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(54) **FLUID PRESSURE CONTROL DEVICE**

(57) A fluid pressure control device 100 includes a first pump passage (10) through which working oil discharged from a first pump (P1) is led, a second pump passage (11) through which the working oil discharged from a second pump (P2) is led, a main passage (12) to which the working oil discharged from the first pump (P1) or the second pump (P2) is selectively led, the main passage communicating with a tank (T), a first control valve (20) provided in the first pump passage (10) and configured to control the flow of the working oil which is supplied to and discharged from a first hydraulic cylinder (1), a second control valve (30) provided in the main passage (12) and configured to control the flow of the working oil which is supplied to and discharged from a second hydraulic cylinder (2), and a switching valve (40) provided in the main passage (12) and configured to selectively switch between the first pump passage (10) and the second pump passage 11 as the passage communicating with the main passage (12).

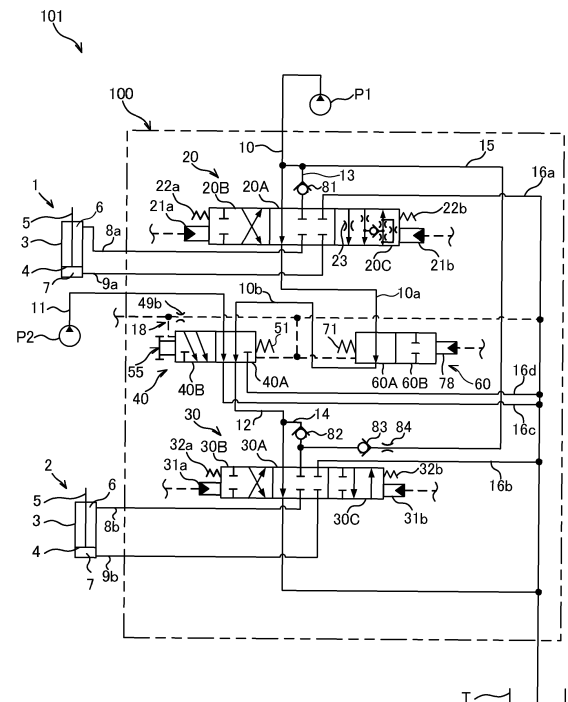


FIG.2

Description

TECHNICAL FIELD

[0001] The present invention relates to a fluid pressure control device.

BACKGROUND ART

[0002] As a hydraulic drive device of a construction machine, JP2012-241803A discloses a hydraulic drive device of a working machine including first and second hydraulic pumps configured to supply pressure oil that respectively actuate a boom cylinder and an arm cylinder, a first boom direction control valve connected to the first hydraulic pump in parallel and configured to control a flow of pressure oil supplied to a boom cylinder, a second arm direction control valve connected to the first hydraulic pump in parallel and configured to control a flow of pressure oil supplied to an arm cylinder, a second boom direction control valve connected to the second hydraulic pump in parallel and configured to control the flow of the pressure oil supplied to the boom cylinder, and a first arm direction control valve connected to the second hydraulic pump in parallel and configured to control the flow of the pressure oil supplied to the arm cylinder.

[0003] This hydraulic drive device further includes a third hydraulic pump configured to supply pressure oil that respectively actuates the boom cylinder and the arm cylinder, a third boom direction control valve connected to the third hydraulic pump and configured to control the flow of the pressure oil supplied to the boom cylinder, a third arm direction control valve connected to the third boom direction control valve in tandem and configured to control the flow of the pressure oil supplied to the arm cylinder, and a second spare direction control valve connected to the third hydraulic pump in parallel to the third boom direction control valve.

[0004] In this hydraulic drive device, by providing a second actuator configured to drive a second specialty attachment connected to an arm and supplying the pressure oil of the third hydraulic pump to the second actuator via the second spare direction control valve, it is possible to drive the second specialty attachment.

SUMMARY OF INVENTION

[0005] In the hydraulic drive device of JP2012-241803A, the third boom direction control valve and the second spare direction control valve are connected to the third hydraulic pump in parallel to each other. Therefore, in a case where the third boom direction control valve and the second spare direction control valve are operated at the same time, by an action of the actuator controlled by one of the control valves, a flow rate of a working fluid supplied to the actuator which is controlled by the other control valve is varied. Thus, at the time of operating the third boom direction control valve and the

second spare direction control valve at the same time, there is a possibility that the action of the actuators controlled by these control valves becomes unstable.

[0006] In order to prevent such an unstable action of the actuators, JP2012-241803A describes that a pipeline part connecting the third hydraulic pump and the second spare direction control valve may be shut off and an additional hydraulic pump may be connected to an additional pump port of the second spare direction control valve via a pipe. According to this, pressure oil of the additional hydraulic pump is supplied to the actuator via the second spare direction control valve, so that it is possible to drive the specialty attachment independently from a boom operation, etc.

[0007] However, whether a certain control valve (spare direction control valve) is connected to the same pump as the other control valve (boom direction control valve) in parallel or connected to another pump independently from the other control valve depends on the working machine to which the hydraulic drive device is installed, needs, etc.

[0008] Depending on whether or not a certain control valve is connected to the same pump as the other control valve in parallel or made independent, a pump configured to supply the working fluid is different and hence a pipe structure is also different.

[0009] Therefore, in the hydraulic drive device described in JP2012-241803A, the hydraulic drive device having plural pipe structures has to be manufactured responding to the working machine to which the hydraulic drive device is installed, needs, etc., and manufacturing cost is increased.

[0010] An object of the present invention is to reduce manufacturing cost of a fluid pressure control device.

[0011] According to one aspect of the present invention, a fluid pressure control device includes: a first pump passage through which a working fluid discharged from a first pump is led; a second pump passage through which a working fluid discharged from a second pump is led; a main passage to which the working fluid discharged from the first pump or the second pump is selectively led; a first control valve provided in the first pump passage and configured to control a flow of the working fluid which is supplied to and discharged from a first actuator; a second control valve provided in the main passage and configured to control a flow of the working fluid which is supplied to and discharged from a second actuator; a supply passage branching from the main passage, the working fluid being led to the second control valve through the supply passage; a parallel passage branching from the first pump passage, the parallel passage being connected to the supply passage; a check valve provided in the parallel passage and configured to allow only a flow of the working fluid from the first pump toward the supply passage; and a switching valve provided in the main passage and configured to selectively switch between the first pump passage and the second pump passage as a passage communicating with the main passage. The switching

valve has: a first switching position at which the first pump passage and the main passage communicate with each other; and a second switching position at which the second pump passage and the main passage communicate with each other.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

Fig. 1 is a configuration diagram showing part of a hydraulic excavator.

Fig. 2 is a hydraulic circuit diagram showing a fluid pressure control device according to an embodiment of the present invention.

Fig. 3 is an enlarged view of part of the hydraulic circuit diagram showing the fluid pressure control device according to the embodiment of the present invention.

Fig. 4 is a sectional view showing a switching valve and a bypass cut valve of the fluid pressure control device according to the embodiment of the present invention, showing a state where the switching valve is placed at a first switching position and the bypass cut valve is placed at an open position.

Fig. 5 is an enlarged sectional view showing the switching valve of the fluid pressure control device according to the embodiment of the present invention.

Fig. 6 is a sectional view showing the switching valve and the bypass cut valve of the fluid pressure control device according to the embodiment of the present invention, showing a state where the switching valve is placed at a second switching position and the bypass cut valve is placed at a shut-off position.

Fig. 7 is a sectional view showing the switching valve and the bypass cut valve of the fluid pressure control device according to the embodiment of the present invention, showing a state where the switching valve is switched to the second switching position by pilot pressure.

DESCRIPTION OF EMBODIMENTS

[0013] Hereinafter, with reference to the drawings, a fluid pressure control device 100 according to an embodiment of the present invention will be described. Hereinafter, the fluid pressure control device 100 used for a construction machine, in particular, for a hydraulic excavator (see Fig. 1) and provided in a fluid pressure control system 101 which is configured to control a flow of a working fluid supplied to and discharged from fluid pressure actuators will be described as an example.

[0014] First, with reference to Fig. 2, the entire configuration of the fluid pressure control system 101 including the fluid pressure control device 100 will be described.

[0015] The fluid pressure control system 101 includes first and second pumps P1 and P2 configured to dis-

charge working oil which serves as the working fluid, a tank T in which the working oil is stored, a first hydraulic cylinder (fluid pressure cylinder) 1 serving as a first actuator configured to drive an object to be driven such as a boom 102, an arm 103, or a bucket 104 (see Fig. 1), a second hydraulic cylinder (fluid pressure cylinder) 2 serving as a second actuator configured to drive a spare attachment (not shown), and the fluid pressure control device 100 configured to control actions of the first hydraulic cylinder 1 and the second hydraulic cylinder 2. Hereinafter, a case where the first hydraulic cylinder 1 drives the boom 102 will be described as an example, and hydraulic cylinders configured to drive the objects to be driven other than the boom 102 will not be described in detail.

[0016] The first pump P1 and the second pump P2 are respectively driven by an engine (not shown) or a motor (not shown) and discharge the working oil.

[0017] The first hydraulic cylinder 1 and the second hydraulic cylinder 2 have the same configurations as each other. Therefore, hereinafter, the configurations of the first hydraulic cylinder 1 will be specifically described, and the configurations of the second hydraulic cylinder 2 will be given the same reference signs as the corresponding configurations of the first hydraulic cylinder 1 and will not be described in detail.

[0018] The first hydraulic cylinder 1 is a double-acting type cylinder having a piston 4 configured to define the inside of a cylinder tube 3 into a rod-side chamber 6 and a bottom side chamber 7. A piston rod 5 is coupled to the piston 4. The working oil is supplied to and discharged from the rod-side chamber 6 of the first hydraulic cylinder 1 through a first rod side passage 8a. The working oil is supplied to and discharged from the bottom side chamber 7 of the first hydraulic cylinder 1 through a first bottom side passage 9a. The working oil is supplied to and discharged from a rod-side chamber 6 of the second hydraulic cylinder 2 through a second rod side passage 8b. The working oil is supplied to and discharged from a bottom side chamber 7 of the second hydraulic cylinder 2 through a second bottom side passage 9b.

[0019] By supplying the working oil to the bottom side chamber 7 and discharging the working oil from the rod-side chamber 6, the first hydraulic cylinder 1 extends and lifts the boom 102. On the contrary, by supplying the working oil to the rod-side chamber 6 and discharging the working oil from the bottom side chamber 7, the first hydraulic cylinder 1 contracts and lowers the boom 102. In the first hydraulic cylinder 1 configured to drive the boom 102, the bottom side chamber 7 is a load side pressure chamber to which self-weight of the boom 102 is applied, and the rod-side chamber 6 is an anti-load side pressure chamber. Therefore, by letting the bottom side chamber 7 serving as the load side pressure chamber communicate with the tank T, the first hydraulic cylinder 1 can also contract by the self-weight of the boom 102. The actions of the first hydraulic cylinder 1 and the second hydraulic cylinder 2 will be described in detail later.

[0020] Next, the fluid pressure control device 100 will

be described.

[0021] The fluid pressure control device 100 controls a flow of the working oil discharged from the first pump P1 and the second pump P2 and controls extension and contraction of the first hydraulic cylinder 1 and the second hydraulic cylinder 2. The first hydraulic cylinder 1 extends and contracts by supplying the working oil discharged from the first pump P1. The second hydraulic cylinder 2 extends and contracts by selectively supplying the working oil discharged from the first pump P1 or the second pump P2. Hereinafter, with reference to the hydraulic circuit diagram of Fig. 2, the entire configuration of the fluid pressure control device 100 will be described.

[0022] As shown in Fig. 2, the fluid pressure control device 100 includes a first pump passage 10 through which the working oil discharged from the first pump P1 is led, a second pump passage 11 through which the working oil discharged from the second pump P2 is led, a main passage 12 to which the working oil discharged from the first pump P1 or the second pump P2 is selectively led, a first control valve 20 provided in the first pump passage 10 and configured to control a flow of the working oil which is supplied to and discharged from the first hydraulic cylinder 1, a second control valve 30 provided in the main passage 12 and configured to control the flow of the working oil which is supplied to and discharged from the second hydraulic cylinder 2, and a switching valve 40 provided in the main passage 12 and configured to selectively switch between the first pump passage 10 and the second pump passage 11 as a passage communicating with the main passage 12.

[0023] Each of the first control valve 20 and the second control valve 30 has a spool (not shown) and serves as a spool valve whose position is switched by moving the spool.

[0024] The first control valve 20 has a pair of pilot chambers 21a, 21b and springs 22a, 22b serving as biasing members, and is actuated in accordance with a pressure difference between the pair of pilot chambers 21a, 21b.

[0025] The first pump passage 10, a first branch passage 13 branching from the first pump passage 10 on the upstream of the first control valve 20 (on the first pump P1 side), a first tank passage 16a communicating with the tank T, and the first rod side passage 8a and the first bottom side passage 9a respectively connected to the first hydraulic cylinder 1 are connected to the first control valve 20. A first check valve 81 configured to allow a flow of the working oil running from the first pump P1 toward the first control valve 20 and restricts a reverse flow is provided in the first branch passage 13.

[0026] The first control valve 20 has a first neutral position 20A at which the first pump passage 10 is opened, and a first extension position 20B and a first contraction position 20C at which the working oil led from the first pump passage 10 is led to the first hydraulic cylinder 1 through the first branch passage 13.

[0027] In a state where pilot pressure is not led to the

pair of pilot chambers 21a, 21b of the first control valve 20, the first control valve 20 is held at the first neutral position 20A by the pair of springs 22a, 22b. At the first neutral position 20A, the first rod side passage 8a, the first bottom side passage 9a, the first branch passage 13, and the first tank passage 16a are respectively shut off. Therefore, the first hydraulic cylinder 1 does not extend and contract and is maintained in a load holding state.

[0028] When the pilot pressure is led to the pilot chamber 21a of the first control valve 20, the first control valve 20 is switched to the first extension position 20B. At the first extension position 20B, the first branch passage 13 and the first bottom side passage 9a communicate with each other, and the first tank passage 16a and the first rod side passage 8a communicate with each other. At the first extension position 20B, the first pump passage 10 is shut off. Therefore, when the first control valve 20 is switched to the first extension position 20B, the working oil discharged from the first pump P1 is supplied to the bottom side chamber 7, and the working oil of the rod-side chamber 6 is discharged to the tank T. Thereby, the first hydraulic cylinder 1 extends.

[0029] When the pilot pressure is led to the other pilot chamber 21b of the first control valve 20, the first control valve 20 is switched to the first contraction position 20C. At the first contraction position 20C, the first branch passage 13 and the first rod side passage 8a communicate with each other, and the first tank passage 16a and the first bottom side passage 9a communicate with each other. At the first contraction position 20C, the first pump passage 10 is opened via a pump restrictor 23 configured to apply resistance to a flow of the working oil passing therethrough. When the first control valve 20 is switched to the first contraction position 20C, the bottom side chamber 7 communicates with the tank T. Thus, the first hydraulic cylinder 1 contracts by discharge pressure supplied from the first pump P1 to the rod-side chamber 6 or a load of the boom 102. The first contraction position 20C corresponds to a driving position.

[0030] With reference to Fig. 3, the first contraction position 20C of the first control valve 20 will be more specifically described. Hereinafter, at the first contraction position 20C, a flow passage allowing communication between the first branch passage 13 and the first rod side passage 8a serves as a "first communication passage 27", and a flow passage allowing communication between the first tank passage 16a and the first bottom side passage 9a serves as a "second communication passage 28". A rod side restrictor 24 and a bottom side restrictor 25 are provided in the first control valve 20 as restrictors configured to apply resistance to the flow of the working oil passing therethrough. The rod side restrictor 24 is provided in the first communication passage 27. The bottom side restrictor 25 has a first restrictor 25a and a second restrictor 25b provided in the second communication passage 28 in series with respect to each other, and a third restrictor 25c provided in parallel to the

first restrictor 25a and the second restrictor 25b.

[0031] The first communication passage 27 and the second communication passage 28 communicate with each other through a third communication passage 29. The third communication passage 29 communicates with the second communication passage 28 in a flow passage between the first restrictor 25a and the second restrictor 25b. An inside check valve 85 configured to allow only a flow of the working oil running from the second communication passage 28 toward the first communication passage 27 is provided in the third communication passage 29. Specific contents to switch the first control valve 20 to the first contraction position 20C and let the first hydraulic cylinder 1 contract will be described in detail later.

[0032] The second control valve 30 has a pair of pilot chambers 31a, 31b and springs 32a, 32b serving as biasing members, and is actuated in accordance with a pressure difference between the pair of pilot chambers 31a, 31b. As shown in Fig. 2, the second control valve 30 is provided in the main passage 12 to which the working oil discharged from the first pump P1 or the second pump P2 is led, the main passage communicating with the tank T. The main passage 12, a second branch passage 14 serving as a supply passage branching from the main passage 12 on the upstream of the second control valve 30, a second tank passage 16b communicating with the tank T, and the second rod side passage 8b and the second bottom side passage 9b respectively connected to the second hydraulic cylinder 2 are connected to the second control valve 30.

[0033] A parallel passage 15 branching from the first pump passage 10 on the upstream of the first control valve 20 joins the second branch passage 14. By the parallel passage 15, the working oil discharged from the first pump P1 is led to the second control valve 30. A second check valve 82 configured to allow a flow of the working oil running from the main passage 12 toward the second control valve 30 and restrict a reverse flow is provided in the second branch passage 14. By the second check valve 82, the working oil led by the parallel passage 15 is restricted from being led to the main passage 12. A third check valve 83 configured to allow a flow of the working oil running from the first pump passage 10 toward the second branch passage 14 and restrict a reverse flow is provided in the parallel passage 15. A restrictor 84 configured to apply resistance to the flow of the working oil passing therethrough is provided in the parallel passage 15 on the upstream side of the third check valve 83 (on the first pump P1 side).

[0034] The second control valve 30 has a second neutral position 30A at which the main passage 12 is opened, and a second extension position 30B and a second contraction position 30C serving as supply positions at which the working oil discharged from the first pump P1 or the second pump P2 is supplied to the second hydraulic cylinder 2.

[0035] In a state where the pilot pressure is not led to the pair of pilot chambers 31a, 31b of the second control

valve 30, the second control valve 30 is held at the second neutral position 30A by the pair of springs 32a, 32b. At the second neutral position 30A, the second branch passage 14, the second rod side passage 8b, the second bottom side passage 9b, and the second tank passage 16b are respectively shut off. Therefore, the second hydraulic cylinder 2 does not extend and contract and is maintained in a load holding state.

[0036] When the pilot pressure is led to the pilot chamber 31a of the second control valve 30, the second control valve 30 is switched to the second extension position 30B. At the second extension position 30B, the second branch passage 14 and the second bottom side passage 9b communicate with each other, and the second tank passage 16b and the second rod side passage 8b communicate with each other. At the first extension position 20B, the main passage 12 is shut off. Therefore, when the second control valve 30 is switched to the second extension position 30B, the working oil discharged from the first pump P1 or the second pump P2 is supplied to the bottom side chamber 7 through the second branch passage 14, and the working oil of the rod-side chamber 6 is discharged to the tank T. Thereby, the second hydraulic cylinder 2 extends.

[0037] When the pilot pressure is led to the other pilot chamber 31b of the second control valve 30, the second control valve 30 is switched to the second contraction position 30C. At the second contraction position 30C, the second branch passage 14 and the second rod side passage 8b communicate with each other, and the second tank passage 16b and the second bottom side passage 9b communicate with each other. At the second extension position 30B, the main passage 12 is shut off. Therefore, when the second control valve 30 is switched to the second contraction position 30C, the working oil discharged from the first pump P1 or the second pump P2 is supplied to the rod-side chamber 6 through the second branch passage 14, and the working oil of the bottom side chamber 7 is discharged to the tank T. Thereby, the second hydraulic cylinder 2 contracts.

[0038] The switching valve 40 has a spool (see Fig. 4) and serves as a two-position spool valve whose position is switched by moving the spool. Hereinafter, the spool of the switching valve 40 will be called a "first spool 41".

[0039] The switching valve 40 is connected to the first pump passage 10 through which the working oil discharged from the first pump P1 is led, the second pump passage 11 through which the working oil discharged from the second pump P2 is led, the main passage 12 through which the working oil is led to the second control valve 30 (second hydraulic cylinder 2), and a third tank passage 16c and a fourth tank passage 16d respectively communicating with the tank T.

[0040] The switching valve 40 has a first switching position 40A at which the first pump passage 10 and the main passage 12 communicate with each other and the second pump passage 11 and the third tank passage 16c communicate with each other, and a second switch-

ing position 40B at which the second pump passage 11 and the main passage 12 communicate with each other and the first pump passage 10 and the fourth tank passage 16d communicate with each other. When the switching valve 40 is switched to the first switching position 40A, the working oil discharged from the first pump P1 is led to the second control valve 30 through the main passage 12. When the switching valve 40 is switched to the second switching position 40B, the working oil discharged from the second pump P2 is led to the second control valve 30 through the main passage 12. Therefore, by switching the position of the switching valve 40, it is possible to select whether the working oil is led to the second control valve 30 from the first pump P1 or the working oil is led to the second control valve 30 from the second pump P2.

[0041] The switching valve 40 has a first spring 51 serving as a first biasing member configured to bias the first spool 41 so that the switching valve 40 is placed at the first switching position 40A, and a switching portion 55 configured to move the first spool 41 against biasing force of the first spring 51 by a manual operation of an operator and switch to the second switching position 40B. Specific configurations and operations of the switching valve 40 will be described in detail later.

[0042] The fluid pressure control device 100 further includes a bypass cut valve 60 provided in the first pump passage 10 on the downstream of the first control valve 20 and on the upstream of the switching valve 40 (between the first control valve 20 and the switching valve 40).

[0043] The bypass cut valve 60 has a spool (see Fig. 4) and serves as a two-position spool valve whose position is switched by moving the spool. Hereinafter, the spool of the bypass cut valve 60 will be called a "second spool 61".

[0044] The bypass cut valve 60 has an open position 60A at which the first pump passage 10 is opened, and a shut-off position 60B at which the first pump passage 10 is shut off. The bypass cut valve 60 has a second spring 71 serving as a second biasing member configured to bias the second spool 61 so that the bypass cut valve 60 is placed at the open position 60A, and a pilot chamber 78 to which pilot pressure that biases the second spool 61 against biasing force of the second spring 71 is led. Specific configurations and operations of the bypass cut valve 60 will be described in detail later.

[0045] Next, actions of the fluid pressure control device 100 will be described.

[0046] In the fluid pressure control device 100, by switching the position of the switching valve 40, switching is made between an action of also driving the second hydraulic cylinder 2 by the first pump P1 configured to supply the working oil to the first hydraulic cylinder 1, and an action of driving the first hydraulic cylinder 1 by the first pump P1 and driving the second hydraulic cylinder 2 by the second pump P2. Hereinafter, a case where the switching valve 40 is placed at the first switching position

40A and a case where the switching valve 40 is placed at the second switching position 40B will be respectively described.

5 [First Switching Position 40A]

[0047] First, the case where the switching valve 40 is switched to the first switching position 40A will be described. In a case where the switching valve 40 is placed at the first switching position 40A, the first pump passage 10 and the main passage 12 communicate with each other, and the working oil discharged from the first pump P1 is led to the second control valve 30.

15 [Single Drive of First Hydraulic Cylinder 1]

[0048] In a case where the second hydraulic cylinder 2 is not driven but the first hydraulic cylinder 1 is singly driven, the second control valve 30 is switched to the second neutral position 30A by the pair of springs 32a, 32b. The bypass cut valve 60 is switched to the open position 60A.

[0049] In a case where the first hydraulic cylinder 1 extends, in accordance with an operation of an operation lever (not shown) by the operator, the pilot pressure is led to the pilot chamber 21a of the first control valve 20. Thereby, the first control valve 20 is switched to the first extension position 20B.

[0050] When the first control valve 20 is switched to the first extension position 20B, the working oil discharged from the first pump P1 is led to the bottom side chamber 7 of the first hydraulic cylinder 1 through the first pump passage 10, the first branch passage 13, and the first bottom side passage 9a. The working oil of the rod-side chamber 6 of the first hydraulic cylinder 1 is discharged to the tank T from the first rod side passage 8a through the first tank passage 16a. Thereby, the first hydraulic cylinder 1 extends.

[0051] In a case where the first hydraulic cylinder 1 contracts, in accordance with an operation of the operation lever by the operator, the pilot pressure is led to the other pilot chamber 21b of the first control valve 20. Thereby, the first control valve 20 is switched to the first contraction position 20C.

[0052] When the first control valve 20 is switched to the first contraction position 20C, the first branch passage 13 and the first rod side passage 8a communicate with each other, and the first pump passage 10 is opened via the pump restrictor 23. At the time of single contraction of the first hydraulic cylinder 1, the main passage 12 is opened by the second control valve 30 and communicates with the tank T. Therefore, the first pump passage 10 communicates with the tank T through the main passage 12, and the discharge pressure of the first pump P1 is not led to the rod-side chamber 6. Meanwhile, in the first hydraulic cylinder 1 configured to drive the boom 102, the self-weight of the boom 102 is applied to the bottom side chamber 7. Therefore, in this case, the bot-

tom side chamber 7 contracts not by the discharge pressure of the first pump P1 but by the load of the boom 102, and the working oil of the bottom side chamber 7 is discharged to the tank T through the first bottom side passage 9a and the first tank passage 16a. The working oil is supplied to the rod-side chamber 6 through the first branch passage 13 following an increase in capacity. In this way, the first hydraulic cylinder 1 contracts by the load of the boom 102.

[0053] The working oil discharged from the bottom side chamber 7 at the time of contraction of the first hydraulic cylinder 1 is led to the tank T through the first restrictor 25a, the second restrictor 25b, and the third restrictor 25c provided in the second communication passage 28 of the first control valve 20 (see Fig. 3). Therefore, the first hydraulic cylinder 1 contracts at speed corresponding to resistance applied by the first restrictor 25a, the second restrictor 25b, and the third restrictor 25c. Thus, by adjusting the resistance applied by the first restrictor 25a, the second restrictor 25b, and the third restrictor 25c, it is possible to adjust the speed of contraction of the first hydraulic cylinder 1.

[0054] By adjusting the resistance applied by the first restrictor 25a, the second restrictor 25b, and the third restrictor 25c, it is also possible to regenerate the working oil discharged from the bottom side chamber 7 to the first communication passage 27 through the second communication passage 28 and the third communication passage 29. Specifically speaking, by adjusting flow passage resistance (opening degrees) of the first restrictor 25a and the third restrictor 25c, it is possible to adjust a ratio between a flow rate (bleed flow rate) of the working oil discharged to the tank T and a flow rate (regeneration flow rate) regenerated to the first communication passage 27 in the working oil discharged from the bottom side chamber 7 of the first hydraulic cylinder 1. In a case where the opening degree of the first restrictor 25a is larger than the opening degree of the third restrictor 25c, the ratio of the regeneration flow rate is increased in accordance with a difference between the opening degrees. On the contrary, in a case where the opening degree of the first restrictor 25a is smaller than the opening degree of the third restrictor 25c, the ratio of the bleed flow rate is increased in accordance with the difference between the opening degrees. In this way, by mainly adjusting the opening degrees of the first restrictor 25a and the third restrictor 25c, it is possible to adjust the regeneration flow rate and the bleed flow rate.

[Single Drive of Second Hydraulic Cylinder 2]

[0055] In a case where the switching valve 40 is placed at the first switching position 40A, and the first hydraulic cylinder 1 is not driven but the second hydraulic cylinder 2 is singly driven, the first control valve 20 is switched to the first neutral position 20A by the pair of springs 22a, 22b. The bypass cut valve 60 is switched to the open position 60A. The working oil discharged from the first

pump P1 is led to the main passage 12 through the first pump passage 10 and the parallel passage 15.

[0056] In a case where the second hydraulic cylinder 2 extends, in accordance with an operation of the operation lever by the operator, the pilot pressure is led to the pilot chamber 31a of the second control valve 30. Thereby, the second control valve 30 is switched to the second extension position 30B.

[0057] When the second control valve 30 is switched to the second extension position 30B, the working oil discharged from the first pump P1 and led to the main passage 12 is led to the bottom side chamber 7 of the second hydraulic cylinder 2 through the second bottom side passage 9b. The working oil of the rod-side chamber 6 of the second hydraulic cylinder 2 is discharged to the tank T from the second rod side passage 8b through the second tank passage 16b. Thereby, the second hydraulic cylinder 2 extends.

[0058] In a case where the second hydraulic cylinder 2 contracts, in accordance with an operation of the operation lever by the operator, the pilot pressure is led to the other pilot chamber 31b of the second control valve 30. Thereby, the second control valve 30 is switched to the second contraction position 30C.

[0059] When the second control valve 30 is switched to the second contraction position 30C, the working oil discharged from the first pump P1 and led through the main passage 12 is led to the rod-side chamber 6 of the second hydraulic cylinder 2 through the second rod side passage 8b. The working oil of the bottom side chamber 7 of the second hydraulic cylinder 2 is discharged to the tank T from the second bottom side passage 9b through the second tank passage 16b. Thereby, the second hydraulic cylinder 2 contracts.

[Double Action]

[0060] Next, a double action in which the first hydraulic cylinder 1 extends and contracts and the second hydraulic cylinder 2 also extends and contracts will be described. Hereinafter, a case where the first control valve 20 is switched to the first extension position 20B and the first hydraulic cylinder 1 extends, and the second control valve 30 is switched to the second extension position 30B and the second hydraulic cylinder 2 extends as the double action will be described.

[0061] A case where the first hydraulic cylinder 1 extends in the double action is basically the same as the case where the first hydraulic cylinder 1 singly extends, and hence will not be described in detail.

[0062] When the first control valve 20 is switched to the first extension position 20B, the first pump passage 10 is shut off. Therefore, the working oil discharged from the first pump P1 is not led to the second branch passage 14 through the first pump passage 10 and the main passage 12. Meanwhile, the working oil discharged from the first pump P1 is led to the second branch passage 14 through the parallel passage 15. Therefore, the working

oil led from the parallel passage 15 to the second bottom side passage 9b through the second branch passage 14 is supplied to the bottom side chamber 7 of the second hydraulic cylinder 2, and the second hydraulic cylinder 2 extends.

[0063] In this way, in the double action in a case where the switching valve 40 is placed at the first switching position 40A, part of the working oil discharged from the first pump P1 is led to the first hydraulic cylinder 1 through the first pump passage 10, and the remaining working oil discharged from the first pump P1 is led to the second hydraulic cylinder 2 through the parallel passage 15.

[0064] In the double action, the second control valve 30 is switched to the second extension position 30B or the second contraction position 30C. Therefore, in a case where the first hydraulic cylinder 1 contracts in the double action, and when the first control valve 20 is switched to the first contraction position 20C, communication between the main passage 12 and the tank T is shut off by the second control valve 30. Thus, in a case where the first hydraulic cylinder 1 contracts in the double action, the discharge pressure of the first pump P1 is led to the rod-side chamber 6 and the first hydraulic cylinder 1 contracts by the discharge pressure of the first pump P1.

[Jack Lifting]

[0065] As described above, when the bypass cut valve 60 is placed at the open position 60A, the second control valve 30 is placed at the second neutral position 30A, and the first control valve 20 is placed at the first contraction position 20C, the first pump passage 10 communicates with the tank T, and the first hydraulic cylinder 1 contracts by the load (self-weight) of the boom 102. Such contraction of the first hydraulic cylinder 1 by the load of the boom 102 is performed in a state where the bucket 104 is not grounded.

[0066] Meanwhile, in the hydraulic excavator, by letting the first hydraulic cylinder 1 contract (lowering the boom 102) in a state where the bucket 104 is grounded, a jack lifting action of lifting the body of the hydraulic excavator is performed. In the jack lifting action, the discharge pressure of the first pump P1 is led to the rod-side chamber 6 of the first hydraulic cylinder 1 and the first hydraulic cylinder 1 contracts.

[0067] At the time of performing the jack lifting action, the pilot pressure is led to the pilot chamber 78 of the bypass cut valve 60 by an operation of the operation lever of the operator. Thereby, the bypass cut valve 60 is switched to the shut-off position 60B, and the first pump passage 10 is shut off. Therefore, in a state where the bypass cut valve 60 is placed at the shut-off position 60B and even when the first control valve 20 is switched to the first contraction position 20C, the first pump passage 10 does not communicate with the tank T. Thus, the discharge pressure of the first pump P1 is led to the rod-side chamber 6 of the first hydraulic cylinder 1 through the first branch passage 13 and the first rod side passage

8a. Thereby, the first hydraulic cylinder 1 contracts by the discharge pressure of the first pump P1, and hence exerts thrust force to lift the body of the hydraulic excavator. In this way, the jack lifting action is performed.

[Second Switching Position 40B]

[0068] Next, a case where the switching valve 40 is switched to the second switching position 40B and the working oil discharged from the second pump P2 is led to the second control valve 30 will be described. In a case where the switching valve 40 is switched to the second switching position 40B, the second pump passage 11 and the main passage 12 communicate with each other, and the first pump passage 10 communicates with the tank T through the fourth tank passage 16d. In a case where the switching valve 40 is placed at the first switching position 40A and the second control valve 30 is placed at the second neutral position 30A, the first pump passage 10 also communicates with the tank T. Therefore, single drive of the first hydraulic cylinder 1 in a case where the switching valve 40 is placed at the second switching position 40B is the same as the case where the switching valve 40 is placed at the first switching position 40A. The jack lifting action is also the same irrespective of the position of the switching valve 40. Therefore, hereinafter, single drive of the second hydraulic cylinder 2 and a double action will be described.

[Single Drive of Second Hydraulic Cylinder 2]

[0069] In a case where the switching valve 40 is placed at the second switching position 40B, the working oil discharged from the second pump P2 is led to the second branch passage 14 through the main passage 12. In a case where the switching valve 40 is placed at the second switching position 40B, the first pump passage 10 communicates with the tank T. Thus, the parallel passage 15 also communicates with the tank T. Therefore, the working oil discharged from the first pump P1 is not led but only the working oil discharged from the second pump P2 is led to the second branch passage 14.

[0070] Therefore, by switching the second control valve 30, the working oil discharged from the second pump P2 is led to the second hydraulic cylinder 2 through the second branch passage 14. In this way, in a case where the switching valve 40 is placed at the second switching position 40B, the second hydraulic cylinder 2 is driven by the working oil discharged from the second pump P2.

[Double Action]

[0071] In a case where the switching valve 40 is placed at the second switching position 40B, and when the first control valve 20 is switched to the first contraction position 20C, the first pump passage 10 communicates with the tank T through the pump restrictor 23. Therefore, the

working oil discharged from the first pump P1 is not led to the parallel passage 15 and only the working oil discharged from the second pump P2 is led to the second branch passage 14.

[0072] In a case where the switching valve 40 is placed at the second switching position 40B, and when the first control valve 20 is switched to the first extension position 20B, the first pump passage 10 is shut off. Therefore, the working oil discharged from the first pump P1 is led to the parallel passage 15. Since the restrictor 84 and the third check valve 83 are provided in the parallel passage 15, a pressure loss is generated in a flow of the working oil led to the parallel passage 15 by the restrictor 84. Since part of the working oil discharged from the first pump P1 is led to the first hydraulic cylinder 1, a flow rate of the working oil led to the parallel passage 15 is accordingly reduced and pressure is also lowered. Therefore, the discharge pressure of the second pump P2 led to the second branch passage 14 becomes larger than the discharge pressure of the first pump P1 led to the parallel passage 15. Thus, the third check valve 83 is not opened and the working oil passing through the parallel passage 15 is restricted from being led to the second branch passage 14. That is, since the third check valve 83 is not opened, only the working oil discharged from the second pump P2 is led to the second branch passage 14.

[0073] In this way, even in the double action in a case where the switching valve 40 is placed at the second switching position 40B, as well as the case where the second hydraulic cylinder 2 is singly driven, the second hydraulic cylinder 2 is driven by the working oil discharged from the second pump P2.

[0074] As described above, in a case where the switching valve 40 is placed at the first switching position 40A, the second hydraulic cylinder 2 is driven by the working oil discharged from the first pump P1 both in the case where the second hydraulic cylinder 2 is singly driven and the case where the double action is performed. In a case where the switching valve 40 is placed at the second switching position 40B, the second hydraulic cylinder 2 is driven by the working oil discharged from the second pump P2 both in the case where the second hydraulic cylinder 2 is singly driven and the case where the double action is performed.

[0075] The spare attachment driven by the second hydraulic cylinder 2 is different in accordance with the type of the hydraulic excavator in which the fluid pressure control device 100 is installed. In a case where large thrust force is required for driving the spare attachment, there is a need for enlarging the second hydraulic cylinder 2. In a case where the working oil of the first pump P1 is led both to the first hydraulic cylinder 1 and the second hydraulic cylinder 2, a flow rate of the working oil supplied to one of the first hydraulic cylinder 1 and the second hydraulic cylinder 2 is varied by an action of the other hydraulic cylinder. Therefore, in a case where the second hydraulic cylinder 2 is relatively large, the flow rate of the

working oil supplied to the second hydraulic cylinder 2 is accordingly increased and there is a possibility that the actions of the first hydraulic cylinder 1 and the second hydraulic cylinder 2 become unstable at the time of the double action.

[0076] On the contrary, there is sometimes a case where the second hydraulic cylinder 2 is small or a case where variation in the flow rate of the working oil supplied to the first hydraulic cylinder 1 and the second hydraulic cylinder 2 is allowed at the time of the double action. In this case, by driving both the first hydraulic cylinder 1 and the second hydraulic cylinder 2 by the working oil of the first pump P1, it is possible to provide no second pump P2 or to utilize the second pump P2 for drive of another hydraulic cylinder. Thus, there is an advantage in terms of cost and efficiency.

[0077] In the fluid pressure control device 100, by switching the position of the switching valve 40 by the manual operation, it is possible to select whether the working oil is led to the second hydraulic cylinder 2 from the first pump P1 or the working oil is led to the second hydraulic cylinder 2 from the second pump P2 in accordance with the type of the hydraulic excavator or needs of a user. It is possible to select the pump configured to supply the working oil to the second hydraulic cylinder 2 by switching the switching valve 40. Thus, in a case where the user drives the second hydraulic cylinder 2 by any pump, it is possible to share a pipe structure of the fluid pressure control device 100. Therefore, it is possible to reduce manufacturing cost of the fluid pressure control device 100.

[0078] In other words, by manually switching the position of the switching valve 40, it is possible to use the identical fluid pressure control device 100 for different hydraulic excavators or for different needs of the user. Thus, the manufacturing cost is reduced.

[0079] In the fluid pressure control device 100, the bypass passage 15 branching from the first pump passage 10 is connected to the second branch passage 14. The second branch passage 14 does not communicate with the tank T when the second control valve 30 is placed at any position. At the time of switching the switching valve 40 to the second switching position 40B, the third check valve 83 is closed by the discharge pressure of the second pump P2. Thus, the discharge pressure of the first pump P1 is not led to the second control valve. Therefore, at the time of letting the first hydraulic cylinder 1 extend in a case where the switching valve 40 is placed at the second switching position 40B, the working oil discharged from the first pump P1 is not led to the tank T or other devices through the bypass passage 15 irrespective of the position of the second control valve 30. In this way, in the fluid pressure control device 100, at the time of placing the switching valve 40 at the second switching position 40B and making the first hydraulic cylinder 1 and the second hydraulic cylinder 2 independent from each other, it is possible to lead all the working oil discharged from the first pump P1 to the first hydraulic cylinder 1 and

let the first hydraulic cylinder 1 extend. That is, in the fluid pressure control device 100, at the time of switching the switching valve 40 to the second switching position 40B, it is also possible to effectively utilize the working oil discharged from the first pump P1. In the present embodiment, when the switching valve 40 is placed at the first switching position 40A, communication between the bypass passage 15 and the tank T is shut off or the working oil is led to the second hydraulic cylinder 2 through the bypass passage 15. Therefore, at the time of placing the switching valve 40 at the first switching position 40A, it is also possible to effectively utilize the working oil discharged from the first pump P1.

[0080] Next, with reference to Figs. 4 and 5, the specific configurations of the switching valve 40 and the bypass cut valve 60 will be described.

[0081] As shown in Fig. 4, the fluid pressure control device 100 includes a housing 90 configured to accommodate the switching valve 40 and the bypass cut valve 60. An accommodation hole 91 serving as a through hole whose ends are open on end surfaces 90a, 90b of the housing 90 is formed in the housing 90. The accommodation hole 91 is formed as a through hole whose inner diameter is uniform.

[0082] The first pump passage 10, the second pump passage 11, the main passage 12, the third tank passage 16c, and the fourth tank passage 16d are formed in the housing 90, and respectively opened on an inner peripheral surface of the accommodation hole 91 through annular ports (reference signs are not shown). Further, in the housing 90, an annular drain port 18a communicating with the tank T is formed and opened on the inner peripheral surface of the accommodation hole 91. Hereinafter, a portion of the first pump passage 10 on the upstream side of the bypass cut valve 60 will be called an "upstream passage 10a" and a portion of the first pump passage 10 on the downstream side will be called a "downstream passage 10b".

[0083] The switching valve 40 has the first spool 41 slidably inserted into the accommodation hole 91. The bypass cut valve 60 has the second spool 61 slidably inserted into the accommodation hole 91. The first spool 41 of the switching valve 40 and the second spool 61 of the bypass cut valve 60 are coaxially accommodated in the accommodation hole 91 while opposing each other.

[0084] The switching valve 40 has a first cap 50 attached to the end surface 90a of the housing 90 and configured to seal one opening of the accommodation hole 91, the first spring 51 provided in the first cap 50 and configured to bias the first spool 41 in the direction in which the first spool 41 is separated from the second spool 61 (leftward in the figure), a pair of first spring seats 52, 53 serving as a pair of first seating members on which both ends of the first spring 51 are seated, the first seating members being configured to relatively move following extension and contraction of the first spring 51, the switching portion 55 attached to the first cap 50 and configured to move the first spool 41 against the biasing force

of the first spring 51 by the manual operation, an inner pressure chamber 58 formed inside the first cap 50, and an introduction port 50c formed in the first cap 50, the introduction port through which the pilot pressure is led to the inner pressure chamber 58.

[0085] The first spool 41 has a first main body portion 42 configured to be brought into sliding contact with the inner peripheral surface of the accommodation hole 91, and a first support portion 46 attached to one end (left end in the figure) of the first main body portion 42.

[0086] The first main body portion 42 has a first land portion 42a, a second land portion 42b, and a third land portion 42c respectively configured to be brought into sliding contact with the inner peripheral surface of the accommodation hole 91 and placed in line with each other in the axial direction. A first annular groove 43a is formed on an outer peripheral surface between the first land portion 42a and the second land portion 42b, and a second annular groove 43b is formed on an outer peripheral surface between the second land portion 42b and the third land portion 42c.

[0087] A first small diameter portion 44 whose outer diameter is smaller than an inner diameter of the accommodation hole 91, and a second small diameter portion 45 provided on the one end side of the first small diameter portion 44 (first support portion 46 side or left side in the figure), the second small diameter portion whose outer diameter is smaller than the first small diameter portion 44 are formed in one end of the first main body portion 42. An annular space 43c is formed between the first small diameter portion 44 and the accommodation hole 91. The second small diameter portion 45 corresponds to a first projecting portion configured to project from the first small diameter portion 44 toward the first support portion 46 in the axial direction and to be abutted with the first support portion 46.

[0088] As shown in Fig. 5, the first support portion 46 is accommodated inside the first cap 50. The first support portion 46 has a first shaft portion 47 having a screw portion 47a configured to be screwed to the second small diameter portion 45 in one end of the first main body portion 42, and a first head portion 48 whose outer diameter is larger than the first shaft portion 47. The first support portion 46 is detachably attached to the first main body portion 42 by screwing the screw portion 47a of the first shaft portion 47.

[0089] The first shaft portion 47 has an outer diameter substantially identical to the second small diameter portion 45 of the first main body portion 42 and is coaxially attached to the second small diameter portion 45. A slit 48a extending in the radial direction is formed on an end surface of the first head portion 48.

[0090] A first large diameter hole 50a communicating with the accommodation hole 91, the first large diameter hole into which the first spool 41 can move, a first small diameter hole 50b communicating with the first large diameter hole 50a, the first small diameter hole whose inner diameter is smaller than the first large diameter hole 50a,

and the introduction port 50c communicating with the first large diameter hole 50a are formed in the first cap 50. The inner pressure chamber 58 is formed by the first small diameter hole 50b and the first large diameter hole 50a. The first head portion 48 of the first support portion 46 moves into the first small diameter hole 50b.

[0091] The first spring 51 is provided in an outer periphery of the first shaft portion 47 of the first support portion 46, and both ends of the first spring 51 are supported by the pair of first spring seats 52, 53. The first spring seat 52 is seated on a level difference surface 50d between the first large diameter hole 50a and the first small diameter hole 50b, and the other first spring seat 53 is seated on the end surface 90a of the housing 90 to which the first cap 50 is attached. Following extension and contraction of the first spring 51 (movement of the first spool 41), the first spring seat 52 relatively move with respect to the other first spring seat 53 along the axial direction of the first spool 41. The first spring 51 is placed between the pair of first spring seats 52, 53 in a compressed state. The first spring 51 exerts the biasing force that moves the first spool 41 so that the switching valve 40 is placed at the first switching position 40A (in other words, the first spool 41 is separated from the second spool 61 of the bypass cut valve 60).

[0092] The pair of first spring seats 52, 53 is formed in the identical shape to each other. As shown in Fig. 5, the first spring seat 52 has a disc plate shaped flange portion 52a in contact with the level difference surface 50d between the first large diameter hole 50a and the first small diameter hole 50b of the first cap 50, and a tubular boss portion 52b extending in the axial direction from the flange portion 52a toward the other first spring seat 53. One end of the first spring 51 is seated on the flange portion 52a. The boss portion 52b is inserted into the first spring 51 and supports an inner periphery of the first spring 51. An inner diameter of the flange portion 52a is formed to be smaller than an outer diameter of the first head portion 48. A slit 52c extending in the radial direction is formed on an end surface of the flange portion 52a in contact with the level difference surface 50d between the first large diameter hole 50a and the first small diameter hole 50b.

[0093] The other first spring seat 53 has a disc plate shaped flange portion 53a in contact with the end surface 90a of the housing 90, and a tubular boss portion 53b extending in the axial direction from the flange portion 53a toward the first spring seat 52. The other end of the first spring 51 is seated on the flange portion 53a. The boss portion 53b is inserted into the first spring 51 and supports the inner periphery of the first spring 51. A slit 53c extending in the radial direction is formed on an end surface of the flange portion 53a in contact with the end surface 90a of the housing 90.

[0094] The switching portion 55 has a switching bolt 56 configured to be screwed into a screw hole 50e which is formed in the first cap 50 and move with respect to the first spool 41 by the manual operation, and a regulating

nut 57 configured to regulate a change in a screwing position of the switching bolt 56 with respect to the screw hole 50e. The screw hole 50e is formed in the first cap 50 to communicate with the inner pressure chamber 58 (first small diameter hole 50b).

[0095] The switching bolt 56 is provided coaxially with the first support portion 46 of the first spool 41. The switching bolt 56 has a screwing portion 56a on which a male thread is formed to be screwed into the screw hole 50e, a contact portion 56b configured to be brought into contact with the first head portion 48 of the first spool 41 from the axial direction, and an operation portion 56c configured to be operated by the operator. The contact portion 56b is accommodated in the first small diameter hole 50b. Part of the screwing portion 56a projects to the outside of the first cap 50 and an operation portion 56c is provided in an end portion of the projecting screwing portion 56a. When the operator grips and rotates the operation portion 56c, the screwing position of the screwing portion 56a with respect to the screw hole 50e is adjusted.

[0096] The regulating nut 57 is screwed to the screwing portion 56a exposed on the outside of the first cap 50. By fastening the regulating nut 57 configured to be screwed to the switching bolt 56 onto the first cap 50, the change in the screwing position of the switching bolt 56 with respect to the screw hole 50e of the first cap 50 is regulated. On the contrary, by loosening the regulating nut 57 and generating a gap between the regulating nut 57 and the first cap 50, it is possible to adjust the screwing position of the switching bolt 56 with respect to the screw hole 50e of the first cap 50, and the switching bolt 56 can move with respect to the first spool 41.

[0097] As shown in Fig. 4, the bypass cut valve 60 has a second cap 70 attached to the end surface 90b of the housing 90 and configured to seal the other opening of the accommodation hole 91, the second spring 71 provided in the second cap 70 and configured to bias the second spool 61 in the direction in which the second spool 61 is separated from the first spool 41 (rightward in the figure), a pair of second spring seats 72, 73 serving as a pair of second seating members on which both ends of the second spring 71 are seated, the second seating members being configured to relatively move following extension and contraction of the second spring 71, and the pilot chamber 78 formed inside the second cap 70.

[0098] The second spool 61 has a second main body portion 62 configured to be brought into sliding contact with the inner peripheral surface of the accommodation hole 91, and a second support portion 66 attached to one end (right end in the figure) of the second main body portion 62.

[0099] The second main body portion 62 has a fourth land portion 62a, a fifth land portion 62b, a sixth land portion 62c, and a seventh land portion 62d respectively configured to be brought into sliding contact with the inner peripheral surface of the accommodation hole 91 and placed in line with each other in the axial direction. A third annular groove 63a is formed on an outer peripheral sur-

face between the fourth land portion 62a and the fifth land portion 62b, and a fourth annular groove 63b is formed on an outer peripheral surface between the fifth land portion 62b and the sixth land portion 62c. A fifth annular groove 63c is formed on an outer peripheral surface between the sixth land portion 62c and the seventh land portion 62d. The fifth annular groove 63c always communicates with the drain port 18a irrespective of the position of the second spool 61.

[0100] A third small diameter portion 64 whose outer diameter is smaller than the inner diameter of the accommodation hole 91, the third small diameter portion configured to project from the second main body portion 62 in the axial direction is formed in one end portion of the second main body portion 62. The third small diameter portion 64 corresponds to a second projecting portion configured to project from the second main body portion 62 toward the second support portion 66 in the axial direction and to be abutted with the second support portion 66.

[0101] The second support portion 66 is accommodated inside the second cap 70. The second support portion 66 has a second shaft portion 67 having a screw portion 67a configured to be screwed to the one end portion of the second main body portion 62 of the second spool 61, and a second head portion 68 whose outer diameter is larger than the second shaft portion 67. The second support portion 66 is detachably attached to the second main body portion 62 by screwing the screw portion 67a of the second shaft portion 67.

[0102] The second shaft portion 67 has an outer diameter substantially identical to the third small diameter portion 64 of the second main body portion 62 and is coaxially attached to the third small diameter portion 64.

[0103] A second large diameter hole 70a communicating with the accommodation hole 91, the second large diameter hole into which the second spool 61 can move, a second small diameter hole 70b communicating with the second large diameter hole 70a, the second small diameter hole whose inner diameter is smaller than the second large diameter hole 70a, and the pilot port 70c communicating with the second small diameter hole 70b are formed in the second cap 70. The pilot chamber 78 is formed by the second small diameter hole 70b and the second large diameter hole 70a. The second head portion 68 of the second support portion 66 moves into the second small diameter hole 70b.

[0104] The second spring 71 is provided in an outer periphery of the second shaft portion 67 of the second support portion 66, and both ends of the second spring 71 are supported by the pair of second spring seats 72, 73. The second spring seat 72 is seated on a level difference surface 70d between the second large diameter hole 70a and the second small diameter hole 70b of the second cap 70, and the other second spring seat 73 is seated on the other end surface 90b of the housing 90. The second spring 71 is placed between the pair of second spring seats 72, 73 in a compressed state. The sec-

ond spring 71 exerts the biasing force that moves the second spool 61 so that the bypass cut valve 60 is placed at the open position 60A (in other words, the second spool 61 is separated from the first spool 41 of the switching valve 40).

[0105] The pair of second spring seats 72, 73 is formed in the identical shape to each other. The second spring seat 72 has a disc plate shaped flange portion 72a in contact with the level difference surface 70d between the second large diameter hole 70a and the second small diameter hole 70b of the second cap 70, and a tubular boss portion 72b extending in the axial direction from the flange portion 72a toward the other second spring seat 73. An inner diameter of the flange portion 72a is formed to be smaller than an outer diameter of the second head portion 68.

[0106] The other second spring seat 73 has a disc plate shaped flange portion 73a in contact with the end surface 90b of the housing 90, and a tubular boss portion 73b extending in the axial direction from the flange portion 73a toward the second spring seat 72. Both ends of the second spring 71 are respectively seated on the flange portions 72a, 73a of the second spring seats 72, 73, and the boss portions 72b, 73b are respectively inserted into the second spring 71 and support the inner periphery of the second spring 71.

[0107] The first spool 41 and the second spool 61 are separated from each other in the axial direction not to be in contact with each other irrespective of the positions of the switching valve 40 and the bypass cut valve 60. An internal space 92 is formed by an end portion of the first spool 41 and an end portion of the second spool 61 in the accommodation hole 91.

[0108] The inner pressure chamber 58 inside the first cap 50 always communicates with the tank T through a drain passage 18. The drain passage 18 includes the slit 53c in the first spring seat 53 (see Fig. 5), the annular space 43c in an outer periphery of the first small diameter portion 44 in the first spool 41, a first internal passage 49 formed in the first main body portion 42 of the first spool 41, the internal space 92 between the first spool 41 and the second spool 61, a second internal passage 69 formed in the second main body portion 62 of the second spool 61, and the drain port 18a formed in the housing 90.

[0109] In the first internal passage 49, a first axial passage 49a passing through the axis of the first main body portion 42, the first axial passage being configured to be opened on an end surface of the first spool 41 which opposes the second spool 61 and communicating with the internal space 92, and a restrictor passage 49b communicating with the first axial passage 49a, the restrictor passage being configured to be opened in the annular space 43c in the outer periphery of the first small diameter portion 44 are formed.

[0110] In the second internal passage 69, a second axial passage 69a passing through the axis of the second main body portion 62, the second axial passage being configured to be opened on an end surface of the second

spool 61 which opposes the first spool 41 and communicating with the internal space 92, and a radial passage 69b communicating with the second axial passage 69a, the radial passage being configured to be opened in the fifth annular groove 63c. Since the fifth annular groove 63c always communicates with the drain port 18a irrespective of the position of the second spool 61, the inner pressure chamber 58 in the first cap 50 always communicates with the tank T through the drain passage 18. Since the inner pressure chamber 58 in the first cap 50 always communicates with the tank T, an erroneous action in which the first spool 41 moves by residual pressure in the first cap 50 is prevented.

[0111] The restrictor passage 49b formed in the first main body portion 42 is a restrictor portion configured to apply resistance to the flow of the working oil passing therethrough. The restrictor passage 49b is a passage in which the resistance applied to the flow of the working oil is the largest in a flow passage of the working oil from the inner pressure chamber 58 to the drain port 18a. The restrictor portion may be formed by an orifice plug, etc. configured to be detachably attached to the drain passage 18.

[0112] Next, with reference to Figs. 4, 6, and 7, actions of the switching valve 40 and the bypass cut valve 60 will be described.

[0113] In a case where the switching valve 40 is switched from the first switching position 40A (state shown in Fig. 4) to the second switching position 40B (state shown in Fig. 6) by the manual operation, the regulating nut 57 is loosened and the switching bolt 56 is rotated to move toward the first spool 41. Thereby, the first spool 41 is pressed by the switching bolt 56 and moves against the biasing force of the first spring 51. Following movement of the first spool 41 against the biasing force of the first spring 51, the first spring seat 52 is pressed by the first head portion 48 and also moves toward the other first spring seat 53.

[0114] The first spool 41 moves against the biasing force of the first spring 51 until the respective boss portions 52b, 53b of the pair of first spring seats 52, 53 are abutted. In other words, by abutting the pair of first spring seats 52, 53, the movement of the first spool 41 against the biasing force of the first spring 51 is restricted. When the first spool 41 moves until the pair of first spring seats 52, 53 is abutted, as shown in Fig. 6, the second pump passage 11 communicates with the main passage 12 through the second annular groove 43b. Communication between the downstream passage 10b of the first pump passage 10 and the main passage 12 is shut off by the second land portion 42b while the downstream passage 10b communicates with the fourth tank passage 16d through the first annular groove 43a. In this state, the regulating nut 57 is fastened onto the housing 90 and the change in the screwing position of the switching bolt 56 (position of the first spool 41) is regulated. In this way, the switching valve 40 is switched to the second switching position 40B.

[0115] In a case where the switching valve 40 is switched from the second switching position 40B (state shown in Fig. 6) to the first switching position 40A (state shown in Fig. 4), the regulating nut 57 is loosened and the switching bolt 56 is rotated to be separated from the first spool 41. Thereby, the first spool 41 receives the biasing force of the first spring 51 and moves together with the first spring seat 52 to follow the switching bolt 56 separated from the first spool 41. The first spool 41 receives the biasing force of the first spring 51 and moves until the first spring seat 52 is abutted with the level difference surface 50d between the first large diameter hole 50a and the first small diameter hole 50b. When the first spool 41 moves until the first spring seat 52 is abutted with the level difference surface 50d between the first large diameter hole 50a and the first small diameter hole 50b, as shown in Fig. 4, the downstream passage 10b of the first pump passage 10 and the main passage 12 communicate with each other through the first annular groove 43a. The second pump passage 11 communicates with the third tank passage 16c through the second annular groove 43b. In this state, the regulating nut 57 is fastened onto the housing 90 and the change in the screwing position of the switching bolt 56 is regulated. In this way, the switching valve 40 is switched from the second switching position 40B to the first switching position 40A.

[0116] As described above, by manually operating the switching portion 55, it is possible to switch the position of the switching valve 40.

[0117] In general, with a fluid pressure control device in which a switching valve configured to be switched by a manual operation is assembled, there is sometimes a case where inspection at the time of shipping is implemented by an automatic inspection line in an inspection process at the time of manufacturing. However, when the manually-operated switching valve is assembled in the fluid pressure control device, there is a need for manually performing an operation check of the switching valve by an operator separately from the inspection by the automatic inspection line. In a case where there is less space around a switching portion of the switching valve, the switching portion is not easily operated and much man-hour is required for a process for checking operations of the switching valve. In this way, there is a case where even the manually-operated switching valve needs to be actuated by an external signal such as a case where an operation check is performed by the automatic inspection line together with the fluid pressure control device. However, in the manually-operated switching valve, in order to prevent an erroneous action by residual pressure inside a first cap, the inside of the first cap desirably communicates with a tank. Therefore, in general, even when pilot pressure is supplied to the inside of the first cap, the pilot pressure is not applied to the first spool, and it is difficult to move the first spool.

[0118] Meanwhile, in the switching valve 40 according to the present embodiment, the restrictor passage 49b

is provided in the drain passage 18 through which the working oil of the inner pressure chamber 58 of the first cap 50 is led to the tank T. Thereby, the inner pressure chamber 58 always communicates with the tank T whereas resistance is applied to the working oil passing through the restrictor passage 49b. Therefore, pressure of the inner pressure chamber 58 to which the pilot pressure is led is maintained to be predetermined pressure without lowering to tank pressure by the restrictor passage 49b. Thereby, when the pilot pressure is supplied to the inner pressure chamber 58 in a state where the switching valve 40 is placed at the first switching position 40A, pressure which is not less than the tank pressure is applied to the slit 48a of the first head portion 48 through the slit 52c in the flange portion 52a of the first spring seat 52 (see Fig. 4). By the pressure applied to the first head portion 48, the first spool 41 is biased against the biasing force of the first spring 51. Therefore, as shown in Fig. 7, even when the switching portion 55 is not operated but while the pilot pressure is supplied to the inner pressure chamber 58, the switching valve 40 is switched to the second switching position 40B by the pressure generated in the inner pressure chamber 58. When supply of the pilot pressure to the inner pressure chamber 58 is stopped, the pressure of the inner pressure chamber 58 is discharged to the tank T through the drain passage 18. Therefore, the first spool 41 receives the biasing force of the first spring 51 and moves, and the switching valve 40 is switched to the first switching position 40A.

[0119] In this way, the position of the switching valve 40 can be switched by the pilot pressure in addition to switching by the manual operation. Since even the manually-operated switching valve 40 can be actuated by an external signal, it is possible to perform the operation check of the switching valve 40 by the automatic inspection line. Thus, it is possible to reduce the man-hour required for the inspection process. The switching valve 40 may be actuated by the pilot pressure not only in a case where inspection is implemented in the automatic inspection line but also in other situations.

[0120] The bypass cut valve 60 is held at the open position 60A by the biasing force of the second spring 71 in a state where the pilot pressure is not led to the pilot chamber 78. At the open position 60A, as shown in Fig. 4, the upstream passage 10a and the downstream passage 10b communicate with each other through the third annular groove 63a and the fourth annular groove 63b of the second spool 61, and the first pump passage 10 is opened.

[0121] In a case where the bypass cut valve 60 is switched from the open position 60A (state shown in Fig. 4) to the shut-off position 60B (state shown in Fig. 6), the pilot pressure is led to the pilot chamber 78 of the bypass cut valve 60. Thereby, the second spool 61 receives the pilot pressure and moves against the biasing force of the second spring 71. The second spool 61 moves against the biasing force of the second spring 71 until the boss portions 72b, 73b of the pair of second spring seats 72,

73 are abutted. Thereby, as shown in Fig. 6, communication between the upstream passage 10a and the downstream passage 10b is shut off by the fifth land portion 62b and the sixth land portion 62c of the second spool 61, and the first pump passage 10 is shut off. In this way, the bypass cut valve 60 is placed at the shut-off position 60B.

[0122] As described above, even in a state where the switching valve 40 is switched to the second switching position 40B and the bypass cut valve 60 is switched to the shut-off position 60B, the first spool 41 and the second spool 61 are not in contact with but separated from each other (see Fig. 6). Therefore, the switching valve 40 and the bypass cut valve 60 are prevented from influencing the actions each other.

[0123] Since the switching valve 40 and the bypass cut valve 60 are respectively the two-position spool valves, it is possible to insert the first spool 41 and the second spool 61 into the single accommodation hole 91 coaxially. Even in this case, the actions of the switching valve 40 and the bypass cut valve 60 do not influence each other. Therefore, in comparison to a case where the first spool 41 and the second spool 61 are respectively inserted into different accommodation holes, it is possible to downsize the housing 90 and it is also possible to reduce cost for processing the accommodation hole 91.

[0124] Next, a modified example of the present embodiment will be described. The following modified example is also included within the range of the present invention and it is also possible to combine the following modified example and the configurations of the above embodiment, or to combine the following modified examples with each other.

[0125] In the above embodiment, the first spool 41 of the switching valve 40 and the second spool 61 of the bypass cut valve 60 are inserted into the accommodation hole 91 serving as a through hole whose inner diameter is uniform. The internal space 92 is formed between the first spool 41 and the second spool 61. Meanwhile, for example, a partition wall portion may be provided between the first spool 41 and the second spool 61, and a portion of the accommodation hole 91 in which the first spool 41 is accommodated and a portion of the accommodation hole 91 in which the second spool 61 is accommodated may be partitioned by the partition wall portion. In this case, in order to discharge the pressure of the inner pressure chamber 58 in the first cap 50 to the tank T, a hole allowing communication between the portions of the accommodation hole 91 configured to accommodate the first spool 41 and the second spool 61 is desirably formed in the partition wall portion. In this case, a restrictor portion may be provided in the partition wall portion.

[0126] According to the above embodiment, the following effects are exerted.

[0127] In the fluid pressure control device 100, by switching the position of the switching valve 40 by the manual operation, it is possible to select whether the

working oil is led to the second hydraulic cylinder 2 from the first pump P1 or the working oil is led to the second hydraulic cylinder 2 from the second pump P2 in accordance with the type of the hydraulic excavator or needs of the user. It is possible to select the pump configured to supply the working oil to the second hydraulic cylinder 2 by switching the switching valve 40. Thus, in a case where the user drives the second hydraulic cylinder 2 by any pump, it is possible to share the pipe structure of the fluid pressure control device 100. Therefore, it is possible to reduce the manufacturing cost of the fluid pressure control device 100.

[0128] In the fluid pressure control device 100, the first spool 41 of the switching valve 40 and the second spool 61 of the bypass cut valve 60 are inserted into the single accommodation hole 91 while opposing each other. Thereby, it is possible to prevent enlargement of the housing 90 and to reduce the manufacturing cost.

[0129] In the fluid pressure control device 100, the restrictor passage 49b serving as the restrictor portion is formed in the drain passage 18. Thus, it is possible to switch the position of the switching valve 40 by the manual operation and it is also possible to switch the position by the pilot pressure supplied to the inner pressure chamber 58. Thereby, for example, it is possible to perform the operation check of the manually-operated switching valve 40 in the automatic inspection line. Thus, it is possible to easily manufacture the fluid pressure control device 100.

[0130] Hereinafter, the configurations, the operations, and the effects of the embodiment of the present invention will be summed up and described.

[0131] The fluid pressure control device 100 includes the first pump passage 10 through which the working oil discharged from the first pump P1 is led, the second pump passage 11 through which the working oil discharged from the second pump P2 is led, the main passage 12 to which the working oil discharged from the first pump P1 or the second pump P2 is selectively led, the main passage communicating with the tank T, the first control valve 20 provided in the first pump passage 10 and configured to control the flow of the working oil which is supplied to and discharged from the first hydraulic cylinder 1, the second control valve 30 provided in the main passage 12 and configured to control the flow of the working oil which is supplied to and discharged from the second hydraulic cylinder 2, the second branch passage 14 branching from the main passage 12, the second branch passage through which the working oil is led to the second control valve 30, the parallel passage 15 branching from the first pump passage 10, the parallel passage being connected to the second branch passage 14, the third check valve 83 provided in the parallel passage 15 and configured to allow only the flow of the working oil running from the first pump P1 toward the second branch passage 14, and the switching valve 40 provided in the main passage 12 and configured to selectively switch between the first pump passage 10 and the second pump passage

11 as the passage communicating with the main passage 12. The switching valve 40 has the first switching position 40A at which the first pump passage 10 and the main passage 12 communicate with each other, and the second switching position 40B at which the second pump passage 11 and the main passage 12 communicate with each other.

[0132] With this configuration, when the switching valve 40 is placed at the first switching position 40A, the main passage 12 through which the working oil is led to the second control valve 30 communicates with the first pump passage 10, and the working oil discharged from the first pump P1 is led to the second control valve 30. Therefore, the first hydraulic cylinder 1 and the second hydraulic cylinder 2 are respectively actuated by the working oil discharged from the first pump P1. When the switching valve 40 is placed at the second switching position 40B, the main passage 12 communicates with the second pump passage 11 and the working oil discharged from the second pump P2 is led to the second control valve 30. Therefore, the first hydraulic cylinder 1 is actuated by the working oil discharged from the first pump P1 and the second hydraulic cylinder 2 is actuated by the working oil discharged from the second pump P2 independently from each other. In this way, by switching the position of the switching valve 40, it is possible to select whether the working oil from the first pump P1 or the working oil from the second pump P2 is led to the second control valve 30. Therefore, irrespective of whether the working oil is led to the second control valve 30 from the first pump P1 or the second pump P2, it is possible to share the pipe structure. Therefore, it is possible to reduce the manufacturing cost of the fluid pressure control device 100.

[0133] In the fluid pressure control device 100, the first actuator is a hydraulic cylinder configured to extend and contract by a pressure difference between the bottom side chamber 7 to which the load of the boom 102 is applied and the rod-side chamber 6, the first control valve 20 has the first neutral position 20A at which the first pump passage 10 is opened, and the first contraction position 20C at which the first pump passage 10 is opened and the first pump passage 10 and the rod-side chamber 6 communicate with each other, the second control valve 30 has the second contraction position 30A at which the main passage 12 communicates with the tank T, and the supply position (the second extension position 30B, the second contraction position 30C) at which the working oil led from the second branch passage 14 is supplied to the second hydraulic cylinder 2, the switching valve 40 allows communication between the second pump passage 11 and the tank T at the first switching position 40A, and allows communication between the first pump passage 10 and the tank T at the second switching position 40B, and the bypass cut valve 60 configured to switch open and shut-off of the first pump passage 10 is provided in the first pump passage 10 on the downstream of the first control valve 20.

[0134] With this configuration, when the bypass cut valve 60 opens the first pump passage 10 and the first control valve 20 is placed at the first contraction position 20C in a state where the switching valve 40 is placed at the first switching position 40A and the second control valve 30 is placed at the second neutral position 30A and in a state where the switching valve 40 is placed at the second switching position 40B, the first pump passage 10 communicates with the tank T. In this case, the working oil discharged from the first pump P1 is not supplied to the first hydraulic cylinder 1 and the first hydraulic cylinder 1 is actuated by the self-weight of the load. Meanwhile, when the first control valve 20 is switched to the first contraction position 20C in a state where the first pump passage 10 is shut off by the bypass cut valve 60, communication between the first pump passage 10 and the tank T is shut off. Thus, the working oil discharged from the first pump P1 is supplied to the first hydraulic cylinder 1. Therefore, the first hydraulic cylinder 1 contracts by the pressure of the working oil discharged from the first pump P1. In this way, by switching the open and the shut-off of the first pump passage 10 by the bypass cut valve 60, it is possible to drive the first hydraulic cylinder 1 by both drive by the load and hydraulic drive.

[0135] The fluid pressure control device 100 further includes the housing 90 configured to accommodate the switching valve 40 and the bypass cut valve 60. The switching valve 40 has the first spool 41 configured to switch the position, the bypass cut valve 60 has the second spool 61 configured to switch the position, and the first spool 41 of the switching valve 40 and the second spool 61 of the bypass cut valve 60 are coaxially accommodated in the accommodation hole 91 formed in the housing 90 while opposing each other.

[0136] With this configuration, it is possible to make the housing 90 compact.

[0137] In the fluid pressure control device 100, the accommodation hole 91 is formed as a through hole whose both ends are open on the end surfaces 90a, 90b of the housing 90, the switching valve 40 further has the first cap 50 attached to the housing 90 and configured to seal the one opening of the accommodation hole 91, the inner pressure chamber 58 formed in the first cap 50, the first spring 51 provided in the first cap 50 and configured to bias the first spool 41 in the direction in which the first spool 41 is separated from the second spool 61, and the switching portion 55 provided in the first cap 50 and configured to move the first spool 41 against the biasing force of the first spring 51 by the manual operation, and the bypass cut valve 60 further has the second cap 70 attached to the housing 90 and configured to seal the other opening of the accommodation hole 91, the pilot chamber 78 formed in the second cap 70, the pilot chamber to which the pilot pressure that biases the second spool 61 toward the first spool 41 is led through the pilot port 70c, and the second spring 71 provided in the second cap 70 and configured to bias the second spool 61 in the direction in which the second spool 61 is separated from the

first spool 41.

[0138] In the fluid pressure control device 100, the introduction port 50c through which the pilot pressure that moves the first spool 41 against the biasing force of the first spring 51 is led to the inner pressure chamber 58 is formed in the first cap 50, the inner pressure chamber 58 in the first cap 50 always communicates with the tank T through the drain passage 18, and the restrictor passage 49b configured to apply resistance to the flow of the passing working fluid is provided in the drain passage 18.

[0139] In the fluid pressure control device 100, the drain passage 18 has the internal space 92 defined in the accommodation hole 91 by the end portion of the first spool 41 and the end portion of the second spool 61 opposing to each other, the first internal passage 49 formed in the first spool 41, the first internal passage allowing communication between the inner pressure chamber 58 and the internal space 92, and the second internal passage 69 formed in the second spool 61, the second internal passage allowing communication between the internal space 92 and the tank T.

[0140] With these configurations, when the pilot pressure is led to the inner pressure chamber 58, part of the working oil in the inner pressure chamber 58 is discharged through the drain passage 18 but resistance is applied by the restrictor passage 49b. Thus, predetermined pressure is generated in the inner pressure chamber 58. Therefore, by supplying the pilot pressure to the inner pressure chamber 58, thrust force that moves the first spool 41 is generated in the inner pressure chamber 58, and it is possible to move the first spool 41.

[0141] In the fluid pressure control device 100, the switching valve 40 further has the pair of first spring seats 52, 53 on which both the ends of the first spring 51 are seated, the first spring seats being configured to relatively move following extension and contraction of the first spring 51, the bypass cut valve 60 further has the pair of second spring seats 72, 73 on which both the ends of the second spring 71 are seated, the second spring seats being configured to relatively move following extension and contraction of the second spring 71, movement of the first spool 41 against the biasing force of the first spring 51 is restricted by abutting the pair of first spring seats 52, 53 with each other, and movement of the second spool 61 against the biasing force of the second spring 71 is restricted by abutting the pair of second spring seats 72, 73 with each other.

[0142] With this configuration, it is possible to easily set moving amounts of the first spool 41 and the second spool 61.

[0143] In the fluid pressure control device 100, the first spool 41 has the first main body portion 42 configured to be brought into sliding contact with the inner peripheral surface of the accommodation hole 91, and the first support portion 46 attached to the end portion of the first main body portion 42, the first support portion in which the first spring 51 is provided in the outer periphery, the

second spool 61 has the second main body portion 62 configured to be brought into sliding contact with the inner peripheral surface of the accommodation hole 91, and the second support portion 66 attached to the end portion of the second main body portion 62, the second support portion in which the second spring 71 is provided in the outer periphery, the first main body portion 42 has the second small diameter portion 45 configured to project toward the first support portion 46 in the axial direction and to be abutted with the first support portion 46, and the second main body portion 62 has the third small diameter portion 64 configured to project toward the second support portion 66 in the axial direction and to be abutted with the second support portion 66.

[0144] With this configuration, by changing projecting amounts of the second small diameter portion 45 and the third small diameter portion 64, it is possible to change the moving amounts of the first spool 41 and the second spool 61 while commonly using the first support portion 46, the second support portion 66, the first spring seats 52, 53, and the second spring seats 72, 73.

[0145] In the fluid pressure control device 100, the accommodation hole 91 is formed as a through hole whose inner diameter is uniform.

[0146] With this configuration, since it is possible to polish-finish the inner peripheral surface of the accommodation hole 91, processing precision of the accommodation hole 91 is improved.

[0147] The embodiments of the present invention described above are merely illustration of some application examples of the present invention and not of the nature to limit the technical scope of the present invention to the specific constructions of the above embodiments.

Claims

1. A fluid pressure control device, comprising:

a first pump passage through which a working fluid discharged from a first pump is led;
 a second pump passage through which a working fluid discharged from a second pump is led;
 a main passage to which the working fluid discharged from the first pump or the second pump is selectively led;
 a first control valve provided in the first pump passage and configured to control a flow of the working fluid which is supplied to and discharged from a first actuator;
 a second control valve provided in the main passage and configured to control a flow of the working fluid which is supplied to and discharged from a second actuator;
 a supply passage branching from the main passage, the working fluid being led to the second control valve through the supply passage;
 a parallel passage branching from the first pump

passage, the parallel passage being connected to the supply passage;

a check valve provided in the parallel passage and configured to allow only a flow of the working fluid from the first pump toward the supply passage; and

a switching valve provided in the main passage and configured to selectively switch between the first pump passage and the second pump passage as a passage communicating with the main passage, wherein

the switching valve has:

a first switching position at which the first pump passage and the main passage communicate with each other; and

a second switching position at which the second pump passage and the main passage communicate with each other.

2. The fluid pressure control device according to claim 1, wherein

the first actuator is a fluid pressure cylinder configured to extend and contract by a pressure difference between a load side pressure chamber to which a load of an object to be driven is applied and an anti-load side pressure chamber,
 the first control valve has:

a first neutral position at which the first pump passage is opened; and

a driving position at which the first pump passage is opened and the first pump passage and the anti-load side pressure chamber communicate with each other,
 the second control valve has:

a second neutral position at which the main passage communicates with a tank; and

a supply position at which the working fluid led from the supply passage is supplied to the second actuator,

the switching valve allows communication between the second pump passage and the tank at the first switching position, and allows communication between the first pump passage and the tank at the second switching position, and

a bypass cut valve configured to switch open and shut-off of the first pump passage is provided in the first pump passage on the downstream of the first control valve.

3. The fluid pressure control device according to claim 2, further comprising:

a housing configured to accommodate the switching valve and the bypass cut valve, where-

- in
the switching valve has a first spool configured to switch a position,
the bypass cut valve has a second spool configured to switch a position, and
the first spool of the switching valve and the second spool of the bypass cut valve are coaxially accommodated in an accommodation hole formed in the housing while opposing each other.
4. The fluid pressure control device according to claim 3, wherein
the accommodation hole is formed as a through hole whose both ends are open on end surfaces of the housing,
the switching valve further has:
- a first cap attached to the housing and configured to seal one opening of the accommodation hole;
an inner pressure chamber formed in the first cap;
a first biasing member provided in the first cap and configured to bias the first spool in the direction in which the first spool is separated from the second spool; and
a switching portion provided in the first cap and configured to move the first spool against biasing force of the first biasing member by a manual operation, and
the bypass cut valve further has:
- a second cap attached to the housing and configured to seal the other opening of the accommodation hole;
a pilot chamber formed in the second cap, pilot pressure that biases the second spool toward the first spool is led to the pilot chamber through a pilot port; and
a second biasing member provided in the second cap and configured to bias the second spool in the direction in which the second spool is separated from the first spool.
5. The fluid pressure control device according to claim 4, wherein
an introduction port through which pilot pressure that moves the first spool against the biasing force of the first biasing member is led to the inner pressure chamber is formed in the first cap,
the inner pressure chamber in the first cap always communicates with the tank through a drain passage, and
a restrictor portion configured to apply resistance to a flow of the working fluid passing therethrough is provided in the drain passage.
6. The fluid pressure control device according to claim 5, wherein
the drain passage has:
- an internal space defined in the accommodation hole by an end portion of the first spool and an end portion of the second spool opposing to each other;
a first internal passage formed in the first spool, the first internal passage allowing communication between the inner pressure chamber and the internal space; and
a second internal passage formed in the second spool, the second internal passage allowing communication between the internal space and the tank.
7. The fluid pressure control device according to any one of claims 4 to 6, wherein
the switching valve further has a pair of first seating members on which both ends of the first biasing member are seated, the first seating members being configured to relatively move following extension and contraction of the first biasing member,
the bypass cut valve further has a pair of second seating members on which both ends of the second biasing member are seated, the second seating members being configured to relatively move following extension and contraction of the second biasing member,
movement of the first spool against the biasing force of the first biasing member is restricted by abutting the pair of first seating members with each other, and
movement of the second spool against the biasing force of the second biasing member is restricted by abutting the pair of second seating members with each other.
8. The fluid pressure control device according to claim 7, wherein
the first spool has:
- a first main body portion configured to be brought into sliding contact with an inner peripheral surface of the accommodation hole; and
a first support portion in which the first biasing member is provided in an outer periphery thereof, the first support portion being attached to an end portion of the first main body portion,
the second spool has:
- a second main body portion configured to be brought into sliding contact with the inner peripheral surface of the accommodation hole; and
a second support portion in which the second biasing member is provided in an outer periphery, the second support portion being

attached to an end portion of the second main body portion,
the first main body portion has a first projecting portion configured to project toward the first support portion in the axial direction and to be abutted with the first support portion, and
the second main body portion has a second projecting portion configured to project toward the second support portion in the axial direction and to be abutted with the second support portion.

9. The fluid pressure control device according to any one of claims 3 to 6, wherein the accommodation hole is formed as a through hole whose inner diameter is uniform.

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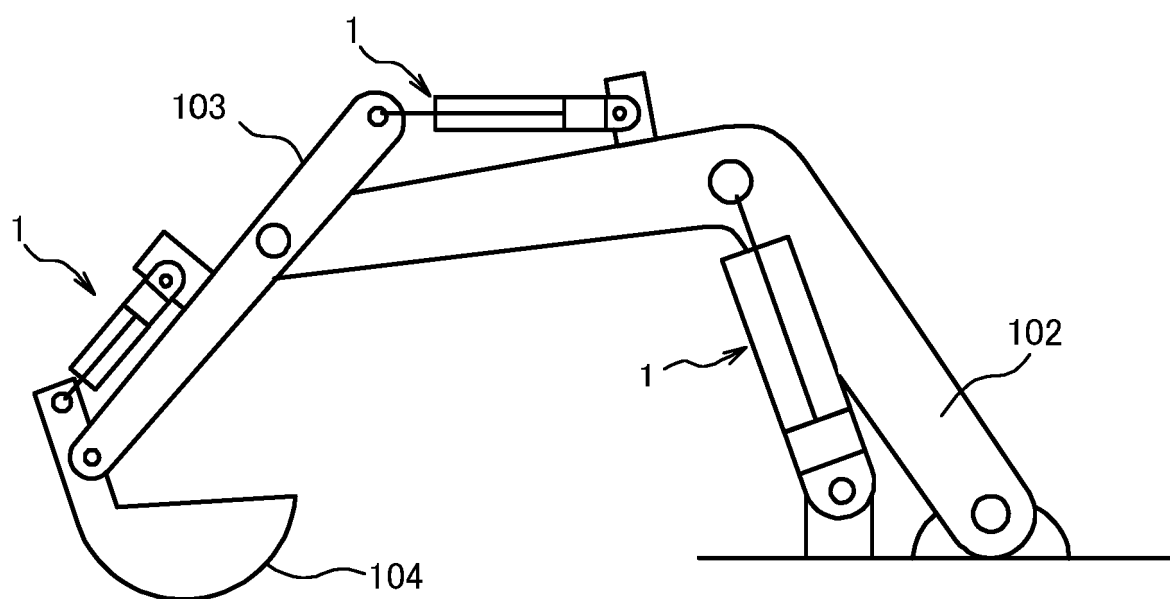


FIG. 1

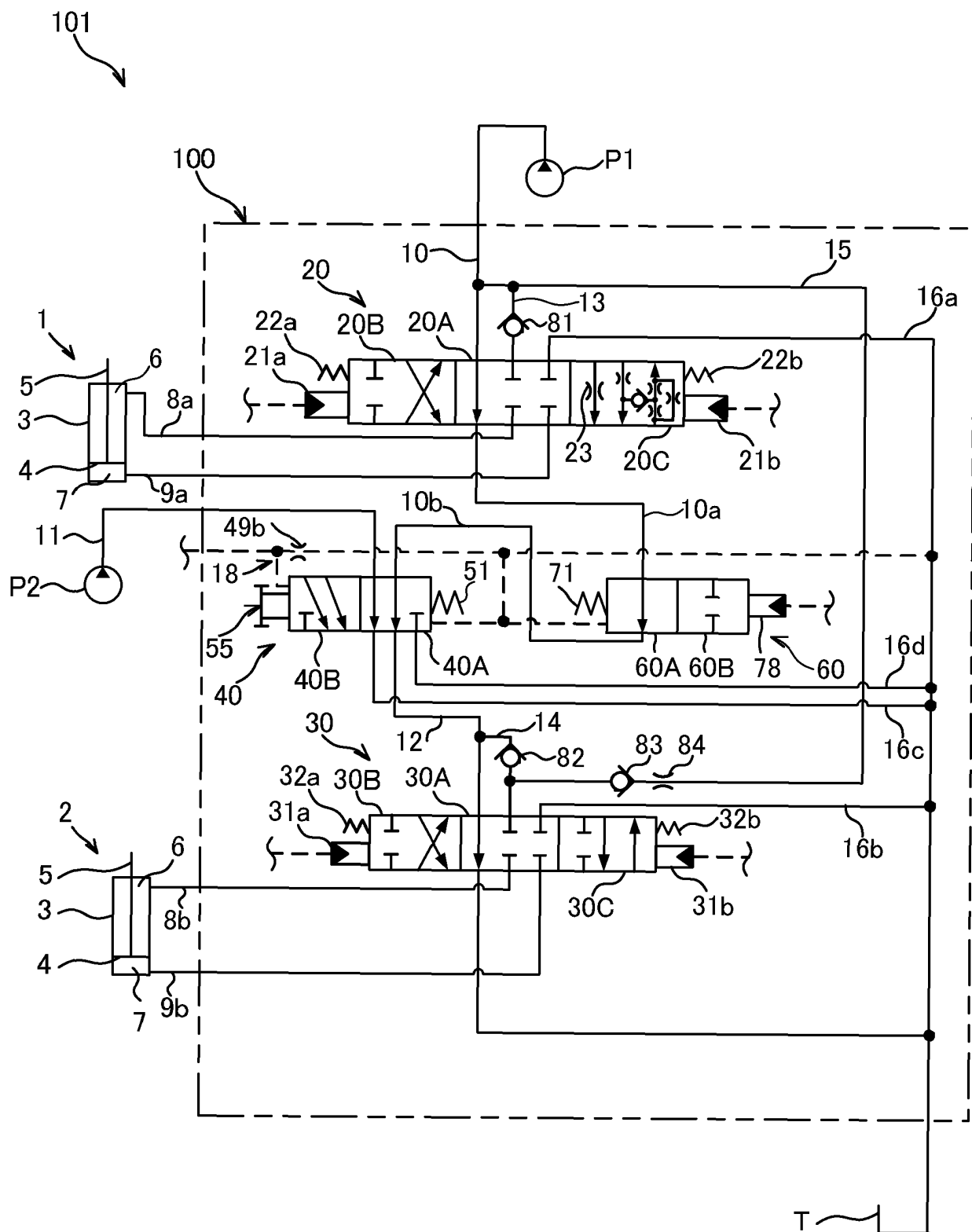


FIG.2

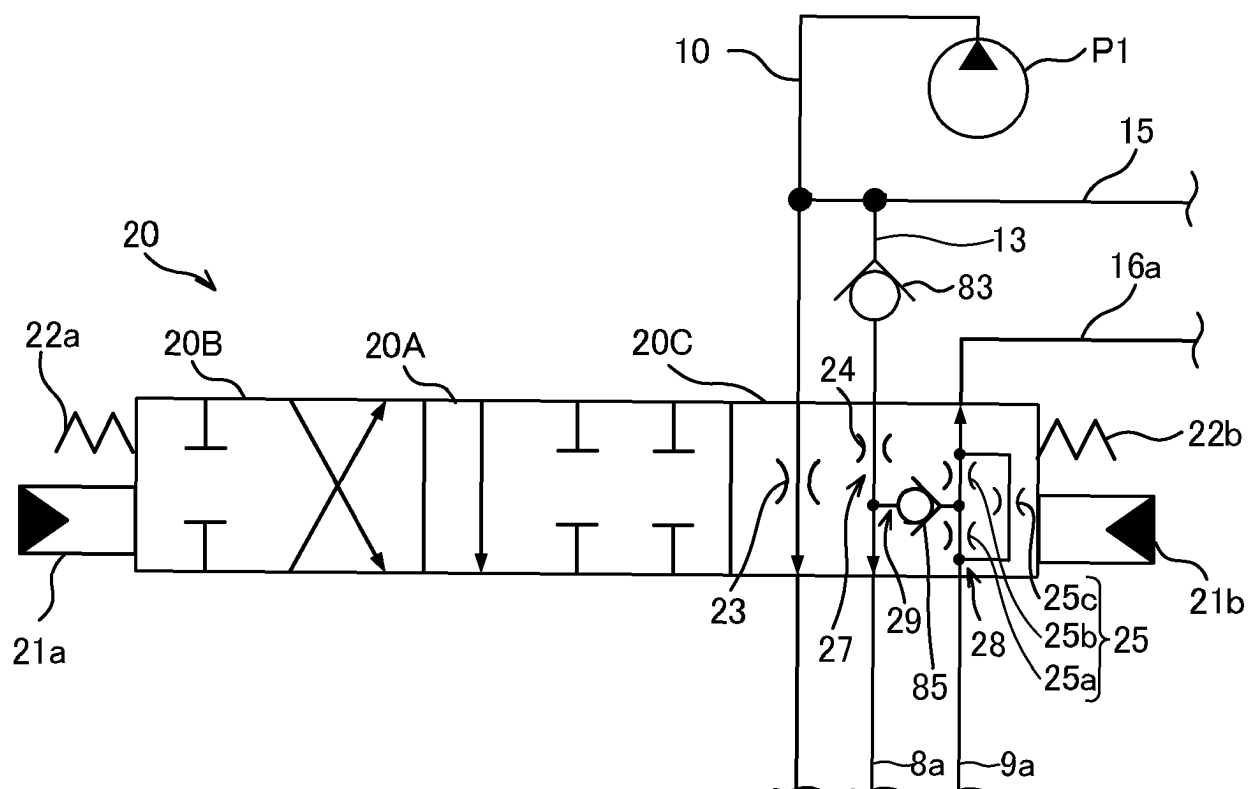


FIG.3

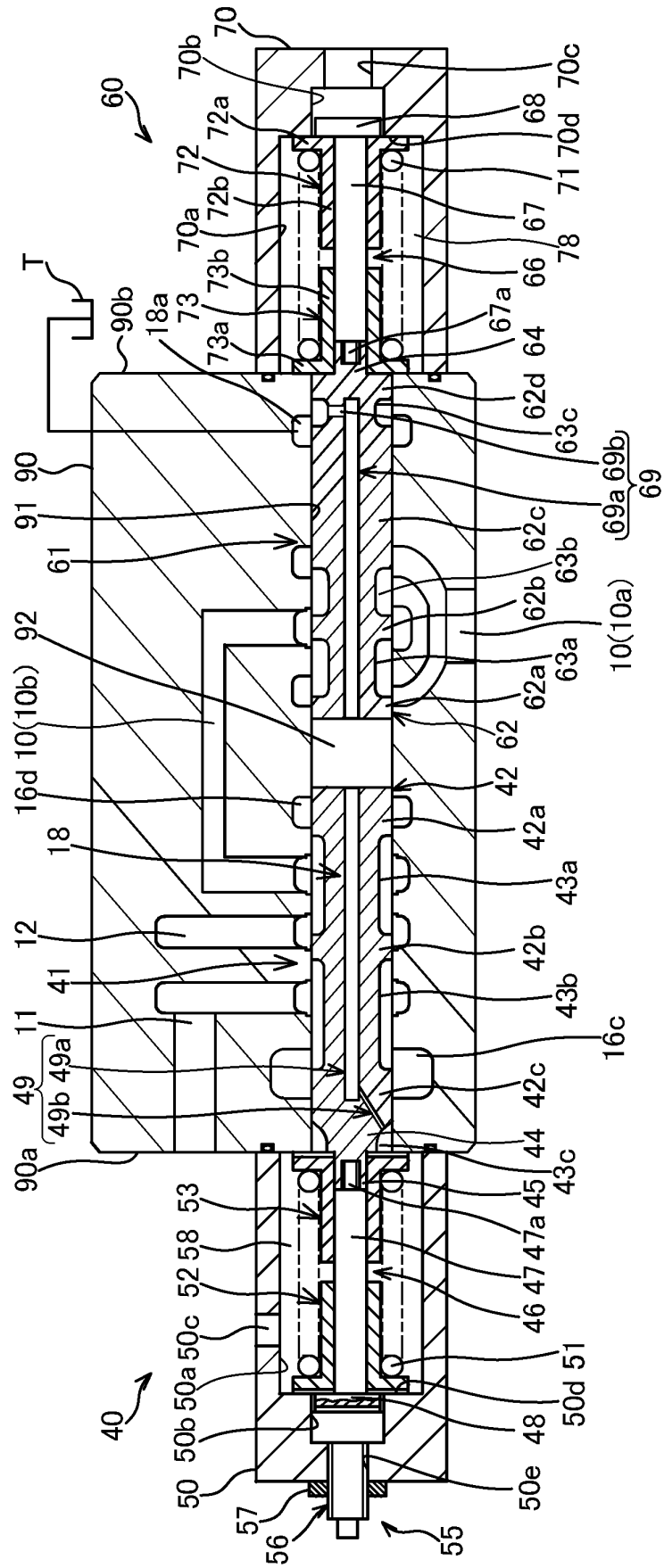


FIG. 4

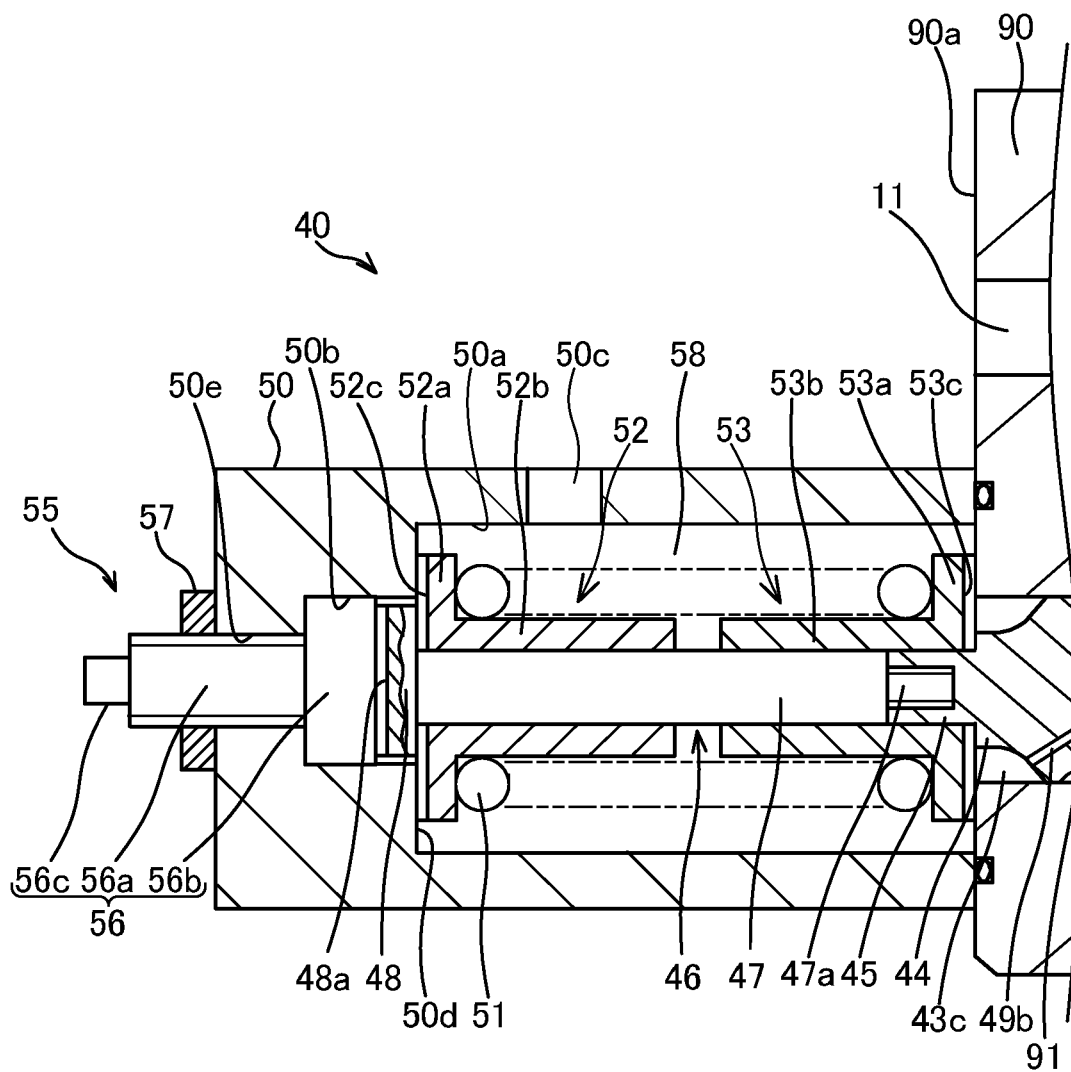


FIG.5

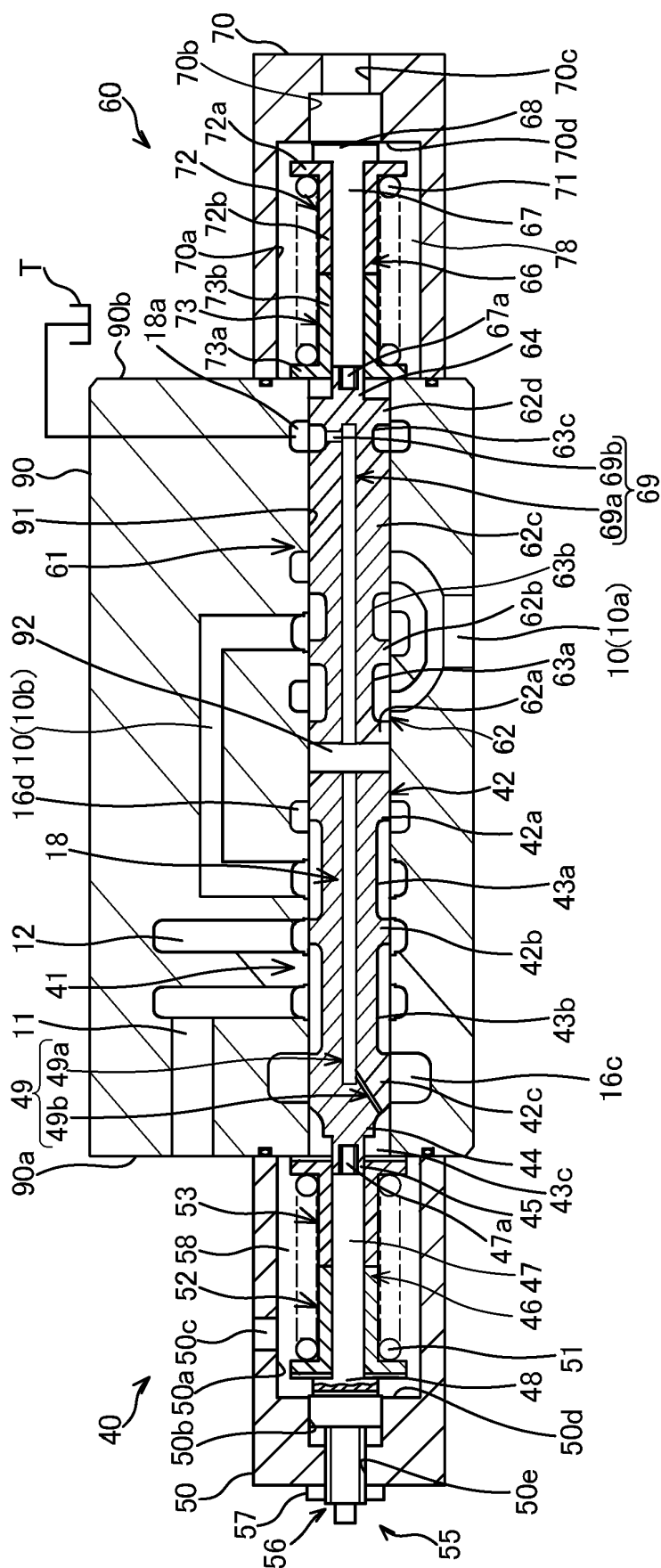


FIG. 6

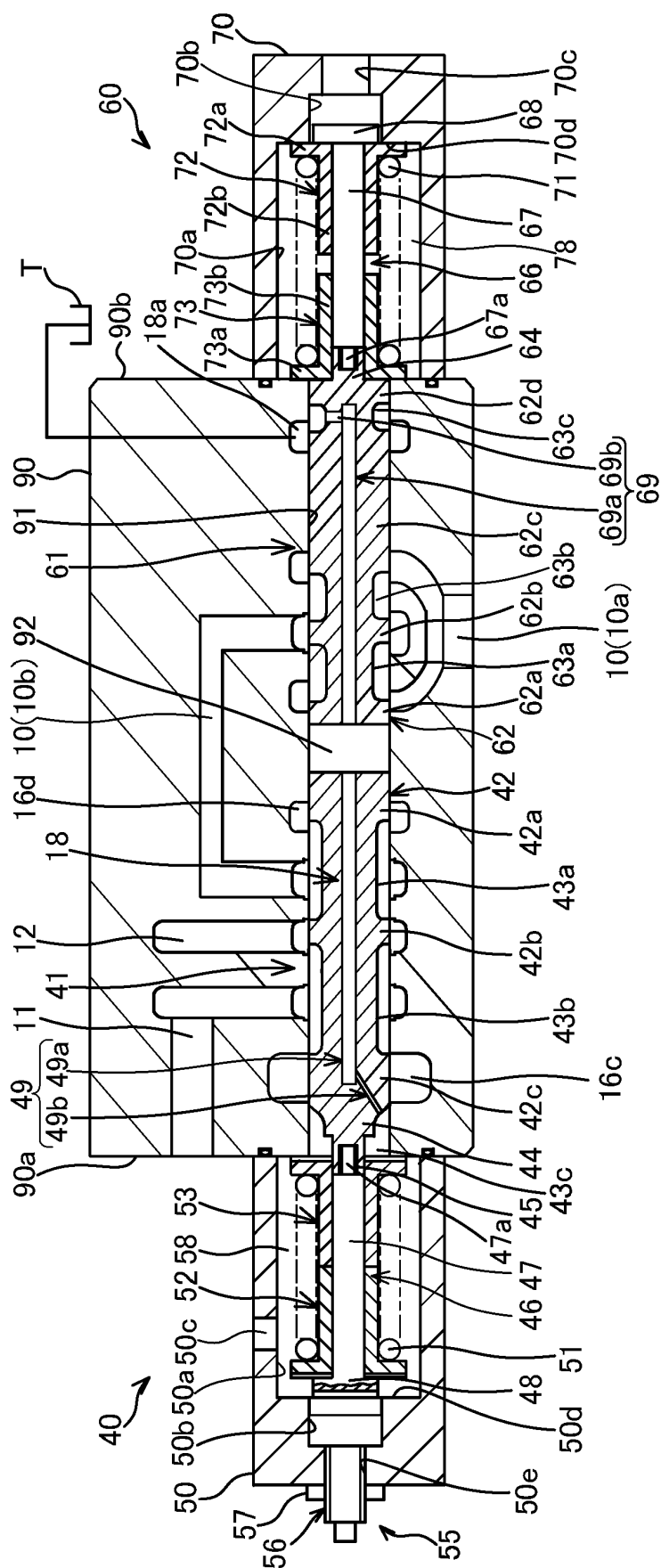


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/041543

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F15B11/17 (2006.01) i, F15B11/00 (2006.01) i

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.Cl. F15B11/17, F15B11/00

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

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 2009-257440 A (SUMITOMO (S.H.I.) CONSTRUCTION MACHINERY COMPANY, LIMITED) 05 November 2009, paragraphs [0018]-[0033], fig. 1-3 (Family: none)	1-9
A	JP 2007-147074 A (CATERPILLAR INC.) 14 June 2007, entire text, all drawings & US 2007/0119159 A1, entire text, all drawings	1-9

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

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"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

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"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

Date of the actual completion of the international search
19 December 2019 (19.12.2019)Date of mailing of the international search report
07 January 2020 (07.01.2020)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2012241803 A [0002] [0005] [0006] [0009]