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(71) Applicant: **Kabushiki Kaisha Toyoda Jidoshokki Seisakusho**
1, Toyoda-cho 2-chome, Kariya-shi Aichi-ken 448(JP)

(72) Inventor: **SUGIURA, Manabu, Kabushiki Kaisha Toyoda Jidoshokki Seisakusho, 1, Toyoda-cho 2-chome Kariya-shi, Aichi-ken 448(JP)**

Inventor: **ITO, Masafumi, Kabushiki Kaisha Toyoda Jidoshokki Seisakusho, 1, Toyoda-cho 2-chome Kariya-shi, Aickhi-ken 448(JP)**

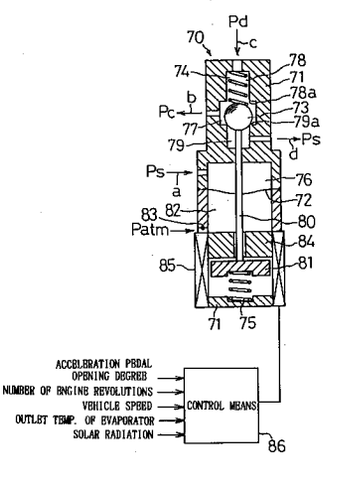
Inventor: **KIMURA, Kazuya, Kabushiki Kaisha Toyoda JidoshokkiSeisakusho, 1, Toyoda-cho 2-chome Kariya-shi, Aichi-ken 448(JP)**

(74) Representative: **Tiedtke, Harro, Dipl.-Ing. et al Patentanwälte Tiedtke-Bühling- Kinne & Partner Bavariaring 4 POB 20 24 03 W-8000 München 2(DE)**

(54) **CONTINUOUSLY VARIABLE CAPACITY TYPE SWASH PLATE COMPRESSOR.**

(57) A continuously variable capacity type swash plate compressor of this invention is characterized by being provided with a control valve which selectively introduces discharge pressure and suction pressure into a controlled pressure room formed between the plunger and housing by means of pressure sensitive means in response to suction pressure or discharge pressure, changes an inclination angle of the swash plate through said plunger and slider, and is provided with variable energizing means for varying pressure control point of said pressure sensing means. The pressure control point is varied with variable load applied to pressure sensing means by variable energizing means. Thus, capacity control adaptable to varying conditions is available in addition to a regular one.

FIG. 2



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Technical Field

The present invention relates to an improvement on a swash plate type continuously variable capacity compressor which employs a plurality of double headed pistons.

Background Art

As a swash plate type continuously variable capacity compressor which is suitable for air-conditioning a vehicle, one disclosed in Japanese Unexamined Patent Publication (KOKAI) No. 138,382/1989 has been known, for instance. As illustrated in Figure 8, the swash plate type continuously variable capacity compressor includes a plurality of double headed pistons 53 which are accommodated in a plurality of bores 52 formed in a cylinder block 51, a driving shaft 54 which is disposed on an axial line being parallel with the bores 52, and a slider 55 which is disposed around the driving shaft 54 slidably. Around a spherical supporting portion 55a of the slider 55, a swash plate 57 is disposed, and it is engaged with the spherical supporting portion 55a at a corresponding spherical portion 57a thereof. The swash plate 57 is engaged with the double headed pistons 53 by way of shoes 56 at the circumferential portions thereof. In front of the swash plate 57 (or on the left-hand side of Figure 8), a connecting portion 57b is projected from the swash plate 57, and it is provided with a guide pin 58. The guide pin 58 is guided by a slot 54b which is drilled in a front shaft portion 54a of the driving shaft 54. Thus, the swash plate 57 is made inclinable as the slider 55 slides on the driving shaft 54, and the center of the inclining movement of the swash plate 57 is adapted so that the position of the upper dead point of the double headed pistons 53 is invariable at the rear side.

Thus, the compressive reaction force of the double headed pistons 53 always acts as a moment "M" which woks in a direction reducing the inclination angle of the swash plate 57. The moment "M" urges a plunger 60 by way of the slider 55 in the right direction of Figure 8. Further, a pressure control chamber 59 is formed between the plunger 60 and a rear housing 50. Into the pressure control chamber 59, a discharge pressure "Pd" and a suction pressure "Ps" are introduced selectively by a control valve 40 (See Figure 9.) which is described later. Accordingly, the plunger 60 is also urged in the left direction of Figure 8. Hence, the inclination angle of the swash plate 57 (i.e., the discharge capacity of the compressor) is defined by the equilibrium between these opposite urging forces which work by way of the plunger 60 and the slider 55.

A general construction of the control valve 40 is illustrated in Figure 9. In a valve main body 41 of the control valve 40, a ball valve 43 is disposed, and it is brought into contact with a diaphragm 42. The ball valve 43 is adapted to operate in accordance with the atmospheric pressure "Patm", the urging forces of opposing springs 44 and 45 and a pressure fluctuation in a pressure detection chamber 46. The suction pressure "Ps" is introduced into the pressure detection chamber 46 which communicates with a swash plate chamber 61 (See Figure 8.) by way of a pressure detection pipe line "a." A valve chamber 47 in which the ball valve 43 is accommodated always communicates with the above-described pressure control chamber 59 (See Figure 8.) by way of a supply pipe line "b." Further, an upper chamber 48 is defined by a first valve seat 48a of the valve chamber 47, and the upper chamber 48 communicates with a discharge chamber 62 (See Figure 8.) by way of a high pressure pipe line "c." Furthermore, a lower chamber 49 is defined by a second valve seat 49a of the valve chamber 47, and the lower chamber 49 communicates with the swash plate chamber 61 by way of a low pressure pipe line "d" as the pressure detection chamber 46 communicates with the swash plate chamber 61. Hence, when the suction pressure "Ps" which is introduced into the pressure detection chamber 46 by way of the detection pressure pipe line "a" overcomes the atmospheric pressure "Patm" and the urging forces of the opposing springs 44 and 45, the diaphragm 42 flexes downward as illustrated in Figure 9, the ball valve 43 sits on the second valve seat 49a, and accordingly the discharge pressure "Pd" which is transmitted by way of the high pressure pipe line "c" is supplied as an operating pressure "Pc" to the pressure control chamber 59 by way of the supply pipe line "b." On the contrary, when the suction pressure "Ps" which is introduced into the pressure detection chamber 46 is overcome by the atmospheric pressure "Patm" and the urging forces of the opposing springs 44 and 45, the diaphragm 42 starts to flex backward in the upper direction, the ball valve 43 frees the second valve seat 49a gradually, the pressure in the pressure control chamber 59 is transmitted by way of the supply pipe line "b" in the opposite direction, it is leaked out to the swash plate 61 by way of the low pressure pipe line "d," and accordingly the operating pressure "Pc" decreases as the pressure in the pressure control chamber 59 is leaked out. Thus, in the conventional compressor, the discharge capacity thereof can be varied in accordance with the variation of the suction pressure "Ps."

In the above-described conventional compressor, the opening degree of the ball valve 43 within the control valve 40 is controlled by the expansion

and contraction of the diaphragm 42 which operates in response to the suction pressure "Ps." Through the pressure variation in the pressure control chamber 59 which depends on the opening degree of the ball valve 43, the inclination angle of the swash plate 57 is controlled. In the thus constructed conventional compressor, the pressure control point of the diaphragm 43 which works as a pressure sensitive means is defined by the atmospheric pressure "Patm" and the spring constants of the opposing springs 44 and 45. As a result, the inclination angle of the swash plate 57, namely the discharge capacity of the compressor, is controlled only by the suction pressure "Ps." Hence, in the case that a vehicle is accelerated quickly and that it is required to sharply reduce the discharge capacity of the compressor in order to inhibit the driving feeling of the vehicle from deteriorating during the quick acceleration, the above-described conventional compressor cannot satisfy the requirement. In addition, a vehicle air-conditioning apparatus which includes the above-described conventional compressor are adjusted so as to carry out an air-conditioning operation which meets the summer time requirements. Hence, in the case that an air-conditioning operation is required which meets the seasonal changes and the external environmental changes, the above-described conventional compressor cannot satisfy the requirement immediately because the conventional compressor does not carry out the capacity control until the suction pressure "Ps" varies. All in all, it can be hardly said that the conventional compressor is a satisfactory one in view of the driving feeling of the vehicle and in view of the air-conditioning function.

It is therefore a primary object of the present invention to provide a swash plate type continuously variable capacity compressor which enables not only to carry out the capacity control steadily but also to carry out the capacity control whenever it is required.

Disclosure of Invention

A swash plate type continuously variable capacity compressor according to the present invention comprises: a cylinder block including a plurality of bores which are adapted for accommodating a plurality of double headed pistons; a driving shaft disposed on an axial line which is parallel with said bores; a slider disposed around said driving shaft slidably; a swash plate disposed around said slider in an inclinable manner, engaging with said double headed pistons and including a guide pin which engages with a slot drilled in said driving shaft; a plunger holding said slider rotatably and adapted for varying an inclination angle of said swash plate by way of an axial displacement of said slider; and a control valve adapted for varying said inclination angle of said swash plate by way of said plunger and said slider by means of a pressure sensitive means which is adapted for responding to either a suction pressure or a discharge pressure and by which the suction pressure and the discharge pressure are selectively introduced into a pressure control chamber formed between said plunger and a housing, wherein said control valve includes a variable urging means which is adapted for varying a pressure control point of said pressure sensitive means.

In view of the construction, the swash plate type continuously variable capacity compressor according to the present invention features that it employs the control valve, which includes the variable urging means, instead of the conventional control valve which is employed by the conventional swash plate type continuously variable capacity compressor. The variable urging means is adapted for varying the pressure control point of the pressure sensitive means. In the present specification and appended claims, the pressure control point means a threshold point of the pressure sensitive means at which the pressure sensitive means is put into equilibrium with a predetermined suction pressure.

The present control valve includes a pressure introduction switching valve which is adapted for selectively introducing the discharge pressure and the suction pressure into the pressure control chamber, the variable urging means which is adapted for varying the pressure control point, and the pressure sensitive means which is adapted for driving the pressure introduction switching valve.

The pressure introduction switching valve is a component in which a movable valve member moves between valve openings which communicate with the suction pressure pipe line and the discharge pressure pipe line respectively in order to adjust the opening degrees of the both valve openings, whereby the suction pressure, the discharge pressure and an intermediate pressure of the suction pressure and the discharge pressure can be selectively introduced into the pressure control chamber. As for the pressure introduction switching valve, Preferred Embodiments of the present invention hereinafter described employ a ball valve as the movable valve member. However, the present invention is not limited thereto.

The pressure sensitive means includes a pressure sensitive unit and the variable urging means. The sensitive unit responds to either one of the suction pressure fluctuation and the discharge pressure fluctuation, and it drives the pressure introduction switching valve reciprocally. The variable urging means varies the pressure control point. As for the pressure sensitive unit, a mechanism can

be employed, in which the suction pressure or the discharge pressure acts on either one of the pressure chambers disposed on both sides of a diaphragm and which includes an urging means, such as a spring or the like. The urging means opposes the suction pressure or the discharge pressure which acts on the either one of the pressure chambers. The thus constructed sensitive means transmits the movements of the diaphragm to the movable valve member of the pressure introduction switching valve, thereby driving the movable valve member. On another side with respect to the diaphragm, there is formed a pressure chamber to which a predetermined pressure, such as an atmospheric pressure, vacuum or the like, is applied. In addition, instead of the diaphragm of the pressure sensitive means, it is possible to employ a piston or the like which is driven by a pressurized fluid or the like.

The variable urging means urges the movable valve member with a variable urging force in a direction or in an opposing direction thereto while it assists the action of the pressure sensitive unit of the pressure sensitive means. Specifically speaking, as for the variable urging means, it is possible to employ a mechanical urging means which is controlled electrically, a pressurized fluid or the like. Since the discharge capacity of the present compressor is controlled in accordance with the seasonal changes and the external environmental changes, the variable urging means can be controlled by a detection and command signal which is derived from an outlet temperature of an evaporator, an external temperature resulting from a solar radiation or the like. Further, since the discharge capacity of the present compressor is controlled in accordance with the quick acceleration of a vehicle, the variable urging means can be controlled by a detection and control signal which is derived from an opening degree of an accelerator pedal (i.e., an opening degree of a throttle valve), a number of engine revolutions, a vehicle speed, or the like.

In the swash plate type continuously variable capacity compressor according to the present invention, the pressure control point of the pressure sensitive member is varied in accordance with the quick acceleration of a vehicle, the seasonal changes, the external environmental changes or the like. Hence, the present compressor can respond to the quick acceleration of a vehicle or the like, and accordingly it can control its discharge capacity immediately in accordance therewith. For instance, the discharge capacity of the present compressor can be dropped sharply in order to avoid the deterioration of the driving feeling during the quick acceleration of a vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 through 4 relate to a compressor of a First Preferred Embodiment according to the present invention, in which:

Figure 1 is a cross sectional view of the compressor;

Figure 2 is a cross sectional view of a control valve of the compressor;

Figure 3 is a graph which illustrates a relationship between a discharge capacity of the compressor and a time elapsed; and

Figure 4 is a graph which illustrates a relationship between an electric current to be supplied to an electromagnet of the compressor and a set suction pressure;

Figures 5 and 6 relate to a compressor of a Second Preferred Embodiment according to the present invention, in which:

Figure 5 is a cross sectional view of a control valve of the compressor; and

Figure 6 is a graph which illustrates a relationship between an electric current to be supplied to an electromagnet of the compressor and a set suction pressure;

Figure 7 is a cross sectional view of a control valve of a compressor of a Third Preferred Embodiment according to the present invention; and

Figures 8 and 9 relate to a conventional compressor, in which:

Figure 8 is a cross sectional view of the conventional compressor; and

Figure 9 is a cross sectional view of a control valve of the conventional compressor;

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, the swash plate type continuous variable capacity compressor according to the present invention will be described in detail with reference to the Preferred Embodiments in detail.

First Preferred Embodiment

As illustrated in Figure 1, the compressor of the First Preferred Embodiment includes a cylinder block 1 which is constituted by connecting a pair of a front block 1a and a rear block 1b each other, a swash plate chamber 2 which is formed in the cylinder block 1 at a middle portion therein, and a pair of a front housing 3 and a rear housing 4 which are connected respectively to a front end surface of the front block 1a and a rear end surface of the rear block 1b. In the cylinder block 1, a plurality of pairs of bores 5a and 5b are formed at opposing positions on the front and rear sides of the swash plate chamber 2, and a plurality of double headed pistons 6 are accommodated in

both of the bores 5a and 5b in a manner being movable back and forth.

Also, in the cylinder block 1 , a driving shaft 7 is supported rotatably on an axial line being parallel with the bores 5a and 5b. The driving shaft 7 includes a front axis portion 7a, a rear axis portion 7b, and a flat connecting portion 7c formed between the front and rear axial portions 7a and 7b. Further, a slot 7d is drilled in the connecting portion 7c. In the rear block 1b, a cover pipe 8 is disposed in a manner being movable along the axial center line of the driving shaft 7. The driving shaft 7 is supported by the front block 1a at the front axial portion 7a by way of a bearing 9a, and it is engaged with a slider 10 at the rear axial portion 7b. The slider 10 is supported rotatably by the cover pipe 8 by way of a bearing 9b.

At the base of the slider 10 which is placed in the swash plate chamber 2, a pair of support shafts 11 are projected radially, and a swash plate 12 is supported in a manner being inclinable by the support shafts 11 which work as engager shafts. The swash plate 12 includes a main body portion 12a, and a rotary force transmitting portion 12b. The main body portion 12a transmits the rotary and swing movement to the double headed pistons 6 by way of shoes 13, and it moves the double headed pistons 6 back and forth. The rotary force transmitting portion 12b projects forward from the main body portion 12a, and it is connected to the slot 7d of the driving shaft 7 by way of a guide pin 15. Hence, the guide pin 15 is guided by the slot 7d in accordance with the axial displacement of the slider 10 which moves together with the cover pipe 8, and accordingly the inclination angle of the swash plate 12 is varied in accordance therewith. The center of the inclining movement of the swash plate 12 is adapted so that the position of the upper dead point of the double headed pistons 6 is invariable at the rear side.

Between the cylinder block 1 and the front housing 3 as well as between the cylinder block 1 and the rear housing 4, valve plates 20 and 21 are interposed respectively. In the front housing 3, there are formed a suction chamber 22 and a discharge chamber 24. Likewise, in the rear housing 4, there are formed a suction chamber 23 and a discharge chamber 25. The discharge chambers 24 and 25 are connected to an external refrigerating circuit by way of a discharge port (not shown). The front suction chamber 22 communicates with the swash plate chamber 2 by way of a front suction passage 26, and it further communicates with a front compression chamber by way of a suction valve mechanism (not shown) which is provided in the valve plate 20. Likewise, the front discharge chamber 24 communicates with the front compression chamber by way of a discharge valve mechanism (not shown). On the other hand, the rear suction chamber 23 communicates with the swash plate chamber 2 by way of a rear suction passage 27, and it further communicates with a rear compression chamber by way of a similar suction valve mechanism (not shown) which is provided in the valve plate 21. Likewise, the rear discharge chamber 25 communicates with the rear compression chamber by way of a discharge valve mechanism (not shown).

On a rear side of the rear suction chamber 23, a plunger 33 is disposed slidably in an axial direction while it is brought into contact with a sleeve portion 8a of the cover pipe 8. Between the plunger 33 and the rear housing 4, a pressure control chamber 32 is formed. Into the pressure control chamber 32, an actuating pressure "Pc" is supplied by a control valve 70 illustrated in Figure 2.

As illustrated in Figure 2, the control valve 70 mainly includes a valve main body 71, and a rod 80 which is disposed in the valve main body 71. Further, a ball valve 73 is fixed at an end of the rod 80, a diaphragm 72 is fixed at a substantially middle portion thereof. As a result, and a movable iron core 81 is fixed at another end thereof, and accordingly the ball valve 73 and the movable iron core 81 are pressed by opposing springs 74 and 75.

A valve chamber 77 of the control valve 70 accommodates the ball valve 73, and it always communicates with the above-described pressure control chamber 32 (See Figure 1.) by way of a supply pipe line "b." Further, an upper chamber 78 which is defined by a first valve seat 78a of the valve chamber 77 communicates with the rear discharge chamber 25 (See Figure 1.) by way of a high pressure pipe line "c," and a lower chamber 79 which is defined by a second valve seat 79a of the valve chamber 77 communicates with the swash plate chamber 2 (See Figure 1.) by way of a low pressure pressure pipe line "d." The portion which includes the ball valve 73 constitutes the pressure introduction switching valve according to the present invention.

A first pressure detection chamber 76 is defined by the diaphragm 72, and it is disposed on the side of the ball valve 73. The first pressure detection chamber 76 communicates with the swash plate chamber 2 by way of a pressure detection pipe line "a." A suction pressure "Ps" is introduced into the first pressure detection chamber 76. A second pressure detection chamber 82 is defined by the diaphragm 72, and it is disposed on the side of the movable iron core 81. Into the second pressure detection chamber 82, an atmospheric pressure "Patm" is introduced by way of an opening 83.

Further, around the movable iron core 81, an

electromagnet 85 is provided integrally with the valve main body 71 on the side of the second pressure detection chamber 82 with respect to the movable iron core 81 (i.e., on a lower side of the valve main body 71 as illustrated in Figure 2). The electromagnet 85 includes a fixed iron core 84, and it is connected to a control means 86. The control means 86 includes a micro-computer to which a potentiometer (not shown) which is adapted for detecting an opening degree of an acceleration pedal (i.e., an opening degree of a throttle valve). Hence, an opening degree of an acceleration pedal is detected by the potentiometer, and accordingly a predetermined value of an electric current which associates with the detected opening degree of the acceleration pedal is applied to the electromagnet 85.

Thus, the part of the control valve 70 which includes the springs 74 and 75, the diaphragm 72 and the first pressure detection chamber 76 constitutes a major part of the pressure sensitive unit according to the present invention. In addition, the part of the control valve 70 which includes the electromagnet 85 including the fixed iron core 84 and the movable iron core 81 constitutes a major part of the variable urging means according to the present invention.

Moreover, as illustrated in Figure 1, the actuating pressure "Pc" which is supplied to the pressure control chamber 32 is transmitted to the swash plate 12 by way of the plunger 33, the cover pipe 8 and the slider 10. Accordingly, the actuating pressure "Pc" opposes the moment "M" which results from the compression reaction force and which works in the direction always reducing the inclination angle of the swash plate 12. Hence, the inclination angle of the swash plate 12, i.e., the discharge capacity of the present compressor, is defined by the equilibrium between the both of the forces.

When the thus constructed present compressor is operated and the driving shaft 7 is rotated, the swash plate 7 is rotated together with the driving shaft 7 integrally and is swung at the same time. Accordingly, the double headed pistons 6b are moved by way of the shoes 13 reciprocally in the bores 5a and 5b. As the double headed pistons 6 are moved reciprocally, the return refrigerant gas which is introduced by way of an inlet pipe line is entered in the swash plate chamber 2 through an inlet portion. Then, the refrigerant gas is introduced into each of the front and rear suction chambers 22 and 23 by way of the front suction passage 26 and the rear suction passage 27 respectively. As a result, the refrigerant gas is suctioned into the front and rear compression chambers, and accordingly it is subjected to a compression action. Then, the refrigerant gas which is discharged from the front and rear compression chambers to the discharge chambers 24 and 25 by way of the discharge valve mechanisms (not shown) is delivered out to an external refrigerant gas circuit by way of a discharge pipe line.

When a vehicle is traveling at a constant velocity, for instance, an electric current of a predetermined value which associates with a predetermined opening degree of the acceleration pedal is applied to the control valve 70 illustrated in Figure 2. In accordance with the electric current of the predetermined value, a set suction pressure "Pso" is determined, and the set suction pressure "Pso" puts the diaphragm 72 into equilibrium at various threshold points.

Then, in the case that the vehicle is traveling at a constant speed, that the refrigerating load is large, and that the suction pressure "Ps" introduced by way of the pressure detection pipe line "a" shifts to a high pressure side, the suction pressure "Ps" itself is introduced into the first pressure detection chamber 76, and accordingly the diaphragm 72 overcomes the atmospheric pressure "Patm" of the second pressure detection chamber 82 and the urging force of the spring 75. Hence, the diaphragm 72 flexes downward until there arises equilibrium at the suction pressure "Ps." As a result, the ball valve 73 is seated on the second valve seat 79a, and the discharge pressure "Pd" which comes by way of the high pressure pipe line "c" is supplied into the pressure control chamber 32 (See Figure 1.) as the actuating pressure "Pc." Therefore, the support shafts 11 of the swash plate 12 are urged forward by way of an urging element which is constituted by the plunger 33, the cover pipe 8 and the slider 10, and the urging element maintains the swash plate 12 at the maximum inclination angle while opposing the moment "M" which results from the compressive reaction force. At this time, the present compressor is operated at the discharge capacity of 100% as illustrated in Figure 3.

On the other hand, in the case that the vehicle is traveling at a constant speed, that the refrigerating load is reduced gradually because the present compressor is operated continuously at the discharge capacity of 100%, and that the suction pressure "Ps" shifts to a low pressure side in accordance therewith, the diaphragm 72 is operated in the control valve 70 illustrated in Figure 2 as follows. Namely, the diaphragm 72 is turned reversively upward so as to lift the ball valve 73 off the second seat 79a by the pressure drop in the first pressure detection chamber 76 which has been in equilibrium with the urging force of the spring 75. Then, the diaphragm 72 is operated in this way until equilibrium with the suction pressure "Ps" is attained. Accordingly, part of the pressure

in the pressure control chamber 32 (See Figure 1.) escapes to the side of the swash plate 2, and the pressure in the pressure control chamber 32 drops. Hence, the swash plate 12 is displaced in a direction which reduces its inclination angle, and consequently the discharge capacity of the present compressor is reduced steadily.

In the case that the vehicle is accelerated when it carries out the above-described traveling at a constant speed, an electric current of a value which exceeds the predetermined value set for the constant speed traveling is applied to the electromagnet 85 of the control valve 70 illustrated in Figure 2, because the opening degree of the acceleration pedal has been increased. With the electric current application, the movable iron core 81 is attracted to the fixed iron core 84 while opposing against the downward deflection of the diaphragm 72, and the seating of the ball valve 73 is shifted from the second valve seat 79a to the first valve seat 78a by way of the rod 80. With the shift, the pressure of the pressure control chamber 32 (See Figure 1.) escapes quickly from the thus freed second valve seat 79a to the side of the swash plate chamber 2 by way of the lower chamber 79 and the low pressure pipe line "d," and accordingly the pressure in the pressure control chamber 32 decreases. As a result, the equilibrium with the moment "M" which acting on the swash plate 12 illustrated in Figure 1 has lost, the urging element retracts, and the swash plate 12 reduces its inclination angle while the guide pin 15 is guided by the slot 7d. Thus, the present compressor reduces its discharge capacity.

In the case that the acceleration of the vehicle is carried out suddenly, the opening degree of the acceleration pedal is increased excessively. Consequently, an electric current of a value which is far above the predetermined value set for the constant speed traveling is applied to the electromagnet 85 of the control valve 70 illustrated in Figure 2, and accordingly the movable iron core 81 in the control valve 70 is moved instantaneously. With the movement, the inclination angle of the swash plate 12 is reduced instantaneously. Thus, the present compressor reduces its discharge capacity promptly as illustrated in Figure 3.

In the case that the traveling of the vehicle is shifted from the acceleration to a traveling at a constant speed to which the vehicle has been accelerated so far, a set suction pressure "Pso'" which is greater than the "Pso" (i.e., "Pso'" > "Pso") is determined by a value of an electric current which depends on the opening degree of the acceleration pedal at the moment. The set suction pressure "Pso'" is adapted for keeping the diaphragm 72 in equilibrium. With the set suction pressure "Pso'," the control operation of the suction pressure "Ps" which is to be introduced into the pressure detection chamber 76 is resumed as follows. Namely, in the compressor of the First Preferred Embodiment, a spring constant of the spring 75 is enhanced substantially in accordance with the increment in the electric current value, the increment in the opening degree of the acceleration pedal or the increment in the speed of the vehicle, and consequently the set suction pressure "Pso" is varied to a higher pressure side. Hence, in the compressor of the First Preferred Embodiment, the value of the electric current to be applied to the electromagnet 85 is in a direct proportion to the set suction pressure "Pso" as illustrated in Figure 4.

In addition, in the compressor of the First Preferred Embodiment, the control valve 70 is controlled by detecting the opening degree of the acceleration pedal in order to control the discharge capacity in accordance with the various speeds of the vehicle. The various speeds of the vehicle herein include the quick acceleration of the vehicle as well. However, in the case that a similar control of the discharge capacity is desired, it is also effective to detect a number of engine revolutions or to detect a vehicle speed directly. Further, in the case that a control of the discharge capacity in accordance with the seasonal changes, the external environmental changes or the like is desired, it is also possible to carry out such a control by controlling the control vale 70 in accordance with the values which are derived by detecting an outlet temperature of an evaporator, a solar radiation, an external temperature, or the like. With these arrangements, for instance, in the case that an excessive air-conditioning is under way, the discharge capacity of the compressor can be decreased. Also, in the case that an insufficient air-conditioning is under way, the discharge capacity of the compressor can be increased. Specifically speaking, in an automatic air conditioner, an air-conditioning in which a hot air and a cold air are intermingled together has been avoided as much as possible, and accordingly a power loss which associates therewith has been inhibited as much as possible. As a result, it is possible to obtain a space which is air-conditioned comfortably.

Second Preferred Embodiment

As illustrated in Figure 5, a control valve 170 can include a fixed iron core 184 of an electromagnet 185 which is disposed on an opposite side of a movable iron core 181 with respect to a second pressure detection chamber 82 (i.e., on a lower side of the movable iron core 181 with respect to the second pressure detection chamber 82 in Figure 5). In other words, the fixed iron core 184 can be disposed on the opposite side with respect to

the side where the fixed iron core 84 of Figure 2 is disposed.

In the compressor of the Second Preferred Embodiment which is provided with the control valve 170, the spring constant of a spring 175 is reduced substantially, and accordingly the value of the electric current to be applied to the electromagnet 185 is in a negative proportion to the set suction pressure "Pso" as illustrated in Figure 6. Hence, the set suction pressure "Pso" is varied to a lower pressure side in accordance with the increment of the electric current value.

Third Preferred Embodiment

As illustrated in Figure 7, a control valve 270 is provided with a servomotor 281 and a nut 283. The servomotor 281 is controlled by a control means. A worm 282 is fixed on a rotary shaft of the servomotor 281, and it is meshed with the nut 283 which is made slidable by a valve main body 71 but which is inhibited from rotating by the valve main body 71. Further, a spring 275 is provided between an upper surface of the nut 283 and a lower surface of a diaphragm 72.

In the compressor of the Third Preferred Embodiment which is provided with the control valve 270, the servomotor 281 rotates its rotary shaft in accordance with pulses which are output by the control means, and accordingly the nut 283 is pushed up by way of the worm 282, thereby enabling to vary the spring constant of the spring 275 substantially. Hence, the discharge capacity of the present compressor can be controlled in accordance with the pulses.

So far, in the above-described compressors of the Preferred Embodiments, an electromagnet or a servomotor is employed as a mechanical urging means which is controlled electrically. When employing an electromagnetic valve, though it is not illustrated herein, a fluid pressure can be utilized to carry out the same objective.

As having been described in detail, since a pressure control point of a pressure sensitive member is varied by a variable urging means which applies a variable load to the pressure sensitive member, it is possible to not only carry out a discharge capacity control of a compressor steadily but also a discharge capacity control thereof whenever it is required in accordance with the present invention. Therefore, when the compressor of the present invention is employed in a vehicle air-conditioning apparatus, a favorable acceleration feeling can be obtained, and at the same time an air-conditioning can be carried out in accordance with the seasonal changes, the external environmental changes, or the like. Thus, the compressor of the present invention is fully satisfactory in view of the feeling of driving as well as the function of the air-conditioning.

Claims

1. A swash plate type continuously variable capacity compressor, comprising:

a cylinder block including a plurality of bores which are adapted for accommodating a plurality of double headed pistons;

a driving shaft disposed on an axial line which is parallel with said bores;

a slider disposed around said driving shaft slidably;

a swash plate disposed around said slider in an inclinable manner, engaging with said double headed pistons and including a guide pin which engages with a slot drilled in said driving shaft;

a plunger holding said slider rotatably and adapted for varying an inclination angle of said swash plate by way of an axial displacement of said slider; and

a control valve adapted for varying said inclination angle of said swash plate by way of said plunger and said slider by means of a pressure sensitive means which is adapted for responding to either a suction pressure or a discharge pressure and by which the suction pressure and the discharge pressure are selectively introduced into a pressure control chamber formed between said plunger and a housing;

wherein said control valve includes a variable urging means which is adapted for varying a pressure control point of said pressure sensitive means.

2. The compressor according to claim 1, wherein said control valve includes a pressure introduction switching valve which is adapted for selectively introducing either said suction pressure or said discharge pressure into said pressure control chamber, a variable urging means which is adapted for varying said pressure control point of said pressure sensitive means, and a pressure sensitive unit which is adapted for operating the pressure introduction switching valve.

3. The compressor according to claim 2, wherein

said pressure introduction switching valve includes a movable valve body, and valve ports which are opened and closed by movements of the movable valve body and which respectively communicate with said suction pressure and said discharge pressure.

4. The compressor according to claim 2, wherein said pressure sensitive means includes a pressure sensitive unit which is adapted for reciprocally operating said pressure introduction switching valve in accordance with either a pressure fluctuation of said suction pressure or a pressure fluctuation of said discharge pressure, and said variable urging means which is adapted for varying said pressure control point of said pressure sensitive means.

5. The compressor according to claim 1, wherein said variable urging means is an electromagnetic apparatus which is adapted for varying said pressure control point of said pressure sensitive means by means of a magnetic force which varies in accordance with an electric current variation.

6. The compressor according to claim 1, wherein said variable urging means is a motor which is adapted for varying said pressure control point of said pressure sensitive means by means of a rotary operation thereof.

Amended claims

1. A swash plate type continuously variable capacity compressor, comprising:

a cylinder block including a plurality of bores which are adapted for accommodating a plurality of double headed pistons;

a driving shaft disposed on an axial line which is parallel with said bores;

a slider disposed around said driving shaft slidably;

a swash plate disposed around said slider in an inclinable manner, engaging with said double headed pistons and including a guide pin which engages with a slot drilled in said driving shaft;

a plunger holding said slider rotatably and adapted for varying an inclination angle of said swash plate by way of an axial displacement of said slider; and

a control valve adapted for varying said inclination angle of said swash plate by way of said plunger and said slider by means of a pressure sensitive means which is adapted for responding to either a suction pressure or a discharge pressure and by which the suction pressure and the discharge pressure are selectively introduced into a pressure control chamber formed between said plunger and a housing;

wherein said control valve includes a valve chamber including a plurality of passages which communicate with said pressure control chamber, said discharge pressure and said suction pressure respectively, a movable valve body disposed in the valve chamber, connected to said pressure sensitive means and moving between valve seats which are formed at an opening of the passages, and a variable urging means which is adapted for varying a pressure control point of said pressure sensitive means.

2. (canceled)

3. (canceled)

4. The compressor according to claim 1, wherein said pressure sensitive means includes a pressure sensitive unit which is adapted for reciprocally operating said pressure introduction switching valve in accordance with either a pressure fluctuation of said suction pressure or a pressure fluctuation of said discharge pressure, and said variable urging means which is adapted for varying said pressure control point of said pressure sensitive means.

5. The compressor according to claim 1, wherein said variable urging means is an electromagnetic apparatus which is adapted for varying said pressure control point of said pressure sensitive means by means of a magnetic force which varies in accordance with an electric current variation.

6. The compressor according to claim 1, wherein said variable urging means is a motor which is adapted for varying said pressure control point of said pressure sensitive means by means of a rotary operation thereof.

Brief statement of amendment under article 19(1)

1. In the accompanying amendment under article 19(1) on the claims, the amendment on claim 1

(the underlined part) is intended to emphasize the differences between the present application and the references cited in the International Search Report.

2. Because claim 1 is amended, claims 2 and 3 are canceled. Accordingly, claim 4 is amended to depend from claim 1.

3. In the accompanying amendment under article 19(1) on the claims, the amendment on claim 6 (the underlined part) is intended to correct a typographical error.

4. Because claim 1 is amended, it is necessary to insert the identical phrase, which is inserted into claim 1, after "said control valve" in page 4, the last line of the description.

5. Because claim 1 is amended, it is necessary to insert the identical phrase, which is inserted into claim 1, before "the pressure sensitive means" in page 5, line 3 of the description.

Notes on This Translation:

a) The above-mentioned page and line indications are those for the original description in Japanese.

b) The amendment on claim 6 is in the nature of the Japanese language strictly. Accordingly, it cannot appear in the translation.

FIG. 1

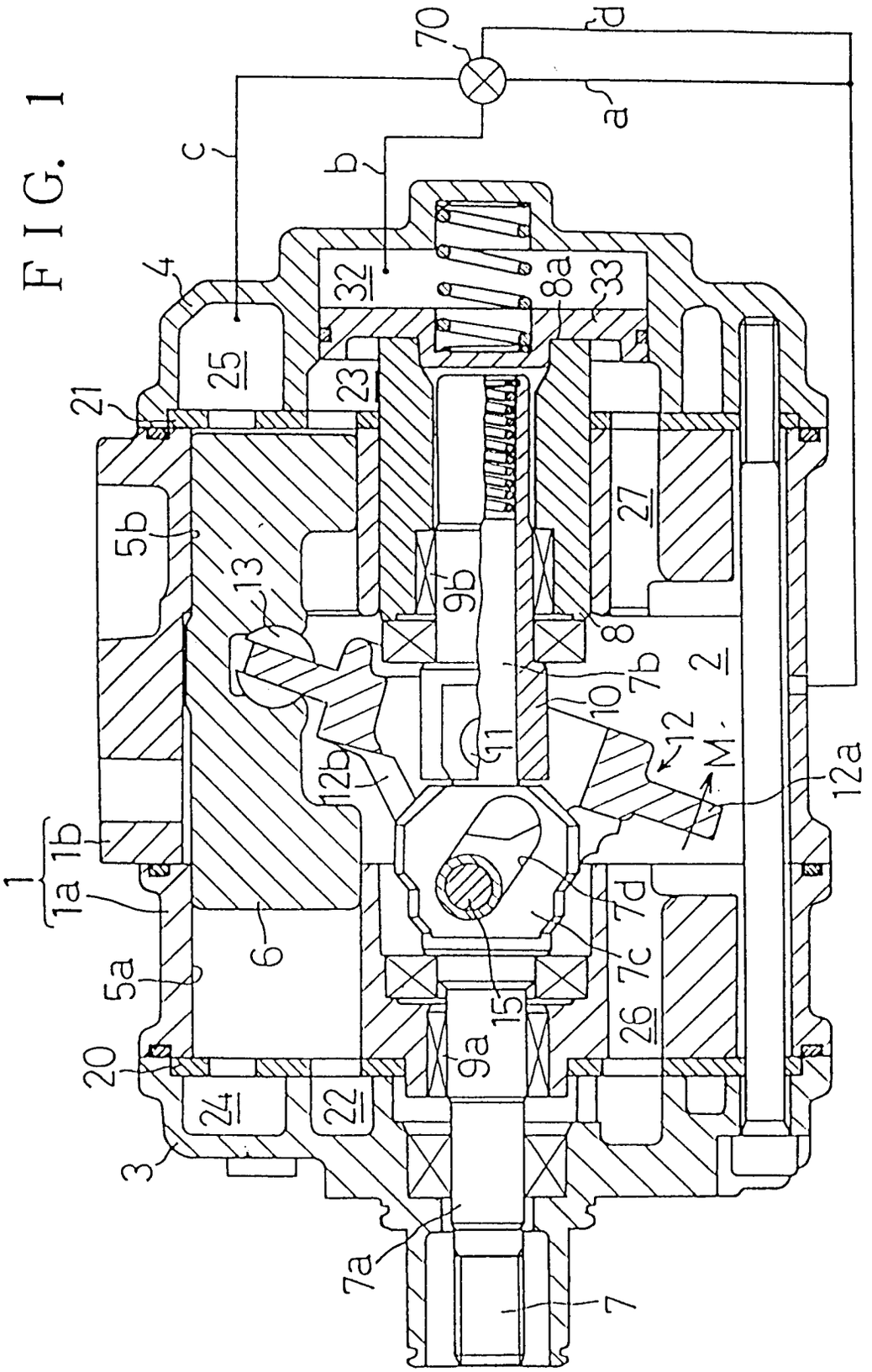

70
d
a
c
b
4
32
8a
33
25
23
21
27
5b
13
9b
8
7b
10
2
11
12
M
12a
12b
1
1a
1b
6
7d
7c
5a
15
26
9a
20
24
22
3
7a
7

FIG. 2

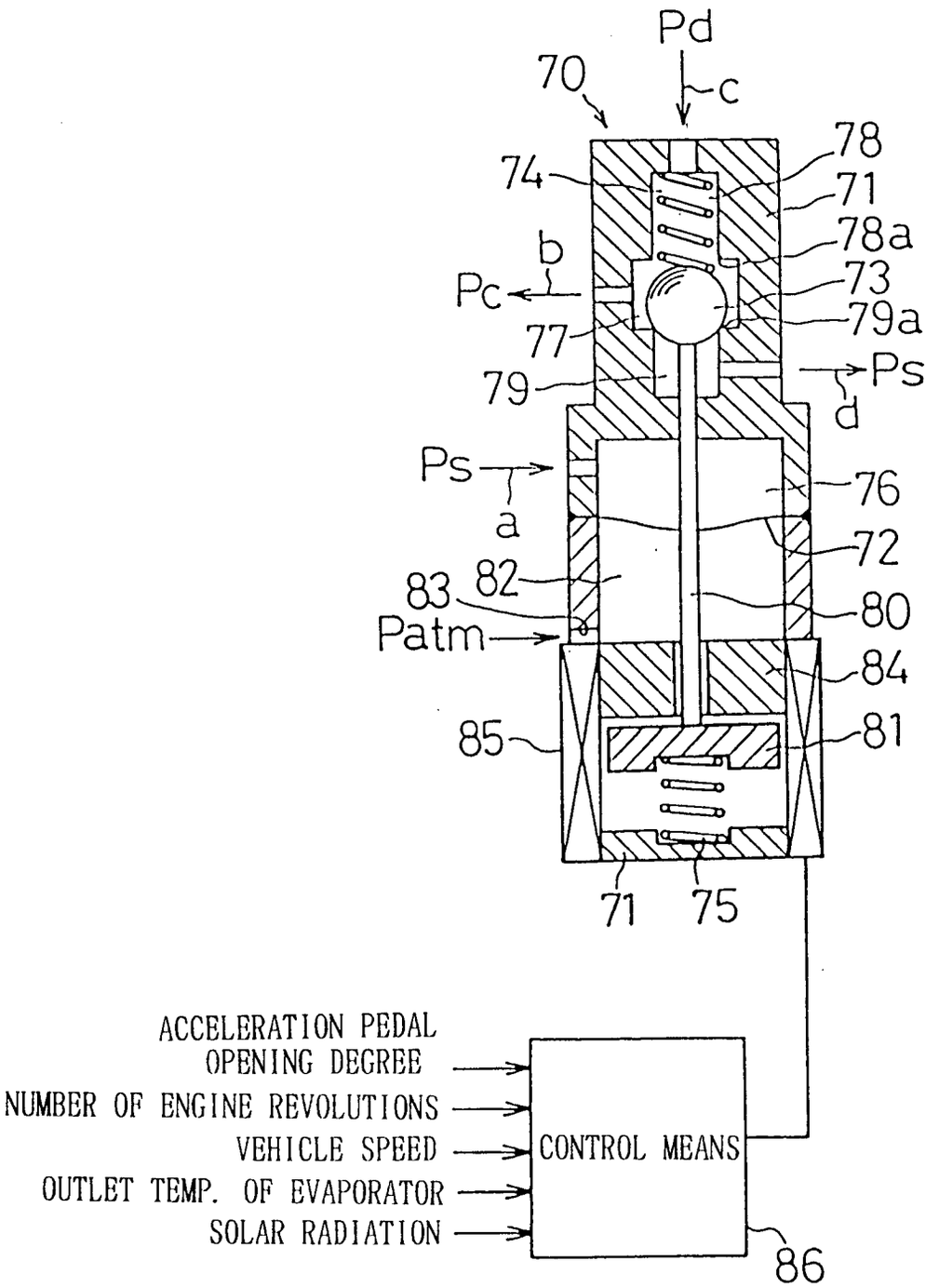

Pd
70
c
78
74
71
78a
b
Pc
73
79a
77
Ps
79
d
Ps
a
76
72
83
82
80
Patm
84
85
81
71
75
ACCELERATION PEDAL OPENING DEGREE
NUMBER OF ENGINE REVOLUTIONS
VEHICLE SPEED
OUTLET TEMP. OF EVAPORATOR
SOLAR RADIATION
CONTROL MEANS
86

FIG. 3

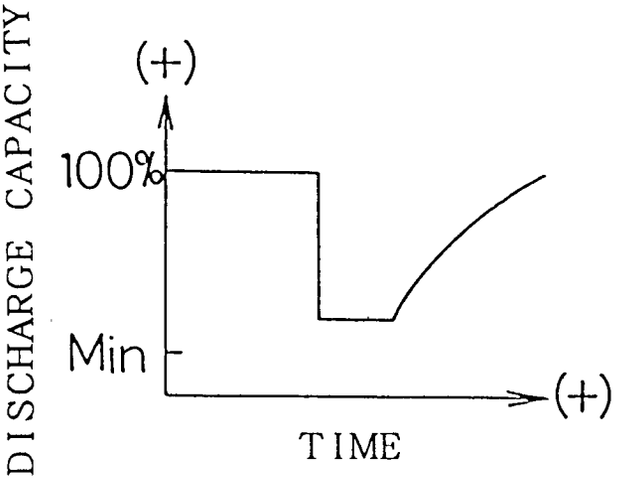

DISCHARGE CAPACITY
(+)
100%
Min
(+)
TIME

FIG. 4

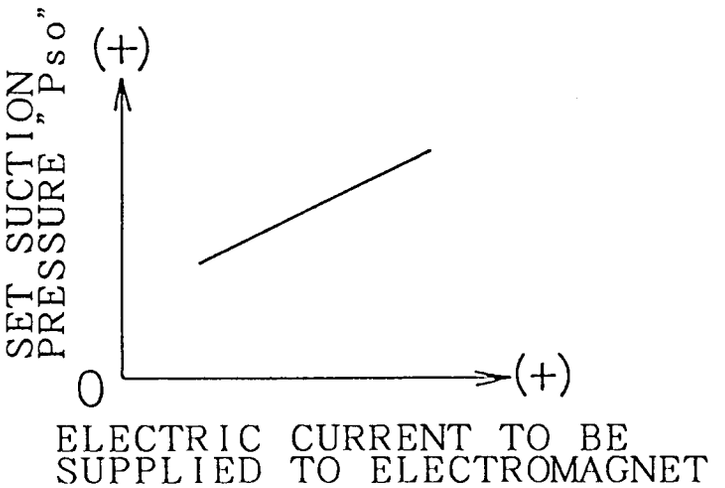

SET SUCTION PRESSURE "Pso"
(+)
0
(+)
ELECTRIC CURRENT TO BE SUPPLIED TO ELECTROMAGNET

FIG. 5

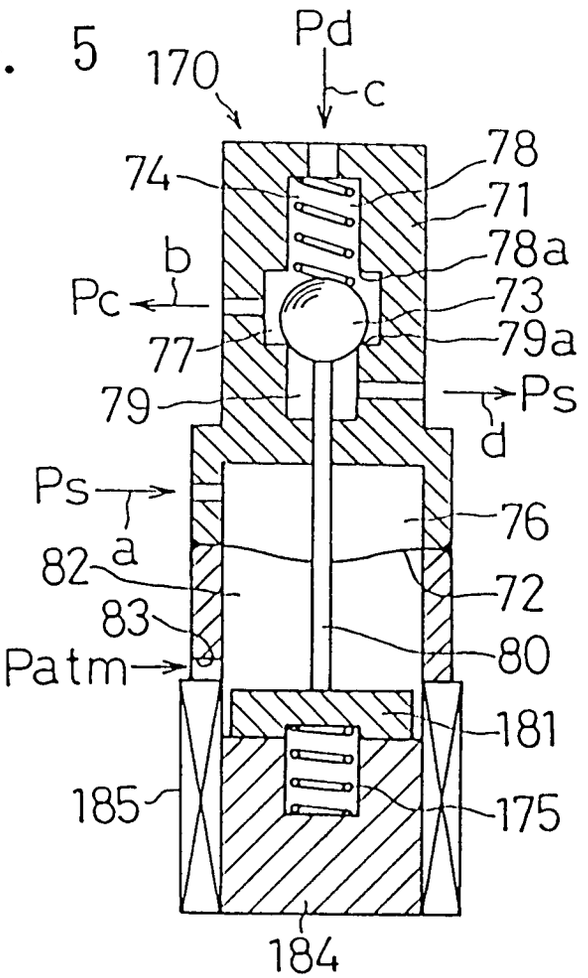

Pd
170
c
74
78
71
78a
b
Pc
73
77
79a
79
Ps
d
Ps
a
76
82
72
83
80
Patm
181
185
175
184

FIG. 6

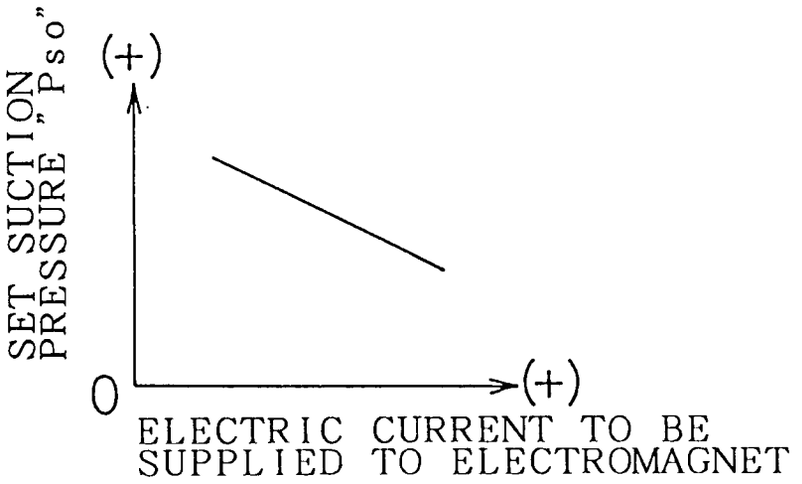

SET SUCTION PRESSURE "Pso"
(+)
0
(+)
ELECTRIC CURRENT TO BE SUPPLIED TO ELECTROMAGNET

FIG. 7

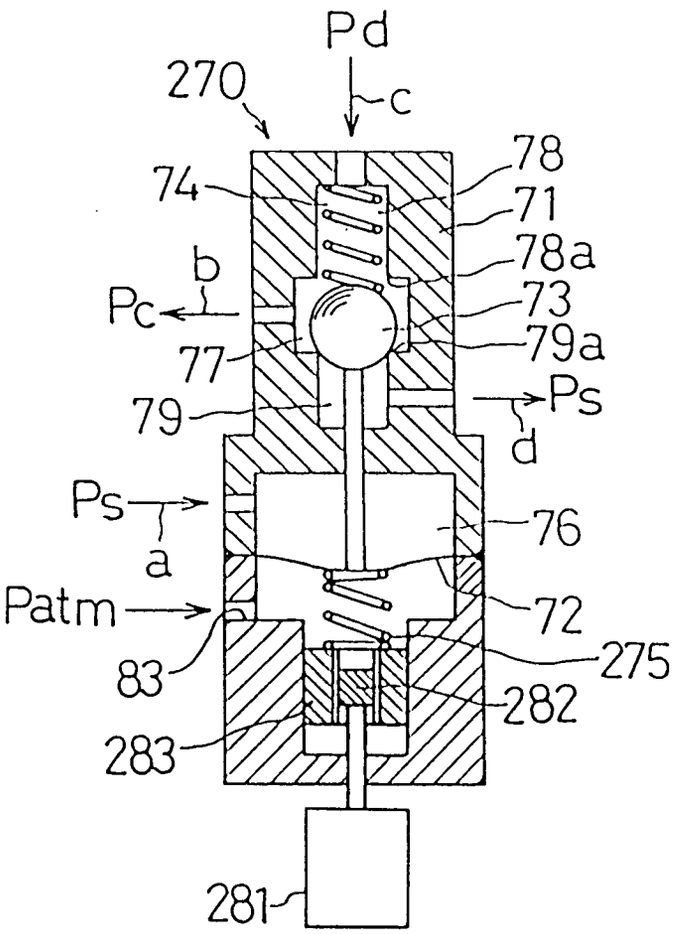

Pd
270
c
78
74
71
78a
b
Pc
73
77
79a
Ps
79
d
Ps
76
a
Patm
72
83
275
282
283
281

FIG. 8

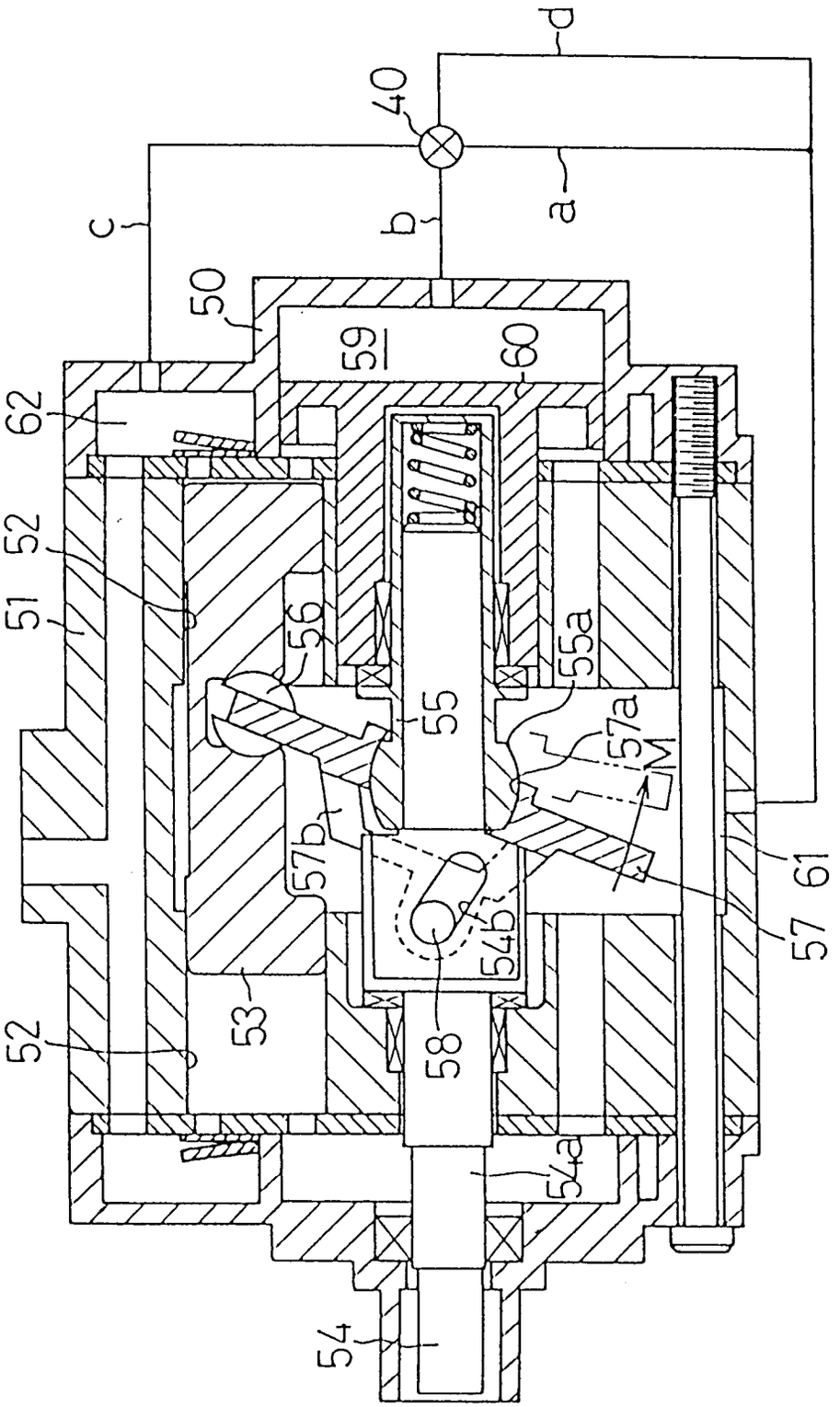
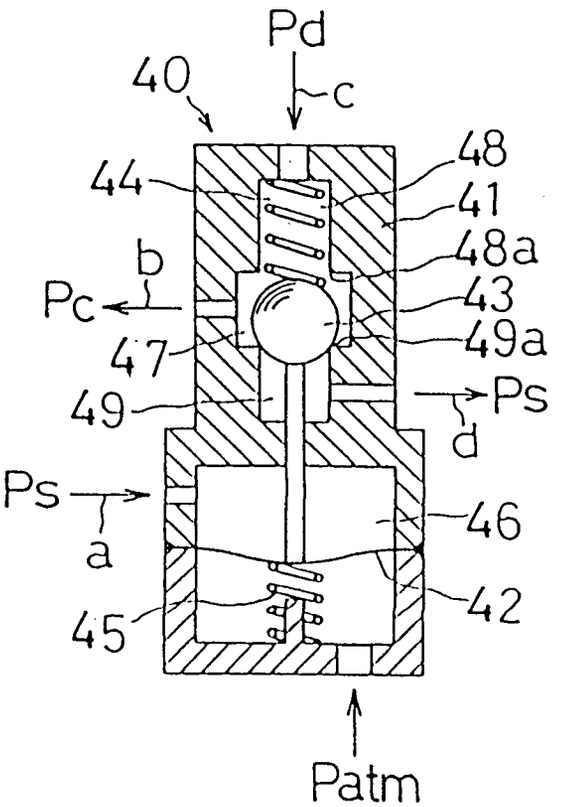

d
40
a
b
c
50
59
60
62
52
51
56
55
55a
57a
M
57b
54b
57
61
53
58
52
54a
54

FIG. 9



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP91/00750

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[5] F04B27/08

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	F04B25/00-27/08

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

Jitsuyo Shinan Koho 1926 - 1991
Kokai Jitsuyo Shinan Koho 1971 - 1991

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	JP, A, 1-219363 (K.K. Nippon Jidosha Buhin Sogo Kenkyusho and another), September 1, 1989 (01. 09. 89), Lines 6 to 18, column 1, page 5, Fig. 1 (Family: none)	1-6
Y	JP, A, 62-247186 (Toyoda Automatic Loom Works, Ltd.), October 28, 1987 (28. 10. 87), Line 16, column 4, page 4 to line 7, column 1, page 5, Fig. 1 (Family: none)	1-6
Y	JP, U, 1-144483 (Karusonic K.K.), October 4, 1989 (04. 10. 89), Column 1, page 1, Fig. 1 (Family: none)	1-6

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
July 11, 1991 (11. 07. 91)	July 29, 1991 (29. 07. 91)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	