sucking member 34 is interposed between the reverse U-shaped lower stopper 43 and a U-shaped portion 37c of plunger 37. Additionally, a valve-opening spring 47 made of a compression coil spring for urging the valve rod 15 downward (in the direction to open the valve) by way of the plunger 37 is interposed between the sucking member 34 and the U-shaped portion 37b of plunger 37.

[0028] On the other hand, a convex stopper 28 for regulating the lowermost descending position of the plunger 37 is projected from an upper central portion of the valve

main body 20. A guide hole 19 (to be described in detail hereinafter) in which the valve rod 15 is slidably inserted is formed at a central portion of the valve main body 20 which is located over the valve chamber and also at a central portion of the convex stopper 28. A suction pressure cooling medium-introducing chamber 23 into which the cooling medium of suction pressure "Ps" of compressor is formed between the plunger 37 and an upper outer periphery of the valve main body 20 (an outer peripheral wall of the convex stopper 28). A plurality of suction pressure cooling medium-introducing ports 27 are formed in the outer wall of the suction pressure cooling medium-introducing chamber 23. A cooling medium of sucking pressure "Ps" that has been introduced into the suction pressure cooling medium-introducing chamber 23 from the cooling medium-introducing ports 27 is designed to be introduced into the pressure sensitive chamber 45 via longitudinal grooves 37a formed on the outer peripheral wall of plunger 37, via a through-hole 37d formed at a central axis of plunger 37 and via a through-hole 39 formed in the sucking member 34. At the same time, this sucking pressure "Ps" is enabled to act on a top surface of the valve rod 15.

[0029] A valve-closing spring 48 made of a conical compression spring for urging the valve rod 15 upward to press an upper end portion of valve rod 15 against the through hole 37d portion of plunger 37 is disposed in the cooling medium outlet port 26 disposed at a lowermost portion of the valve main body 20.

[0030] In the control valve 1 of this embodiment, the diameters of the valve aperture 22, the valve rod 15 and the guide hole 10 are all made larger than those of the control valve 5 shown in FIG. 3 described above so as to make the control valve 20 applicable to a compressor of large capacity. Further, as clearly seen from FIG. 1 and FIG. 2 (partially enlarged), a contracted hole portion 19b is formed at an upper portion of the guide hole 19, and a diametrically reduced rod portion 15b which can be slidably inserted into the contracted hole portion 19b is formed at an upper portion of the valve rod 15. The valve rod 15 is provided with an equalizing hole 51 for introducing a cooling medium pressure "Pc" of the cooling medium outlet port 26 into an equalizing pressure introducing chamber 52 which is interposed between an enlarged hole portion 19A located below the contracted hole portion 19b of the guide hole 19 and a diametrically enlarged rod portion 15A located below the diametrically reduced rod portion 15b of the valve rod 15. This equalizing hole 51 extends, piercing through the axis of the valve rod 15, from a lower end of the valve rod 15 up to an upper portion of the valve rod 15 which is located near the diametrically reduced rod portion 15b. A plurality of lateral holes opening to the equalizing pressure introducing chamber 52 are formed at an upper portion of the valve rod 15. On an outer circumferential portion of the enlarged hole portion 19A of valve rod 15 (a lower end portion of the valve rod 15), which is adapted to be slidably contacted with the guide hole 19, there are formed

three annular grooves 15c.

[0031] In the control valve 1 constructed as described above, when the solenoid portion consisting of the coil 32, the stator 33 and the sucking member 34 is electro-excited, the plunger 37 is drawn toward the sucking member 34, forcing the valve rod 15 to move upward (in the valve-closing direction) by the urging force of the valve-closing spring 48. On the other hand, the cooling medium of suction pressure "Ps" that has been introduced into the cooling medium-introducing ports 27 from the compressor is introduced from the suction pressure cooling medium-introducing chamber 23 into the pressure sensitive chamber 45 via longitudinal grooves 37a formed on the outer peripheral wall of plunger 37 and via a through-hole 39 formed in the sucking member 34. The bellows main body 40 (the interior thereof is kept in vacuum) is caused to displace, i.e. contract or expand depending on the pressure (the suction pressure "Ps") inside the pressure sensitive chamber 45 (when the suction pressure "Ps" is high, the bellows main body 40 is contracted, and when the suction pressure "Ps" is low, the bellows main body 40 is expanded). Then, this displacement is transmitted, via the operating rod 14 and the plunger 37, to the valve rod 15, thereby making it possible to adjust the magnitude of opening of valve (the effective cross-sectional area of passageway between the valve aperture 22 and the valve body 15a). Namely, the magnitude of opening of valve can be determined depending on the sucking force of the plunger 37 to be effected by the solenoid portion consisting of the coil 32, the stator 33 and the sucking member 34, on the urging force of the bellows main body 40, and on the urging force of the valve-opening spring 47 and the valve-closing spring 48. Further, depending on this magnitude of opening of valve, the quantity (magnitude of restriction) of cooling medium of discharge pressure "Pd" that has been introduced from the discharge pressure cooling medium inlet port 25 into the valve chamber 21 and that can be delivered toward the cooling medium outlet port 26, i.e. toward the crank chamber can be adjusted, thus making it possible to control the pressure "Pc" (feeding pressure) inside the crank chamber.

[0032] In the control valve 1 for a variable capacity compressor according to this embodiment, the pressure of the cooling medium outlet port side acting on the valve body 15a of valve rod 15 (the pressure "Pc" to be fed to the crank chamber) is transmitted, via the equalizing hole 51 formed in the valve rod 15, into the equalizing pressure introducing chamber 52, enabling the pressure "Pc" to act so as to push the valve rod 15 downward, i.e. to minimize (cancel) the pressure difference between the cooling medium feeding pressure "Pc" and the suction pressure "Ps". As a result, even if the valve aperture 22 is enlarged to increase the flow rate of cooling medium in order to make the control valve applicable to a compressor of large capacity, it is possible to prevent the valve rod (valve body) from being pushed upward that might have been caused by the effect of pressure difference be-

tween the cooling medium feeding pressure "Pc" and the suction pressure "Ps", thus overcoming the problems involved in the control of valve. As a result, it is now possible to provide a control valve which is applicable to a compressor of large capacity while making it possible to share the components employed in other kinds of control valve.

[0033] Further, part of the cooling medium that has been introduced into the valve chamber 21 from the discharge pressure cooling medium inlet port 25 is enabled to enter into the equalizing pressure introducing chamber 52 through a slide-contacting interface between the diametrically enlarged rod portion 15A of valve rod 15 and the enlarged hole portion 19A of guide hole 19. In other words, since the leakage of cooling medium (from the discharge pressure "Pd" to the suction pressure "Ps") in the conventional control valve can be substantially prevented and hence the discharge pressure "Pd" is allowed to pass toward the feeding pressure "Pc", there is no possibility that the pressure control can be badly affected. As a result, it is possible to enhance the accuracy of pressure control.

[0034] Further, since the annular grooves 15c are formed on the valve rod 15, it is possible to minimize the leakage of pressure from the discharge pressure "Pd" to the feeding pressure "Pc" due to the labyrinth effects by these annular grooves 15c. At the same time, due to the provision of annular grooves 15c, it is possible to entrap fine foreign matters that may be intruded into the sliding interface between the valve rod 15 and the guide hole 19. As a result, the clogging of the sliding interface between the valve rod 15 and the guide hole 19 due to fine foreign matters can be prohibited, thus obviating the operation failure of valve rod 15, e.g. the trouble of valve rod 15 where the valve rod 15 is prevented from moving upward, thus leaving it behind even if the plunger 37 is attracted toward the sucking member 34.

Claims

1. A control valve for a variable capacity compressor, which comprises:

a valve main body equipped with a valve rod having a valve body, with a valve chamber having a guide hole in which the valve rod is enabled to slidably insert and a valve aperture with which the valve body can be retroactively contacted, with a cooling medium inlet port disposed on an upstream side of the valve aperture for introducing a cooling medium of discharge pressure from the compressor, and with a cooling medium outlet port disposed on a downstream side of the valve aperture and communicated with a crank chamber of the compressor;

an electromagnetic actuator for driving the valve rod to move in the direction of opening or closing the valve aperture; and

a pressure sensitive moving member for driving the valve rod to move in the direction of opening or closing the valve aperture in response to a sucking pressure of the compressor;

which is **characterized in that** a contracted hole portion is formed at an upper portion of the guide hole, that a diametrically reduced rod portion which can be slidably inserted into the contracted hole portion is formed at an upper portion of the valve rod, and that the valve rod is provided with an equalizing hole for introducing a cooling medium pressure of the cooling medium outlet port into an equalizing pressure introducing chamber which is interposed between an enlarged hole portion located below the contracted hole portion of the guide hole and a diametrically enlarged rod portion located below the diametrically reduced rod portion of the valve rod.

2. A control valve for a variable capacity compressor, which comprises:

a valve main body equipped with a valve rod having a valve body, with a valve chamber having a guide hole in which the valve rod is enabled to slidably insert and a valve aperture with which the valve body can be retroactively contacted, with a cooling medium inlet port disposed on an upstream side of the valve aperture for introducing a cooling medium of discharge pressure from the compressor, and with a cooling medium outlet port disposed on a downstream side of the valve aperture and communicated with a crank chamber of the compressor;

an electromagnetic actuator constituted by a coil, a cylindrical stator disposed on the inner peripheral side of the coil, a sucking member secured to the stator, and a plunger disposed below the sucking member and enabled to slide up and down;

a pressure sensitive chamber which is formed on the inner peripheral side of the stator and over the sucking member and to which an inlet pressure is introduced therein from the compressor;

a pressure sensitive driving member disposed in the pressure-sensitive chamber; and an operating rod interposed between a pressure sensitive driving member and the plunger;

wherein the valve body is designed to be moved in the valve-closing direction as the plunger is moved close to the sucking member and in the valve-opening direction as the operating rod is pushed downward by the actuation of the pressure sensitive driving member;

the control valve being further **characterized in that** a contracted hole portion is formed at an upper portion of the guide hole, that a diametrically

reduced rod portion which can be slidingly inserted into the contracted hole portion is formed at an upper portion of the valve rod, and that the valve rod is provided with an equalizing hole for introducing a cooling medium pressure of the cooling medium outlet port into an equalizing pressure introducing chamber which is interposed between an enlarged hole portion located below the contracted hole portion of the guide hole and a diametrically enlarged rod portion located below the diametrically reduced rod portion of the valve rod.

3. The control valve for a variable capacity compressor according to claim 1 or 2, wherein the valve rod is provided with an annular groove on an outer circumferential portion thereof which is designed to be slidingly contacted with the enlarged hole portion of guide hole.

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FIG. 1

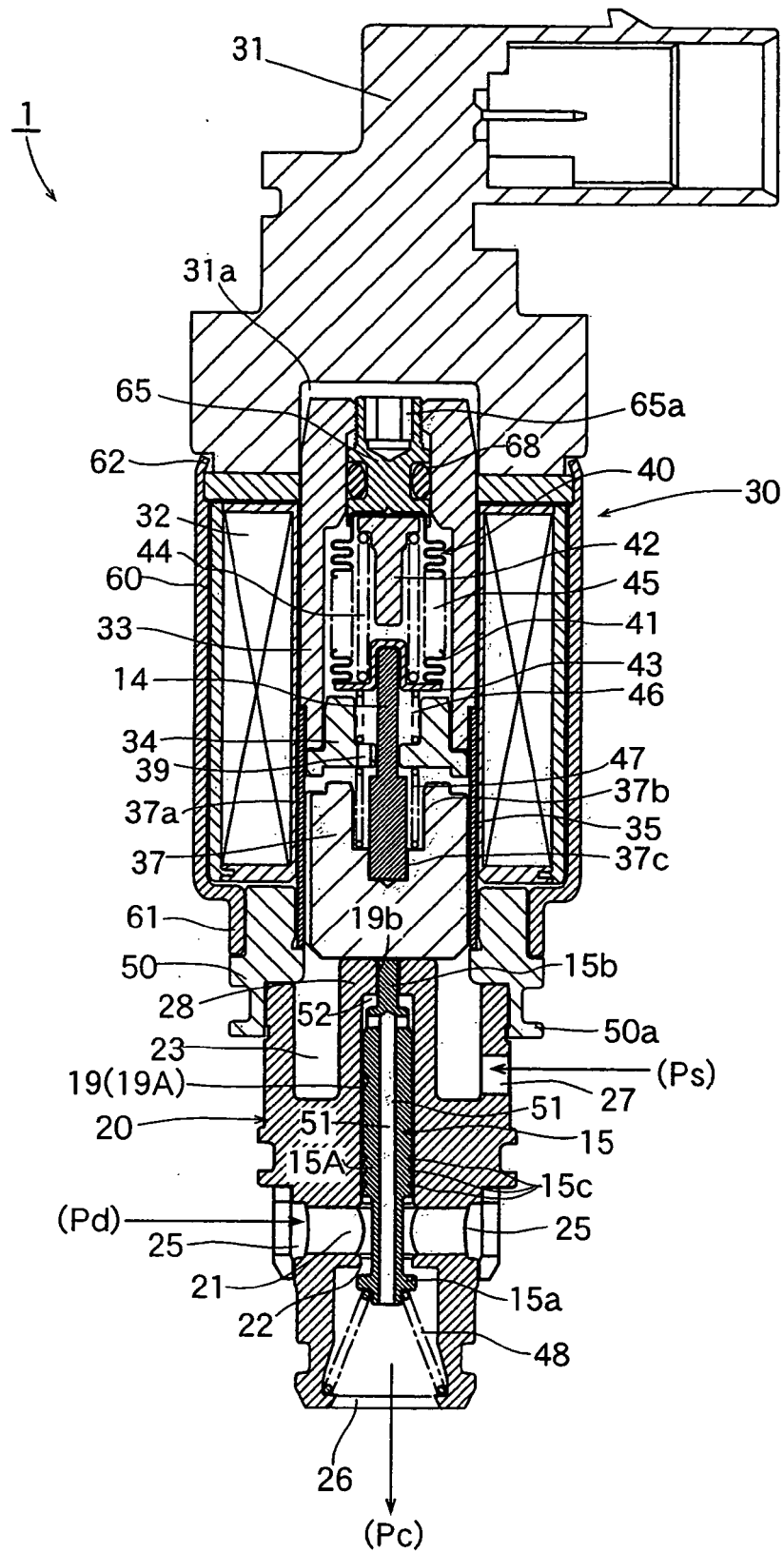


FIG. 2

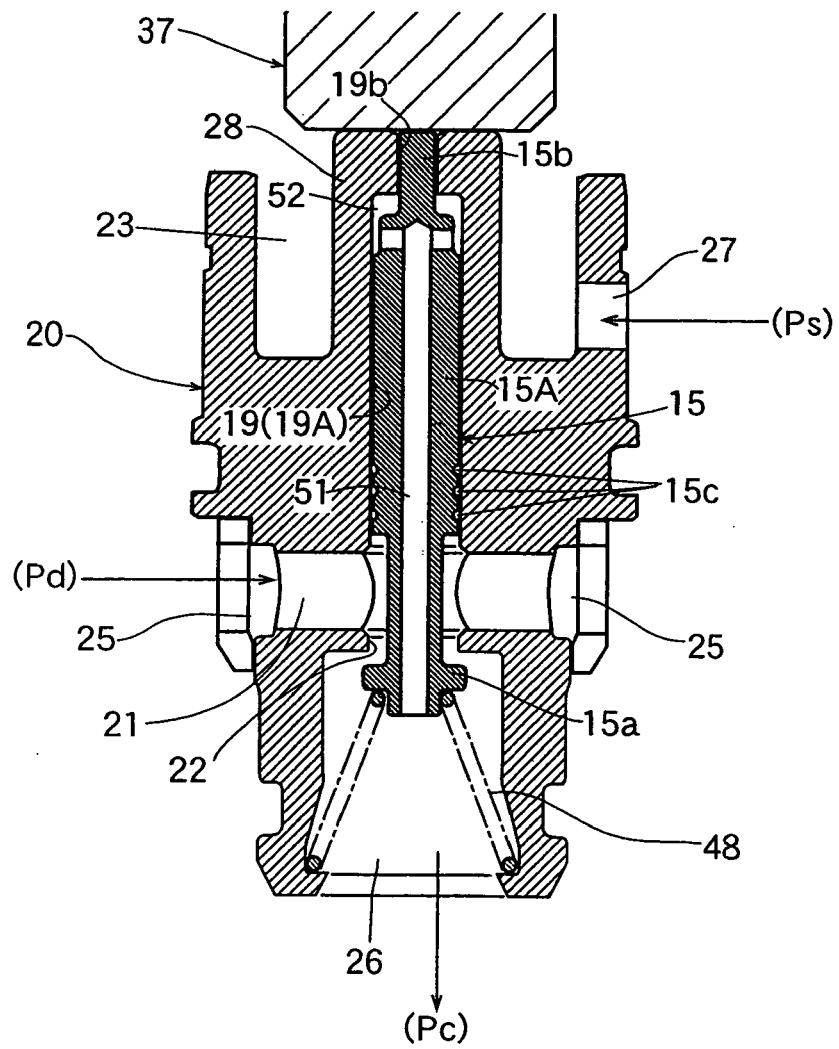
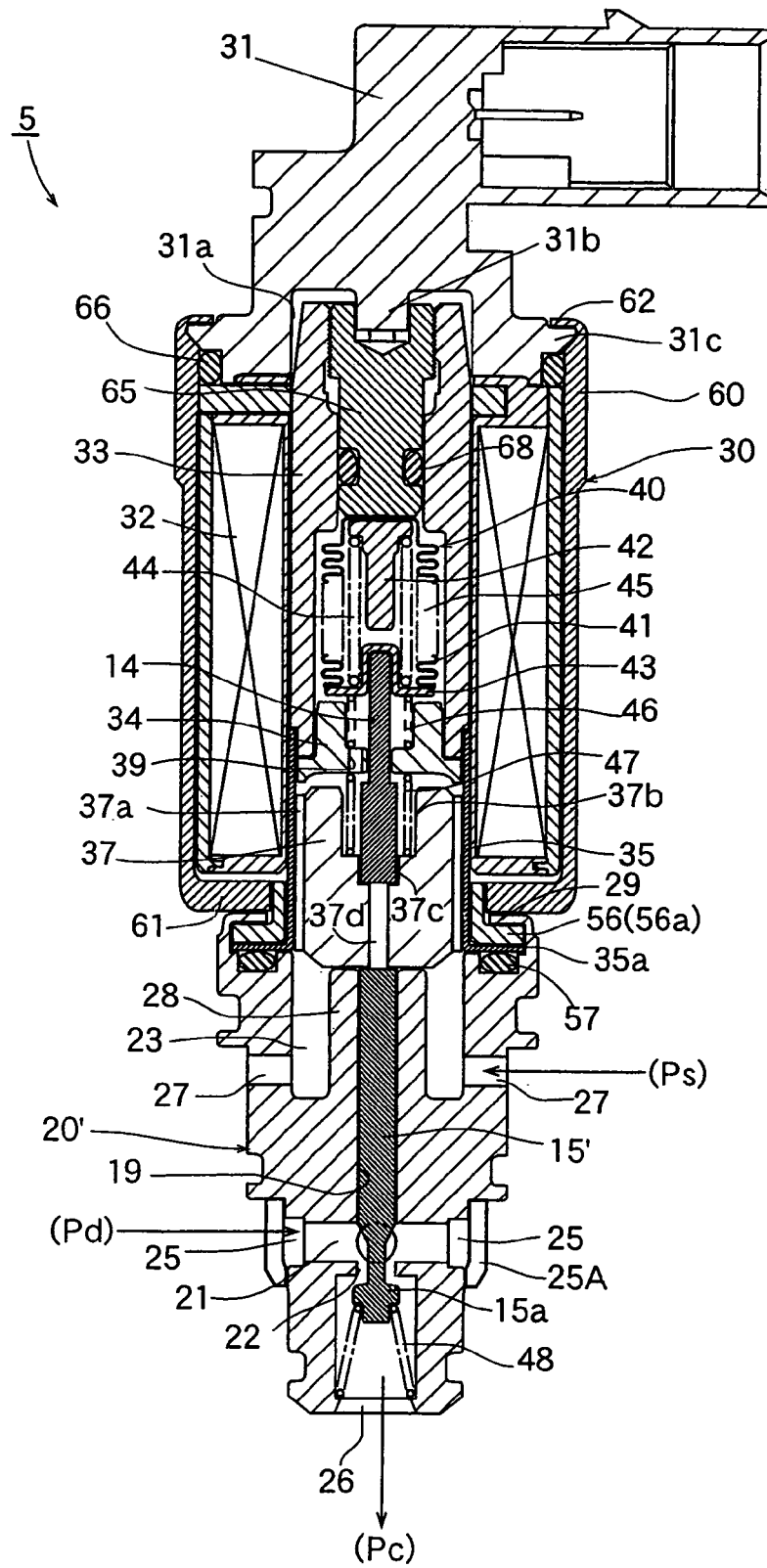


FIG. 3



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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