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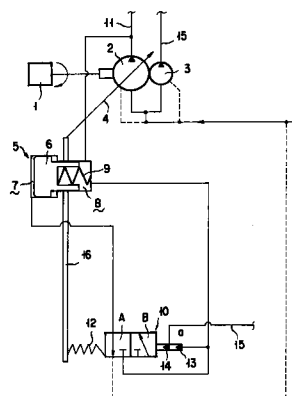
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(54) APPARATUS FOR CONTROLLING SWASH-PLATE PUMP AND MOTOR

(57) A swash-plate controlling apparatus for a swash-plate type pump or a swash-plate type motor comprises: a cylinder bore (31) formed in a housing (20); a piston (40) slidably inserted into the cylinder bore (31); a large-sized pressure-receiving chamber (43) and a small-sized pressure-receiving chamber (44) defined at both end sides of the piston, respectively, for pushing the piston in one or another direction by the action of pressurized oil charged in the respective chamber; a spool bore (45) formed at an axial central portion of the piston; a spool (47) slidably inserted into the spool bore (45); a first port (58), a second port (65) and a drain port (66) each provided between the piston and the spool, for being communicated with or shut off from each other by the action of a relative movement of the piston and the spool; another pressure-receiving chamber (54) defined at one end side of the spool for pushing the spool in one direction by the action of the pressurized oil charged in another pressure-receiving chamber; and a spring (74) for urging the piston and the spool in another direction; wherein the piston is connected to the swash-plate (4) so that a tilting angle of the swash-plate is changed when the piston is moved, wherein the small-sized pressure-receiving chamber is communicated with a main port (26) of the swash-plate type pump or the swash-plate type motor, the first port is communicated with the small-sized pressure-receiving chamber and the another pressure-receiving chamber, the second port is communicated with the large-sized

pressure-receiving chamber, and the drain port is communicated with a tank (18) through the housing; wherein a communication between the first port and the second port is shut off and the second port is communicated with the drain port when the piston is relatively moved with respect to the spool in one direction; and wherein the first port is communicated with the second port and a communication between the second port and the drain port is shut off when the piston is relatively moved in another direction with respect to the spool.

FIG. 1



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Description

TECHNICAL FIELD

The present invention relates to a swash-plate controlling apparatus for a swash-plate type pump or a swash-plate type motor enabling to set an input torque and an output torque to an almost constant value by controlling a tilting angle of the swash-plate for the swash-plate type pump and the swash-plate type motor.

BACKGROUND ART

A swash-plate type pump is a pump in which a discharge amount (capacity) per unit number of rotation is controlled to be increased or decreased by tilting the swash-plate. The capacity becomes large when a tilting angle of the swash plate is increased, while a small capacity is given for a decreased tilting angle. An input torque of the swash-plate type pump is calculated by multiplying a pressure of a delivered pressurized-oil by the capacity.

A swash-plate type motor is one in which an influent amount (capacity) per unit number of rotation is controlled to be increased or decreased by tilting the swash-plate. The capacity becomes large when a tilting angle of the swash-plate is increased, while a small capacity is given for a decreased tilting angle. An output torque of the swash-plate type motor is calculated by multiplying a pressure of a supplied pressurized-oil by the capacity.

For the purpose of retaining the input torque of the swash-plate type pump to a constant value, it is sufficient to control the tilting angle of the swash-plate by utilizing the pressure of the delivered pressurized oil. As an example of such apparatus for controlling the tilting angle of the swash plate, for example, an apparatus disclosed in Japanese Patent Laid-Open Publication No. SHO 52-90802 is well known.

The apparatus described above is constructed in a manner that a first pushing device and a servo valve are provided in a housing, so that the first pushing device pushes the swash-plate in a direction for decreasing the tilting angle or the servo valve pushes the swash-plate in a direction for increasing the tilting angle.

In this regard, the servo valve comprises: a housing; a piston slidably inserted into a first bore formed in the housing; a follow-up sleeve slidably inserted into a second bore formed in the housing; a servo spool valve slidably inserted into the follow-up sleeve; a load piston coaxially provided with regard to the servo spool valve; and a spring or the like for pushing the servo spool valve. In the servo valve described above, the tilting angle of the swash-plate is controlled by the first pushing device and the servo valve so as to take an angle which meets the delivery pressure of the swash-plate type pump.

However, the swash-plate controlling apparatus described above comprises the first pushing device and

the servo valve, and further comprises a large number of parts or elements such as the housing, piston, follow-up sleeve, servo spool valve, load piston, spring or the like, so that assembling work of the apparatus will not only be complicated but also involve high cost due to large numbers of the parts or elements to be worked and assembled. In addition, an overall size of the servo valve would become disadvantageously large, so that a large space is required for installing the housing, thereby to cause a problem that the swash-plate type pump would be assembled in a large size.

The present invention has been achieved for solving the above problems and an object of the present invention is to provide a swash-plate controlling apparatus for a swash-plate type pump or a swash-plate type motor which enables to simplify the assembling work of the apparatus due to the reduced number of the parts or elements, which can be manufactured at a low cost, and enables to manufacture the swash-plate type pump and the swash-plate type motor in a small size since an entire size of the apparatus is small and a space for installing the housing can be reduced.

DISCLOSURE OF THE INVENTION

In order to achieve the above mentioned object, the swash-plate controlling apparatus for the swash-plate type pump or the swash-plate type motor according to the present invention comprises: a housing; a cylinder bore formed in the housing; a piston slidably inserted into the cylinder bore; a large-sized pressure-receiving chamber and a small-sized pressure-receiving chamber defined at both end sides of the piston, respectively, for pushing the piston in one or another direction by the action of pressurized oil charged in the large-sized pressure-receiving chamber and the small-sized pressure-receiving chamber; a spool bore formed at an axial central portion of the piston; a spool slidably inserted into the spool bore; a first port, a second port and a drain port each provided between the piston and the spool for being communicated with or shut off from each other by the action of a relative movement of the piston and the spool; another pressure-receiving chamber defined at one end side of the spool for pushing the spool in one direction by the action of the - pressurized oil charged in another pressure-receiving chamber; and a spring for urging the piston and the spool in another direction,

wherein the piston is connected to the swash-plate of the swash-plate type pump or the swash-plate type motor so that a tilting angle of the swash-plate is changed when the piston is moved;

wherein the small-sized pressure-receiving chamber is communicated with a main port of the swash-plate type pump or the swash-plate type motor, the first port is communicated with the small-sized pressure-receiving chamber and the another pressure-receiving chamber, the second port is communicated with the large-sized pressure-receiving chamber, and

the drain port is communicated with a tank through the housing;

wherein a communication between the first port and the second port is shut off and the second port is communicated with the drain port when the piston is relatively moved with respect to the spool in one direction; and

wherein the first port is communicated with the second port and a communication between the second port and the drain port is shut off when the piston is relatively moved in another direction with respect to the spool.

In the construction described above, the swash-plate controlling apparatus adopts the basic construction in which the piston is inserted into the cylinder bore formed in the housing, the spool is inserted into the piston, and the spring for urging the spool is provided, so that it becomes possible to simplify the assembling work of the apparatus due to the reduced number of the parts or elements, and to manufacture the apparatus at a low cost. In addition, an entire size of the apparatus becomes small and a space for installing the housing can be reduced, so that the swash-plate type pump and the swash-plate type motor can be manufactured in a small size.

In the structure described above, it is preferable to screw a bolt into the housing and the bolt is locked by being fastened with a lock nut, and then, the spring is preferably interposed among the bolt and the piston and the spool.

According to this structure, when the bolt is tightened or loosened from an outside the housing, an urging force of the spring can be controlled. This means that a set value of the input torque of the swash-plate type pump or the output torque of the swash-plate type motor can be changed by a manual operation to be performed from outside the housing.

Further, in the construction described above, it is preferable that the spool is formed in a stepped-shape having a large-sized portion and a small-sized portion, the small-sized portion is formed so as to protrude to the small-sized pressure-receiving chamber, and a rod member of the plug fixed to the piston is fitted into an axial center portion of the large-sized portion formed in the spool, thereby to define a pressure-receiving chamber for changing the input torque so that an external pressure can be supplied to the pressure-receiving chamber for changing the input torque.

According to this construction, when the pressure of the pressurized oil to be supplied to the pressure-receiving chamber is changed, a force for pushing the spool in one direction can be controlled, whereby the set value of the input torque of the swash-plate type pump or the output torque of the swash-plate type motor can be changed by an external hydraulic pressure.

Furthermore, in the construction described above, it is preferable to form the another pressure-receiving chamber between the plug and the large-sized portion

of the spool.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more apparent and more easily be understood from the following detailed description when taken in conjunction with the accompanying drawings in which preferred embodiments of the present invention are shown by way of illustrative examples.

Further, the embodiments shown in the accompanying drawings are not for specifying or limiting the scope of this invention, but for merely making the explanation and understanding of this invention more easily.

In the accompanying drawings:

FIG. 1 is an explanatory view showing an operational principle of one embodiment of a swash-plate controlling apparatus for a swash-plate type pump and a swash-plate type motor according to the present invention;

FIG. 2 is a sectional view showing an embodiment of the swash-plate type pump described above;

FIG. 3 is a sectional view taken along the line III-III of FIG. 2;

FIG. 4 is an enlarged partial sectional view of FIG. 3; and

FIG. 5 is a sectional view taken along the line V-V of FIG. 2.

BEST MODE FOR EMBODYING THE INVENTION

The preferred embodiment of the swash-plate controlling apparatus for a swash-plate type pump and a swash-plate type motor according to the present invention will be described hereunder with reference to the accompanying drawings.

At first, a principle of the swash-plate controlling apparatus for a swash-plate type pump and a swash-plate type motor will be explained hereunder.

(Structure)

As shown in FIG. 1, a swash-plate type pump 2 and a fixed-capacity type pump 3 are constructed so as to be driven by an engine 1. A swash-plate 4 of the swash-plate type pump 2 is tilted by a piston 6 of a cylinder 5 through a link 16, and the piston 6 is pushed in a direction for decreasing the tilting angle by the action of the pressurized oil filling in the large-sized pressure-receiving chamber 7, or the piston 6 is pushed in a direction for increasing the tilting angle by the action of the spring 9 and the pressurized oil filling in the small-sized pressure-receiving chamber 8.

The large-sized pressure-receiving chamber 7 is connected to be switchable to either one of a tank 18 or a pump delivery path 11 (through the small-sized pressure-receiving chamber 8) by a switching operation of a

change-over valve 10. The small-sized pressure-receiving chamber 8 is normally connected to the pump delivery path 11 of the swash-plate type pump 2. The change-over valve 10 is pushed to take a drain position A by the spring 12, or pushed to take a supply position B by the pressurized oil in a first pressure-receiving portion 13 and a second pressure-receiving portion 14.

The first pressure-receiving portion 13 is connected to the pump delivery path 11 of the swash-plate type pump 2 through the small-sized pressure-receiving chamber 8, and the second pressure-receiving portion 14 is connected to the delivery path 15 of the fixed-capacity type pump 3. Further, the spring 12 of the change-over valve 10 is connected to the piston 6 through the link 16, whereby a movement of the piston 6 is fed back to the change-over valve 10.

(Operation)

In a condition as shown in FIG. 1, when a pressure of the delivered pressurized-oil (hereinafter referred to as simply to "delivery pressure") of the swash-plate type pump 2 is increased, the change-over valve 10 is pushed to take the supply position B whereby the delivered pressurized-oil from the swash-plate type pump 2 is also supplied to the large-sized pressure-receiving chamber 7. As the result, the piston 6 is pushed in a direction for decreasing the tilting angle by a pressure difference dependent on a difference in pressure-receiving areas between the large-sized pressure-receiving chamber 7 and the small-sized pressure-receiving chamber 8, so that the tilting angle of the swash-plate 4 is decreased thereby to reduce the capacity of the swash-plate type pump 2.

Further, when the link 16 is moved in the right direction in FIG. 1 in accordance with a movement of the piston 6, an urging force of the spring 12 is increased and the change-over valve 10 is then pushed to take the drain position A, whereby the large-sized pressure-receiving chamber 7 is communicated with the tank 18. As a result, the piston 6 is pushed in the direction for increasing the tilting angle by the action of the spring 9 and the delivery pressure of the pressurized oil supplied from the swash-plate type pump 2 to the small-sized pressure-receiving chamber 8, so that the tilting angle of the swash-plate 4 increases, thereby to increase the capacity of the swash-plate type pump 2.

As a result, upon repeating the sequential operations described above, the swash-plate 4 is controlled so as to provide a tilting angle so that a product of the delivery pressure and the capacity (i.e., the input torque) would be an almost constant value.

In this regard, the change-over valve 10 can be switched to take the supply position B by also the pressure in the second pressure-receiving portion 14, so that the input torque can be set to an arbitrary value by changing the pressure in the second pressure-receiving portion 14.

Next, a concrete structure of the swash-plate controlling apparatus will be explained hereunder.

(Structure of The Swash-Plate Type Pump 2)

As shown in FIG. 2, a shaft 22 is rotatably supported in the housing 20 and a cylinder block 21 is fixed to the shaft 22. The cylinder block 21 is formed to have a plurality of cylinder bores 23 whose axes are parallel to an axis of the cylinder block 21. A piston 24 is slidably inserted into the respective cylinder bores 23, and an end portion of the piston 24 is formed so as to slidably move along a front surface 4a of the swash-plate 4 through a shoe 19 in a circumferential direction of the swash-plate 4. Whenever the cylinder block 21 rotates by a rotation angle of about 180°, a piston chamber 25 of the cylinder bore 23 is alternately communicated with the main port 26 or the drain port (not shown). Consequently, while the cylinder block 21 rotates by a rotation angle of about 180°, the pressurized oil is sucked into the piston chamber 25, and while rotating at the remaining angle of 180°, the oil in the piston chamber 25 is pressurized thereby to be discharged from the main port 26.

By the way, a back surface 4b of the swash-plate 4 constitutes a part of a cylinder surface which is to be formed around a center axis contained in this specification paper, the center axis also being normal to the shaft 22 shown in FIG. 2. The swash-plate 2 is swingably supported along a guide portion 27 which constitutes a part of the cylinder surface mating with the back surface 4b of the housing 20. When a slider 28 connected to the swash plate 4 is moved by a control apparatus 29 in a direction normal to this specification paper, the swash-plate 4 swings around the axis of the cylinder surface, thereby to change the tilting angle of the swash-plate 4.

(Concrete Structure of The Controlling Apparatus 29)

As shown in FIGs. 3, 4 and 5, the housing 20 has a large-sized first screw bore 30, a cylinder bore 31 and small-sized second screw bore 32 that are coaxially and continuously formed along the same center axis. A first stopper 33 is screwed into the first screw bore 30 and is locked by a lock nut 34, while a second stopper 35 is screwed into the second screw bore 32 and is locked by another lock nut 36.

The cylinder bore 31 is formed in a stepped-shaped bore comprising a large-sized cylinder bore 37 and a small-sized cylinder bore 38. A cutout portion 39 is formed at a part of a circumferential wall of the large-sized cylinder bore 37 so as to open toward a portion in the housing 20, and a slider 28 connected to the swash-plate 4 is positioned at the cutout portion 39.

Further, a piston 40 is inserted into the cylinder bore 31, and the piston 40 is formed in a shape of stepped-piston comprising a large-sized piston 41 inserted into the large-sized cylinder bore 37 and a

small-sized piston 42 inserted into the small-sized cylinder bore 38. Consequently, a large-sized pressure-receiving chamber 43 is formed between the large-sized piston 41 and the first stopper 33, while a small-sized pressure-receiving chamber 44 is formed between the large-sized piston 42 and the second stopper 35.

Furthermore, a spool bore 45 is formed at a center axial portion of the large-sized piston 41, while a large-sized bore 46 is formed at a center axial portion of the small-sized piston 42. The spool bore 45 is formed in a shape of stepped-bore into which the spool 47 having a step is inserted. At an axial center of the large-sized portion 48 formed in the spool 47, a rod member 50 provided at a plug 49 inserted into a left end portion of the large-sized piston 41 is inserted, thereby to form a first pressure-receiving chamber 51, and the first pressure-receiving chamber 51 is communicated with an annular groove 52 of the large-sized portion 48. In addition, the plug 49 is locked by a screw plug 53 screwed into the large-sized piston 41, and a second pressure-receiving chamber 54 is formed between the plug 49 and an end surface of the large-sized portion 48.

In addition, at an axial center portion of the spool 47, a bore 55 is formed in the axial direction, and one end portion of the bore 55 is opened toward an end surface of the small-sized portion 56 of the spool 47, thereby to be communicated with the small-sized pressure-receiving chamber 44. The other end portion of the bore 55 is communicated with the first port 58 which is composed of an annular groove formed at an outer circumferential surface of the large-sized portion 48 through a bore 57 formed in a radial direction.

In addition, as shown in FIGs. 4 and 5, the first port 58 is communicated with the second pressure-receiving chamber 54 through a first small-sized hole 59 formed in a radial direction, a slit-shaped recessed portion 63 and a second small-sized hole 60, while the annular recessed portion 52 is communicated with an inlet port 64 through a third small-sized hole 61 formed in a radial direction and a slit-shaped recessed portion 62.

Further, at the large-sized portion of the spool bore 45, a second port 65 formed of an annular recessed portion and a drain port 66 formed of a small-sized bore are provided. Furthermore, the second port 65 is communicated with the large-sized pressure-receiving chamber 43 through a fourth small-sized hole 67 and a fifth small-sized hole 68. The drain port 66 is communicated with an interior (tank) of the housing 20. In addition, the small-sized pressure-receiving chamber 10 is communicated with the main port 26 through an oil bore 69 formed in the housing 20.

A bolt 70 is screw-engaged with the second stopper 35 and then fastened by a lock nut 71. A spring 74 is provided between a receiver 72 provided at top end of the bolt 70 and a movable receiver 73. In this structure, the movable receiver 73 abuts against an end portion of the small-sized portion 56 formed on the spool 47 by the

action of an urging force of the spring 74, thereby to push the spool 47 in a left direction in the figure.

The large-sized piston 41 is formed with a cutout recessed portion 75 to which the slider 28 is fitted and connected, whereby the piston 40 is connected to the swash-plate 4.

Next, an operation of the embodiment will be explained hereunder.

In an initial state where the pressurized oil is not supplied to the small-sized pressure-receiving chamber 44, the spool valve 47 and the piston 40 are pushed in a left direction by the spring 74 and the end surface of the large-sized piston 41 abuts against the first stopper 33, so that a communication between the first port 58 and the second port 65 is shut off, and the second port 65 is communicated with the drain port 66 whereby the large-sized pressure-receiving chamber 43 is communicated with the tank.

Namely, there can be established a state where the change-over valve 10 takes the drain position A.

In the state described above, when the pressurized oil (delivered pressurized oil having a pressure of P_1) in the main port 26 delivered from the swash-plate pump 2 flows into the small-sized pressure-receiving chamber 44 through the oil bore 69, the pressurized oil flows into the first port 58 through the bores 55 and 57, and then flows into the second pressure-receiving chamber 54 through the first small-sized hole 59, the recessed portion 63 and the second small-sized hole 60, and fills it.

At this time, the spool 47 is pushed and displaced in the left direction by the action of the pressure P_1 applied to the end surface of the small-sized portion 56, or pushed in the right direction by the action of the pressure P_1 applied to the end surface of the large-sized portion 48. In this regard, assuming that a diameter of the small-sized portion 56 is d_1 , a diameter of the rod member 50 is d_2 and a diameter of the large-sized portion 48 is d_3 , wherein $d_3 > d_2 > d_1$, a driving force calculated from an equation of $\pi/4 (d_3^2 - d_2^2 - d_1^2) \times P_1$ is applied to the spool 47 so as to move the spool 47 in the right direction.

When the driving force becomes larger than the urging force of the spring 47, the spool 47 is pushed in the right direction, so that the first port 58 is communicated with the second port 65, and a communication between the second port 65 and the drain port 66 is shut off, whereby the pressurized oil in the first port 58 flows into the large-sized pressure-receiving chamber 43 through the second port 65, the third small-sized hole 67 and the fourth small-sized hole 68. That is, the change-over valve 10 shown in FIG. 1 will be in a state taking the supplying position B, then the delivery pressure of the swash-plate pump 2 is applied to the large-sized pressure-receiving chamber 43.

When the pressurized oil flows into the large-sized pressure-receiving chamber 43, the piston 40 is pushed to move in the right direction by the action of the pressure difference caused by a difference between the

pressure receiving areas of the large-sized pressure-receiving chamber 43 and the small-sized pressure-receiving chamber 44. As the result, the swash-plate 4 is tilted by the slider 28 in a direction for decreasing the tilting angle.

At this time, even if the piston 40 moves in the right direction, the driving force for moving the spool 47 in the right direction is balanced with the urging force of the spring 74, so that the spool 47 remains unmoved, and then, the piston 40 relatively moves with respect to the spool 47.

When the piston 40 is moved in the right direction by a predetermined distance, the communication between the first port 58 and the second port 65 is shut off, and the second port 65 is communicated with the drain port 66, whereby the pressurized oil in the large-sized pressure-receiving chamber 43 flows into the tank through the drain port 66. At this time, the piston 40 moves in the left direction by the action of the pressure in the small-sized pressure-receiving chamber 44, so that the first port 58 is communicated with the second port 65, and the communication between the second port 65 and the drain port 66 is shut off.

By repeating the above mentioned operations, the piston 40 is stopped to a position corresponding to the delivery pressure. As a result, the tilting angle of the swash-plate 4 i.e., the capacity of the swash-plate type pump 2 is controlled to be a value corresponding to the delivery pressure, whereby the input torque of the swash-plate type pump 2 can be set to a constant value as the set value.

Further, in the above explanations, an explanation regarding to an operation of the pressurized oil in the first pressure-receiving chamber 51 is omitted. However, the first pressure-receiving chamber 51 is equivalent to the second pressure-receiving chamber 14. Therefore, when the spool 47 is pushed to move rightward by the action of the pressurized oil in the first pressure-receiving chamber 51, the value of the input torque can be changed.

Further, when the lock nut 71 is loosened and then the bolt 70 is tightened or loosened so as to change the urging force of the spring 74, the set value of the input torque can also be changed.

Furthermore, when the lock nuts 34 and 36 are loosened and then the first stopper 33 and the second stopper 35 are forwardly or backwardly moved to change the positions thereof, a maximum tilting angle and a minimum tilting angle of the swash-plate can be changed.

Though the embodiment described above relates to the swash-plate type pump, the structure of the swash-plate controlling apparatus according to the present invention can also be applied to the swash-plate type motor in the same manner as in the swash-plate type pump. In such a case, the pressurized oil is supplied to the main port 26 from a hydraulic pump, so that the apparatus may be constructed so as to introduce the

pressurized oil supplied from the hydraulic pump into the small-sized pressure-receiving chamber 44 through the main port 26 and the oil bore 69.

As described above, according to the swash-plate controlling apparatus for the swash-plate type pump or the swash-plate type motor of the present invention, the tilting angle of the swash-plate is controlled to be an angle corresponding to the hydraulic pressure of the main port 26, so that the input torque of the swash-plate type pump or the output torque of the swash-plate type motor can be set to an almost constant value.

In addition, the swash-plate controlling apparatus according to the present invention adopts a basic structure in which the piston 40 is inserted into the cylinder bore 31 formed in the housing 20, the spool 47 is inserted into the piston 40, and the spring 74 for urging the spool 47 is provided, so that it becomes possible to simplify the assembling work of the apparatus due to the reduced number of the parts or elements, and to manufacture the apparatus at a low cost. In addition, an entire size of the apparatus becomes small and a space for installing the housing can be reduced, so that the swash-plate type pump and the swash-plate type motor can be manufactured in a small size.

Furthermore, according to the swash-plate controlling apparatus of the present invention, when the bolt 70 is tightened or loosened from outside the housing 20, the urging force of the spring 74 can be controlled. This means that a set value of the input torque of the swash-plate type pump or the output torque of the swash-plate type motor can be changed by a manual operation to be performed from outside the housing.

In addition, according to the swash-plate controlling apparatus of the present invention, when the pressure of the pressurized oil to be supplied to the pressure-receiving chamber 51 is changed, a force for pushing the spool 47 in one direction can be controlled, whereby the set value of the input torque of the swash-plate type pump or the output torque of the swash-plate type motor can be changed by an external hydraulic pressure.

Although the present invention has been described with reference to the exemplified embodiments, it will be apparent to those skilled in the art that various modifications, changes, omissions, additions and other variations can be made in the disclosed embodiments of the present invention without departing from the scope or spirit of the present invention. Accordingly, it should be understood that the present invention is not limited to the described embodiments and shall include the scope specified by the elements defined in the appended claims and scope equivalent to the claims.

Claims

1. A swash-plate controlling apparatus for a swash-plate type pump or a swash-plate type motor comprising: a housing; a cylinder bore formed in said housing; a piston slidably inserted into said cylinder

bore; a large-sized pressure-receiving chamber and a small-sized pressure-receiving chamber defined at both end sides of said piston, respectively, for pushing the piston in one or another direction by the action of pressurized oil charged in said large-sized pressure-receiving chamber and said small-sized pressure-receiving chamber; a spool bore formed at an axial central portion of the piston; a spool slidably inserted into the spool bore; a first port, a second port and a drain port each provided between the piston and the spool for being communicated with or shut off from each other by the action of a relative movement of the piston and the spool; another pressure-receiving chamber defined at one end side of the spool for pushing the spool in one direction by the action of the pressurized oil charged in another pressure-receiving chamber; and a spring for urging the piston and the spool in another direction,

wherein said piston is connected to the swash-plate of the swash-plate type pump or the swash-plate type motor so that a tilting angle of the swash-plate is changed when the piston is moved;

wherein said small-sized pressure-receiving chamber is communicated with a main port of the swash-plate type pump or the swash-plate type motor, said first port is communicated with the small-sized pressure-receiving chamber and the another pressure-receiving chamber, said second port is communicated with the large-sized pressure-receiving chamber and said drain port is communicated with a tank through the housing;

wherein a communication between the first port and the second port is shut off and the second port is communicated with the drain port when the piston is relatively moved with respect to the spool in one direction; and

wherein said first port is communicated with said second port and a communication between the second port and the drain port is shut off when the piston is relatively moved in another direction with respect to said spool.

2. A swash-plate controlling apparatus for a swash-plate type pump or a swash-plate type motor according to claim 1, wherein said housing is provided with a bolt to be screwed into the housing and said bolt is fixed and locked by fastening a lock nut thereto and said spring is interposed among said bolt and the piston and the spool.
3. A swash-plate controlling apparatus for a swash-plate pump or a swash-plate type motor according to claim 1 or 2, wherein said spool is formed in a stepped-shape having a large-sized portion and a small-sized portion, said small-sized portion is formed so as to protrude to said small-sized pressure-receiving chamber and a rod member of the

plug fixed to the piston is fitted into an axial center portion of said large-sized portion formed in the spool, thereby to define a pressure-receiving chamber for changing an input torque so that an external pressure can be supplied to said pressure-receiving chamber for changing the input torque.

4. A swash-plate controlling apparatus for a swash-plate type pump or a swash-plate type motor according to claim 1 or 2, wherein said another pressure-receiving chamber is formed between the plug and the large-sized portion of the spool.

FIG. 1

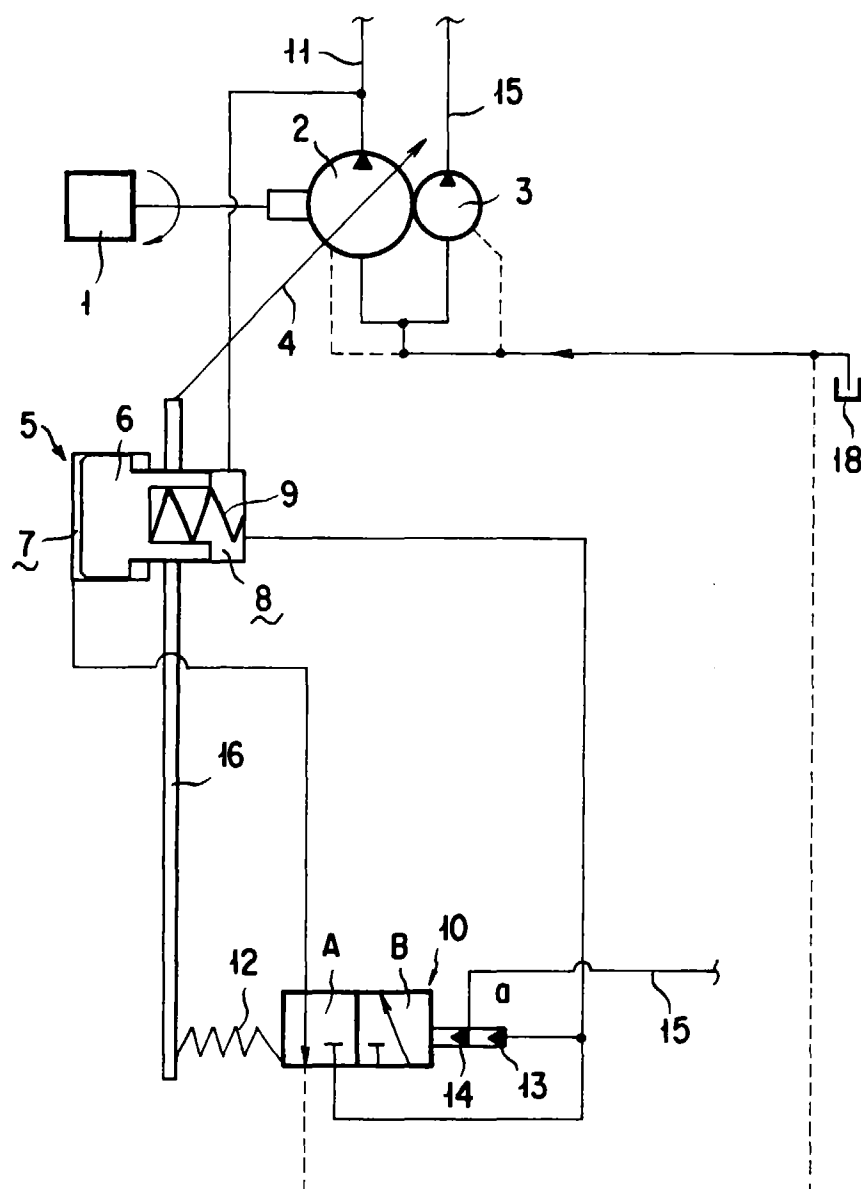


FIG. 2

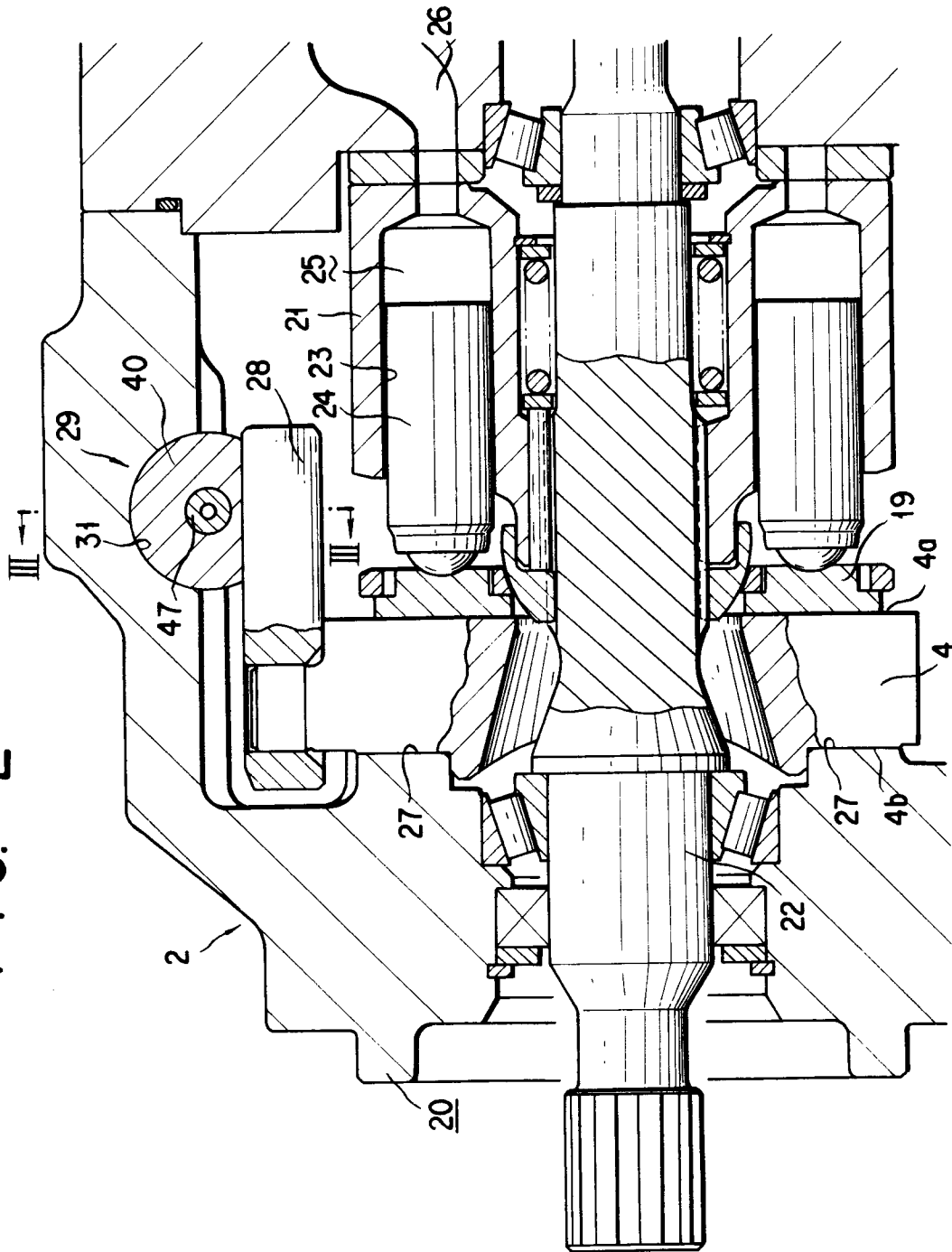


FIG. 3

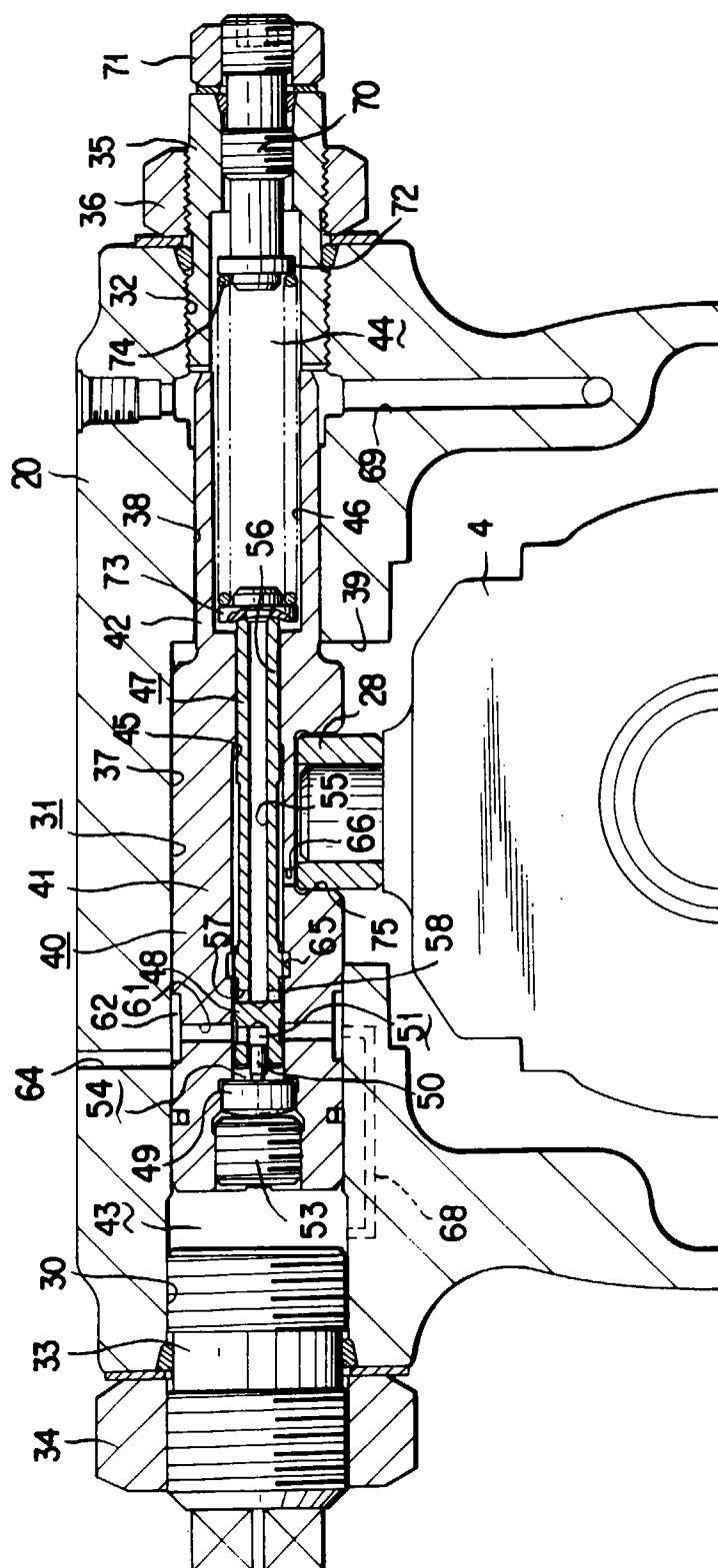


FIG. 4

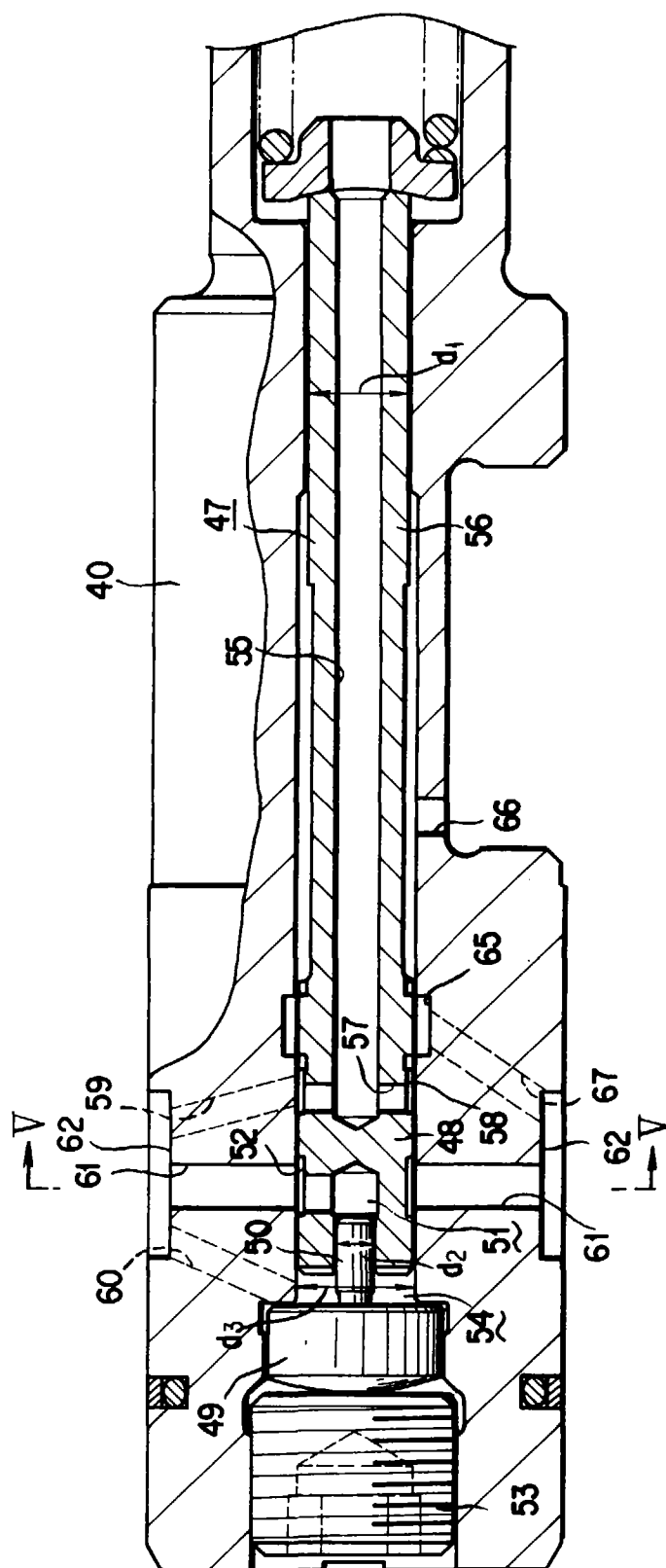
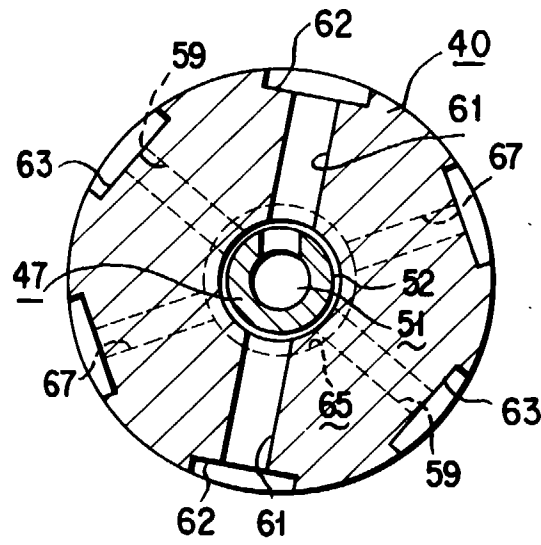


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP96/01006

A. CLASSIFICATION OF SUBJECT MATTER

Int. C1⁶ F04B1/26, 101, F03C1/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. C1⁶ F04B1/26, 101, F03C1/40

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1926 - 1996

Kokai Jitsuyo Shinan Koho 1971 - 1996

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 60-113076, A (Daikin Industries, Ltd.), June 19, 1985 (19. 06. 85) (Family: none)	1 - 4
A	JP, 63-106381, A (Kayaba Industry Co., Ltd.), May 11, 1988 (11. 05. 88) (Family: none)	1 - 4
A	JP, 5-99124, A (Komatsu Ltd.), April 20, 1993 (20. 04. 93) (Family: none)	1 - 4

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search

June 18, 1996 (18. 06. 96)

Date of mailing of the international search report

July 9, 1996 (09. 07. 96)

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