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(54) FLUID PRESSURE CONTROL DEVICE

(57) A fluid pressure control device 100 includes a switch valve 30 configured to control flow of working oil from a first pump 7 to a hydraulic cylinder 1; a flow-combining control valve 60 configured to control flow of working oil supplied from a second pump 8 to the hydraulic cylinder 1; a first connecting passage 14 and a second connecting passage 15 connecting the switch valve 30 and the flow-combining control valve 60. The flow-combining control valve 60 has: a second extending position 60B at which a second bottom side passage 13b is communicated with the second pump passage 11a; and a second contracting position 60C at which a first connecting passage 14 is communicated with the second tank passage 17, and a second rod side passage 12b is shut off from the second tank passage 17.

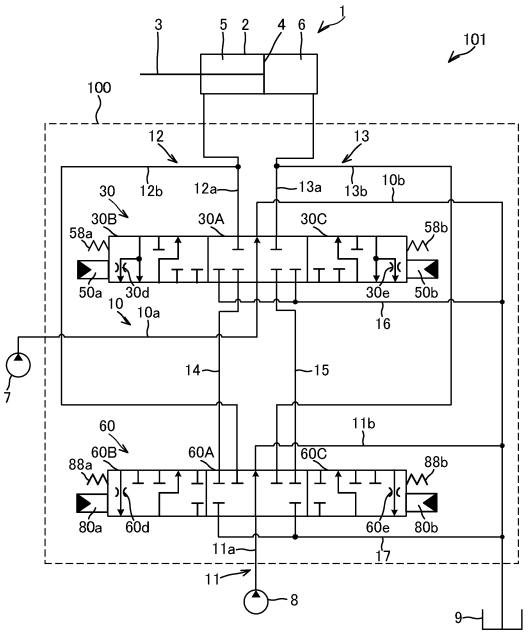

FIG. 1

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Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] JP2001-165106A discloses a flow combining mechanism provided with a pair of circuit systems. In the flow combining mechanism, pumps are each separately connected to the respective circuit systems, and a pump discharged fluid from a second circuit system is joined to a first switch valve of a first circuit system via the second switch valve of the second circuit system.

[0003] In the first switch valve, a pair of actuator ports are formed in a valve main body, and a spool is provided inside thereof so as to be freely slidable. In addition, the valve main body is formed with a U-shaped parallel feeder, and a discharge flow channel of a first pump is connected to the parallel feeder. When the spool is switched, a first actuator port is communicated with a tank port by annular grooves formed in the spool, and a second actuator port is communicated with the discharge flow channel of the first pump via the annular grooves and the parallel feeder.

[0004] In the second switch valve, the valve main body is formed with the U-shaped parallel feeder, and one end portion thereof is connected to an end portion of the parallel feeder of the first switch valve. A tandem passage, a neutral passage, and a supply passage are formed in the valve main body of the second switch valve, and the discharge flow channel of a second pump is connected to the tandem passage and the supply passage. As the spool is switched, the discharged fluid from the second pump is supplied to the parallel feeder of the second switch valve. At this time, if the first switch valve has been switched, the discharged fluid from the second pump is supplied to the parallel feeder of the first switch valve via an end portion of the parallel feeder of the second switch valve and is supplied to the actuator port by being combined with the discharged fluid from the first pump.

SUMMARY OF INVENTION

[0005] With the fluid pressure control device disclosed in JP2001-165106A, the valve main body of the second switch valve is formed with a communication port that is always in communication with the actuator port formed in the valve main body of the first switch valve. As the spool of the second switch valve is moved towards one side, the communication port communicates with the tank port that is formed in the valve main body of the second switch valve and that communicates with a tank. Thus, in this case, the actuator port communicates with the tank via the communication port of the second switch valve. As described above, in the fluid pressure control device disclosed in JP2001-165106A, the first actuator port communicates with the tank in accordance with the movement of the spool of the first switch valve and also communicates with the tank in accordance with the movement of the spool of the second switch valve.

[0006] In the above, in general, in a spool valve, in order to ensure the slidability of the spool, a small clearance is formed between an outer circumference of the spool and an inner circumference of a valve housing.

[0007] With the fluid pressure control device disclosed in JP2001-165106A, because the first switch valve and the second switch valve respectively control the communication between the actuator port and the tank, there is a risk in that working fluid in the actuator port leaks out of the tank from the outer circumferences of the respective spools of the first switch valve and the second switch valve.

[0008] An object of the present invention is to suppress a leakage of working fluid from a spool valve of a fluid pressure control device.

[0009] According to one aspect of the present invention, a fluid pressure control device, which is configured to be capable of combining working fluid discharged from a first pump and working fluid discharged from a second pump and of supplying the combined working fluid to a fluid pressure chamber of a fluid pressure actuator, includes: a first pump passage configured to guide the working fluid discharged from the first pump; a second pump passage configured to guide the working fluid discharged from the second pump; a first spool valve configured to control a flow of the working fluid to be supplied from the first pump to the fluid pressure actuator; a second spool valve configured to control the flow of the working fluid to be supplied from the second pump to the fluid pressure actuator; a connecting passage connecting the first spool valve and the second spool valve; a first fluid pressure passage configured to allow the first spool valve communicate with the fluid pressure chamber of the fluid pressure actuator; a second fluid pressure passage configured to allow the second spool valve communicate with the fluid pressure chamber of the fluid pressure actuator; a first tank passage connected to the first spool valve and communicated with a tank; and a second tank passage connected to the second spool valve and communicated with the tank. The first spool valve has: a first supply position at which the first fluid pressure passage is communicated with the first pump passage; and a first discharge position at which the first fluid pressure passage is communicated with the first tank passage and the first fluid pressure passage is communicated with the connecting passage. The second spool valve has: a second supply position at which the second fluid pressure passage is communicated with the second pump passage; and a second discharge position at which the connecting passage is communicated with the second tank passage and the second fluid pressure passage is shut off from the second tank passage.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

FIG. 1 is a hydraulic circuit diagram showing a fluid pressure control device according to an embodiment of the present invention.

FIG. 2 is a sectional view showing the fluid pressure control device according to the embodiment of the present invention and shows a state in which a switch valve is set at a first neutral position and a flow-combining control valve is set at a second neutral position.

FIG. 3 is a sectional view showing the fluid pressure control device according to the embodiment of the present invention and shows a state in which the switch valve is set at a first extending position and a flow-combining control valve is set at a second extending position.

FIG. 4 is a hydraulic circuit diagram showing a modification of the fluid pressure control device according to the embodiment of the present invention.

FIG. 5 is a hydraulic circuit diagram of the fluid pressure control device according to a comparative example of the present invention.

FIG. 6 is an enlarged sectional view of the fluid pressure control device according to the comparative example of the present invention.

DESCRIPTION OF EMBODIMENTS

[0011] A fluid pressure control device 100 according to an embodiment of the present invention will be described bellow with reference to the drawings. In the following, as an example, a description will be given of the fluid pressure control device 100 that is provided in a fluid pressure control system 101 used for a construction machinery, in particular a hydraulic excavator, to control flows of working fluid supplied/discharged to/from a fluid pressure actuator.

[0012] An overall configuration of the fluid pressure control system 101 provided with the fluid pressure control device 100 will be first explained with reference to FIG. 1.

[0013] The fluid pressure control system 101 controls movement of a hydraulic cylinder 1 serving as the fluid pressure actuator for driving objects to be driven (not shown) such as a boom, an arm, a bucket, or the like. In the following, the fluid pressure control device 100 that controls the movement of the hydraulic cylinder 1 for driving the boom serving as the object to be driven will be explained as an example.

[0014] As shown in FIG. 1, the fluid pressure control system 101 is provided with a first pump 7 and a second pump 8 that are each driven by an engine (not shown) or a motor (not shown) and that discharge working oil serving as the working fluid, a tank 9 that stores the working oil, and the fluid pressure control device 100 that moves the hydraulic cylinder 1 by controlling the flow of the working oil that is supplied/discharged to/from the hydraulic cylinder 1.

[0015] The hydraulic cylinder 1 is a double acting type cylinder having a piston 4 that partitions an interior of a cylinder tube 2 into a rod side chamber 5 and a bottom-side chamber 6 that are respectively fluid pressure chambers. A piston rod 3 is linked to the piston 4.

[0016] As the working oil is supplied to the bottom-side chamber 6 and the working oil is discharged from the rod side chamber 5, the hydraulic cylinder 1 is extended to lift the boom. Conversely, as the working oil is supplied to the rod side chamber 5 and the working oil is discharged from the bottom-side chamber 6, the hydraulic cylinder 1 is contracted to lower the boom.

[0017] The fluid pressure control device 100 is provided with a first neutral passage 10 that connects the first pump 7 and the tank 9, a second neutral passage 11 that connects the second pump 8 and the tank 9, a switch valve 30 serving as a first spool valve that is provided on the first neutral passage 10 and that controls the flow of the working oil from the first pump 7 to the hydraulic cylinder 1, and a flow-combining control valve 60 serving as a second spool valve that is provided on the second neutral passage 11 and that controls the flow of the working oil supplied from the second pump 8 to the hydraulic cylinder 1. The fluid pressure control device 100 can combine the working oil discharged from the first pump 7 and the working oil discharged from the second pump 8 and supply the combined working oil to the hydraulic cylinder 1.

[0018] The first neutral passage 10 is formed of a first pump passage 10a that is an upstream passage of the switch valve 30 and that guides the working oil discharged from the first pump 7 and a first downstream passage 10b that is a downstream passage of the switch valve 30. The second neutral passage 11 is an upstream passage of the flow-combining control valve 60, and is formed of a second pump passage 11a that guides the working oil discharged from the second pump 8 and a second downstream passage 11b that is a downstream passage of the flow-combining control valve 60. The first downstream passage 10b and the second downstream passage 11b are joined with each other and communicate with the tank 9.

[0019] In addition, the fluid pressure control device 100 is provided with a rod side passage 12 that communicates with the rod side chamber 5 of the hydraulic cylinder 1, a bottom side passage 13 that communicates with the bottom-side chamber 6 of the hydraulic cylinder 1, a first connecting passage 14 and a second connecting passage 15 that respectively connect the switch valve 30 and the flow-combining control valve 60, a first tank passage 16 that is connected to the switch valve 30 and communicates with the tank 9, and a second tank passage 17 that is connected to the flow-combining control valve 60 and communicates with the tank 9.

[0020] The rod side passage 12 has a first rod side

passage 12a through which the switch valve 30 is communicated with the rod side chamber 5 and a second rod side passage 12b through which the flow-combining control valve 60 is communicated with the rod side chamber 5. The first rod side passage 12a and the second rod side passage 12b are joined with each other and communicate with the rod side chamber 5.

[0021] The bottom side passage 13 has a first bottom side passage 13a through which the switch valve 30 is communicated with the bottom-side chamber 6 and a second bottom side passage 13b through which the flow-combining control valve 60 is communicated with the bottom-side chamber 6. The first bottom side passage 13a and the second bottom side passage 13b are joined with each other and communicate with the bottom side chamber 6.

[0022] The switch valve 30 is a spool valve having eight ports and three positions. In the switch valve 30, in response to an operation direction and an operation amount of an operation lever (not shown) by an operator, a pilot pressure is guided to a pair of first pilot pressure chambers 50a and 50b, and a position is switched. Specifically, in the switch valve 30, a first spool 40 (see FIG. 2), which will be described below, is moved to the position in accordance with the level of the pilot pressure externally supplied to the pair of first pilot pressure chambers 50a and 50b, and the position is switched between a first neutral position 30A, a first extending position 30B, and a first contracting position 30C.

[0023] In a state in which the pilot pressure is not supplied to the pair of first pilot pressure chambers 50a and 50b, the switch valve 30 is maintained at the first neutral position 30A by a biasing force exerted by centering springs 58a and 58b. At the first neutral position 30A, the first neutral passage 10 is opened, and the working oil discharged from the first pump 7 is guided to the tank 9 through the first neutral passage 10. At the first neutral position 30A, the respective communications of the rod side chamber 5 and the bottom-side chamber 6 with the first pump passage 10a, the first tank passage 16, the first connecting passage 14, and the second connecting passage 15 are shut off. With such a configuration, the supply/discharge of the working oil to/from the hydraulic cylinder 1 is shut off, and the hydraulic cylinder 1 is in a load-holding state.

[0024] As the pilot pressure is guided to the one first pilot pressure chamber 50a, the switch valve 30 is switched to the first extending position 30B in accordance with the level of the pilot pressure. At the first extending position 30B, the first pump passage 10a of the first neutral passage 10 is shut off from the first downstream passage 10b and is communicated with the first bottom side passage 13a. In addition, at the first extending position 30B, the first rod side passage 12a is communicated with the first tank passage 16 via a first rod side restrictor 30d imparting resistance to the flow of the working oil flowing therethrough and is communicated with the first connecting passage 14. With such a configuration, the working oil that has been discharged from the first pump 7 is supplied to the bottom-side chamber 6 and the working oil in the rod side chamber 5 is discharged to the tank 9, and thereby, the hydraulic cylinder 1 is extended. In addition, the flowing amount of the working oil discharged from the rod side chamber 5 through the first tank passage 16 is controlled by the first rod side restrictor 30d, and thereby, the speed of the extension of the hydraulic cylinder 1 is controlled.

[0025] As the pilot pressure is guided to the other first pilot pressure chamber 50b, the switch valve 30 is switched to the first contracting position 30C in accordance with the level of the pilot pressure. At the first contracting position 30C, the first pump passage 10a is shut off from the first downstream passage 10b and is communicated with the first rod side passage 12a. In addition, at the first contracting position 30C, the first bottom side passage 13a is communicated with the first tank passage 16 via a first bottom side restrictor 30e imparting resistance to the flow of the working oil flowing therethrough and is communicated with the second connecting passage 15. With such a configuration, the working oil that has been discharged from the first pump 7 is supplied to the rod side chamber 5, and the working oil in the bottom-side chamber 6 is discharged to the tank 9, and thereby, the hydraulic cylinder 1 is contracted. In addition, the flowing amount of the working oil discharged from the bottom-side chamber 6 through the first tank passage 16 is controlled by the first bottom side restrictor 30e, and thereby, the speed of the extension of the hydraulic cylinder 1 is controlled.

[0026] The flow-combining control valve 60 is the spool valve having eight ports and three positions. In the flow-combining control valve 60, when the operation amount of the operation lever by the operator is equal to or greater than a predetermined amount, the pilot pressure is guided to a pair of second pilot pressure chambers 80a and 80b in accordance with the operation direction of the operation lever, and the position is switched. Specifically, in the flow-combining control valve 60, a second spool 70 (see FIG. 2), which will be described below, is moved to the position in accordance with the level of the pilot pressure externally supplied to the pair of second pilot pressure chambers 80a and 80b, and the position is switched between a second neutral position 60A, a second extending position 60B, and a second contracting position 60C.

[0027] In a state in which the pilot pressure is not supplied to the pair of second pilot pressure chambers 80a and 80b, the flow-combining control valve 60 is maintained at the second neutral position 60A by the biasing force exerted by centering springs 88a and 88b. At the second neutral position 60A, the second neutral passage 11 is opened, and the working oil discharged from the second pump 8 is guided to the tank 9 through the second neutral passage 11. In addition, at the second neutral position 60A, the respective communications of the second tank passage 17 with the second rod side passage

12b, the second bottom side passage 13b, the first connecting passage 14, and the second connecting passage 15 are shut off.

[0028] As the pilot pressure is guided to the one second pilot pressure chamber 80a, the flow-combining control valve 60 is switched to the second extending position 60B in accordance with the level of the pilot pressure. At the second extending position 60B, the second pump passage 11a of the second neutral passage 11 is shut off from the second downstream passage 11b and is communicated with the second bottom side passage 13b. With such a configuration, the working oil that has been discharged from the second pump 8 is combined with the working oil that has been discharged from the first pump 7, and the combined working oil is supplied to the bottom-side chamber 6.

[0029] At the second extending position 60B, the first connecting passage 14 is communicated with the second tank passage 17 via a second rod side restrictor 60d. With such a configuration, a part of the working oil discharged from the rod side chamber 5 is discharged to the tank 9 through the switch valve 30, the first connecting passage 14, the flow-combining control valve 60, and the second tank passage 17. The flowing amount of the working oil discharged from the rod side chamber 5 through the second tank passage 17 is controlled by the second rod side restrictor 60d, and thereby, the speed of the extension of the hydraulic cylinder 1 is controlled. In addition, at the second extending position 60B, the communication of the second rod side passage 12b with the second tank passage 17 is shut off.

[0030] As the pilot pressure is guided to the other second pilot pressure chamber 80b, the flow-combining control valve 60 is switched to the second contracting position 60C in accordance with the level of the pilot pressure. At the second contracting position 60C, the second pump passage 11a is shut off from the second downstream passage 11b and is communicated with the second rod side passage 12b. With such a configuration, the working oil that has been discharged from the second pump 8 is combined with the working oil that has been discharged from the first pump 7 and guided to the first rod side passage 12a, and the combined working oil is supplied to the rod side chamber 5.

[0031] In addition, at the second contracting position 60C, the second connecting passage 15 is communicated with the second tank passage 17 via a second bottom side restrictor 60e. With such a configuration, a part of the working oil that has been discharged from the bottom-side chamber 6 is discharged to the tank 9 through the switch valve 30, the second connecting passage 15, the flow-combining control valve 60, and the second tank passage 17. The flowing amount of the working oil discharged from the bottom-side chamber 6 through the second tank passage 17 is controlled by the second bottom side restrictor 60e, and thereby, the speed of the extension of the hydraulic cylinder 1 is controlled. In addition, at the second contracting position 60C, the communication between the second bottom side passage 13b and the second tank passage 17 is shut off.

[0032] As described above, the fluid pressure control device 100 according to this embodiment is configured such that, in both cases of the extension and contraction of the hydraulic cylinder 1, it is possible to combine the working oil discharged from the second pump 8 with the working oil that has been discharged from the first pump 7 and to supply the combined working oil to the hydraulic cylinder 1.

[0033] In addition, in the fluid pressure control device 100, the flow-combining control valve 60 shuts off the second tank passage 17 from the second rod side passage 12b and the second bottom side passage 13b at the second neutral position 60A. In the flow-combining control valve 60, at the second extending position 60B, the communication between the second rod side passage 12b and the second tank passage 17 is shut off, and at the second contracting position 60C, the communication between the second bottom side passage 13b and the second tank passage 17 is shut off. As described above, the second bottom side passage 13b and the second rod side passage 12b serving as a second fluid pressure passage guide the working oil that has been discharged from the second pump 8 to the hydraulic cylinder 1, but do not guide the working oil that has been discharged from the hydraulic cylinder 1 to the tank 9. The working oil that has been discharged from the hydraulic cylinder 1 is discharged to the tank 9 from the first connecting passage 14 or the second connecting passage 15 through the second tank passage 17.

[0034] In a case in which the working oil discharged from the first pump 7 and the working oil discharged from the second pump 8 are combined, and in which the combined working oil is supplied to the bottom-side chamber 6 serving as a fluid pressure chamber, the first connecting passage 14 corresponds to "a connecting passage", the first bottom side passage 13a corresponds to "a first fluid pressure passage", and the second bottom side passage 13b corresponds to "the second fluid pressure passage" in the claims. In addition, in this case, the first extending position 30B, the first contracting position 30C, and the first rod side restrictor 30d of the switch valve 30 correspond to "a first supply position", "a first discharge position", and "a first discharge restrictor" in the claims, respectively, and the second extending position 60B and the second contracting position 60C of the flow-combining control valve 60 correspond to "a second supply position" and "a second discharge position" in the claims, respectively.

[0035] Conversely, in a case in which the working oil discharged from the first pump 7 and the working oil discharged from the second pump 8 are combined, and in which the combined working oil is supplied to the rod side chamber 5 serving as the fluid pressure chamber, the second connecting passage 15, the first rod side passage 12a, and the second rod side passage 12b correspond to "the connecting passage", "the first fluid pressure pas-

sage", and "the second fluid pressure passage" in the claims, respectively. In addition, in this case, the first contracting position 30C, the first extending position 30B, and the first bottom side restrictor 30e of the switch valve 30 correspond to "the first supply position", "the first discharge position", and "the first discharge restrictor" in the claims, respectively, and the second contracting position 60C and the second extending position 60B of the flow-combining control valve 60 correspond to "the second supply position" and "the second discharge position" in the claims, respectively.

[0036] Next, a specific configuration of the fluid pressure control device 100 according to this embodiment will be described with reference to FIG. 2.

[0037] As shown in FIG. 2, the switch valve 30 has a first housing 100a in which a first spool hole 31 is formed, the first spool 40 that is received in the first spool hole 31 so as to be freely movable, the pair of first pilot pressure chambers 50a and 50b that respectively face both ends of the first spool 40, and a centering spring 58 that imparts the biasing force to the first spool 40.

[0038] The first spool hole 31 is a through hole whose both ends respectively open at end surfaces of the first housing 100a. In the first housing 100a, a first downstream side port 32 that communicates with the first downstream passage 10b of the first neutral passage 10, a pair of first upstream side ports 33a and 33b that communicate with the first pump passage 10a of the first neutral passage 10 on the upstream side, a first rod side port 35a that communicates with the first rod side passage 12a, a first bottom side port 35b that communicates with the first bottom side passage 13a, a pair of connecting ports 36a and 36b that respectively communicate with the first connecting passage 14 and the second connecting passage 15, and a pair of first tank ports 37a and 37b that communicate with the first tank passage 16 are respectively formed to have annular shapes in an inner circumference of the first spool hole 31 so as to open to the first spool hole 31.

[0039] In addition, although a detailed illustration is omitted, a first bridge passage 10c whose both ends open to the first spool hole 31 is formed in the first housing 100a. Both ends of the first bridge passage 10c open to the first spool hole 31 via a pair of first bridge ports 34a and 34b that are respectively formed to have annular shapes in the inner circumference of the first spool hole 31.

[0040] A pair of first caps 51a and 51b for closing openings of the first spool hole 31 are respectively attached to both ends of the first housing 100a. The pair of first pilot pressure chambers 50a and 50b of the switch valve 30 are respectively formed in the pair of first caps 51a and 51b.

[0041] In the one first cap 51a, a recessed portion 52a into which the first spool 40 can enter and a pilot port 54a that communicates with the recessed portion 52a are formed. Because the recessed portion 52a is provided, the one first pilot pressure chamber 50a is formed, and so, the pilot pressure is guided to the recessed portion 52a through the pilot port 54a.

[0042] In the other first cap 51b, a first large diameter hole 52b into which the first spool 40 can enter, a first small diameter hole 53b that has a smaller inner diameter than the first large diameter hole 52b and that communicates with the first large diameter hole 52b, and a pilot port 54b that communicates with the first small diameter hole 53b are formed. Because the first small diameter hole 53b and the first large diameter hole 52b are provided, the other first pilot pressure chamber 50b is formed, and so, the pilot pressure is guided to the first pilot pressure chamber 50b through the pilot port 54b.

[0043] A first support member 55 is attached to an end portion of the first spool 40 so as to be coaxial with the first spool 40. The first support member 55 has a first shaft portion 56 that is fixed to the end portion of the first spool 40 and a first head portion 57 that has a larger outer diameter than the first shaft portion 56. As shown in FIG. 2, the first head portion 57 of the first support member 55 is inserted into the first small diameter hole 53b at the first neutral position 30A.

[0044] The centering spring 58 is provided in the other first cap 51b. Specifically, the centering spring 58 is provided around an outer circumference of the first shaft portion 56 of the first support member 55 between the end surface of the first spool 40 and the first head portion 57. When the switch valve 30 is positioned at the first neutral position 30A, both ends of the centering spring 58 are respectively seated, via spring washers 59a and 59b, on an end surface of the first housing 100a and on a step surface 52c formed between the first large diameter hole 52b and the first small diameter hole 53b of the first cap 51b. The single centering spring 58 shown in FIG. 2 functions as the pair of centering springs 58a and 58b in the hydraulic circuit diagram shown in FIG. 1.

[0045] As the first spool 40 is moved to the right direction in the figure by the pilot pressure guided to the one first pilot pressure chamber 50a, the one spring washer 59a being seated on the first housing 100a is pushed by the first spool 40 and is moved to the right direction in the figure together with the first spool 40. At this time, the movement of the other spring washer 59b to the right direction in the figure is restricted by the step surface 52c of the first cap 51b, and so, the centering spring 58 is compressed. As the supply of the pilot pressure to the first pilot pressure chamber 50a is shut off, the first spool 40 is moved to the left direction in the figure by a restoring force of the centering spring 58, and thereby, the switch valve 30 is held at the first neutral position 30A.

[0046] Conversely, as the first spool 40 is moved to the left direction in the figure by the pilot pressure guided to the other first pilot pressure chamber 50b, the other spring washer 59b being seated on the step surface 52c of the first cap 51b is pushed by the first head portion 57 and is moved to the left direction in the figure together with the first spool 40. At this time, between the movement of the one spring washer 59a to the left direction in

the figure is restricted by the first housing 100a, the centering spring 58 is caused to be compressed. When the supply of the pilot pressure to the first pilot pressure chamber 50b is shut off, the first spool 40 is moved to the right direction in the figure by the restoring force of the centering spring 58, and thereby, the switch valve 30 is held at the first neutral position 30A.

[0047] The first spool 40 has a first land part 41, a pair of second land parts 42a and 42b, a pair of third land parts 43a and 43b, a pair of fourth land parts 44a and 44b, and a pair of fifth land parts 45a and 45b, which are each in sliding contact with the inner circumference of the first spool hole 31. In the first spool 40, the one fifth land part 45a, the one fourth land part 44a, the one third land part 43a, the one second land part 42a, the first land part 41, the other second land part 42b, the other third land part 43b, the other fourth land part 44b, and the other fifth land part 45b are provided in this order in the shaft direction from one end towards the other end of the first spool 40 (from the left side to the right side in FIG. 2).

[0048] A pair of first pump grooves 46a and 46b are formed as annular grooves between the first land part 41 and the pair of second land parts 42a and 42b. First bridge grooves 47a and 47b are respectively formed between the pair of mutually adjacent second land parts 42a and 42b and the pair of third land parts 43a and 43b. First connecting grooves 48a and 48b are respectively formed between the pair of mutually adjacent third land parts 43a and 43b and the pair of fourth land parts 44a and 44b. First tank grooves 49a and 49b are respectively formed between the pair of mutually adjacent fourth land parts 44a and 44b and the pair of fifth land parts 45a and 45b.

[0049] In outer circumferences of the pair of fourth land parts 44a and 44b of the first spool 40, notches 40a and 40b respectively serving as the first rod side restrictor 30d and the first bottom side restrictor 30e (see FIG. 1) are formed so as to respectively extend in the shaft direction of the first spool 40 and so as to respectively communicate with the first tank grooves 49a and 49b. The notches 40a and 40b respectively impart the resistance to the flows of the working oil discharged to the tank 9 from the rod side chamber 5 and the bottom-side chamber 6 through the first tank passage 16. In this embodiment, although a plurality of (two for each in FIG. 2) notches 40a and 40b are respectively formed along the circumferential direction of the first spool 40, the configuration is not limited thereto, and only a single notch may be formed. In a case in which the plurality of notches 40a and 40b are formed in the first spool 40, whole of the plurality of the notch 40a form the first rod side restrictor 30d shown in FIG. 1. Similarly, in a case in which the plurality of notches 40b are formed in the first spool 40, whole of the plurality of notches 40b form the first bottom side restrictor 30e.

[0050] The flow-combining control valve 60 has a second housing 100b in which a second spool hole 61 is formed, the second spool 70 that is received in the second spool hole 61 so as to be freely movable, the second pilot pressure chambers 80a and 80b that respectively face both ends of the second spool 70, and a centering spring 88 that imparts the biasing force to the second spool 70.

[0051] In this embodiment, the second housing 100b is formed integrally with the first housing 100a of the switch valve 30. In other words, the switch valve 30 and the flow-combining control valve 60 are accommodated in a common housing functioning as both of the first housing 100a and the second housing 100b. The configuration is not limited thereto, and the first housing 100a and the second housing 100b may be formed separately from each other.

[0052] The second spool hole 61 is a through hole whose both ends respectively open at end surfaces of the second housing 100b. The second spool hole 61 is formed such that its center axis extends in parallel with the center axis of the first spool hole 31. In the second housing 100b, a second downstream side port 62 that communicates with the second downstream passage 11b of the second neutral passage 11, a pair of second upstream side ports 63a and 63b that communicate with the second pump passage 11a of the second neutral passage 11 on the upstream passage, a second rod side port 65a that communicates with the second rod side passage 12b, a second bottom side port 65b that communicates with the second bottom side passage 13b, a pair of combining ports 66a and 66b that respectively communicate with the first connecting passage 14 and the second connecting passage 15, and a pair of second tank ports 67a and 67b that communicate with the second tank passage 17 are respectively formed to have annular shapes in an inner circumference of the second spool hole 61 so as to open to the second spool hole 61.

[0053] In addition, a second bridge passage 11c whose both ends open to the second spool hole 61 is formed in the second housing 100b. Both ends of the second bridge passage 11c open to the second spool hole 61 via a pair of second bridge ports 64a and 64b that are respectively formed to have annular shapes in the inner circumference of the second spool hole 61.

[0054] A pair of second caps 81a and 81b for closing openings of the second spool hole 61 are respectively attached to both ends of the second housing 100b. The pair of second pilot pressure chambers 80a and 80b of the flow-combining control valve 60 are respectively formed in the pair of second caps 81a and 81b. The centering spring 88 is provided in the one second cap 81a. In addition, a second support member 85 is attached to end portion of the second spool 70 so as to be coaxial with the second spool 70.

[0055] Because the pair of second caps 81a and 81b and the second support member 85 have the similar configurations with those of the pair of first caps 51a and 51b and the first support member 55 in the switch valve 30, a detailed description is omitted. In the one second cap 81a, a recessed portion 82a and a pilot port 84a are formed in a corresponding manner to the recessed por-

tion 52a and the pilot port 54a in the one first cap 51a. In the other second cap 81b, a second large diameter hole 82b, a second small diameter hole 83b, a step surface 82c, and a pilot port 84b are formed in a corresponding manner to the first large diameter hole 52b, the first small diameter hole 53b, the step surface 52c, and the pilot port 54b in the other first cap 51b. In addition, the second support member 85 has a second shaft portion 86 and a second head portion 87 in a corresponding manner to the first shaft portion 56 and the first head portion 57 in the first support member 55.

[0056] In addition, because the centering spring 88 and a pair of spring washers 89a and 89b of the flow-combining control valve 60 also have similar configurations with those of the centering spring 58 and the pair of spring washers 59a and 59b of the switch valve 30, a detailed description is omitted. The single centering spring 88 of the flow-combining control valve 60 shown in FIG. 2 exhibits functions of the centering springs 88a and 88b in the hydraulic circuit diagram shown in FIG. 1.

[0057] The second spool 70 has a first control land part 71, a pair of second control land parts 72a and 72b, a pair of third control land parts 73a and 73b, a pair of fourth control land parts 74a and 74b, and a pair of fifth control land parts 75a and 75b, which are each in sliding contact with the second spool hole 61. In the second spool 70, the one fifth control land part 75a, the one fourth control land part 74a, the one third control land part 73a, the one second control land part 72a, the first control land part 71, the other second control land part 72b, the other third control land part 73b, the other fourth control land part 74b, and the other fifth control land part 75b are provided in this order in the shaft direction from one end towards the other end of the second spool 70 (from the left side to the right side in FIG. 2).

[0058] A pair of second pump grooves 76a and 76b are formed as annular grooves between the first control land part 71 and the pair of second control land parts 72a and 72b. Second bridge grooves 77a and 77b are respectively formed between the pair of mutually adjacent second control land parts 72a and 72b and the pair of third control land parts 73a and 73b. Combining connecting grooves 78a and 78b are respectively formed between the pair of mutually adjacent third control land parts 73a and 73b and the pair of fourth control land parts 74a and 74b. In addition, second tank grooves 79a and 79b are respectively formed between the pair of mutually adjacent fourth control land parts 74a and 74b and the pair of fifth control land parts 75a and 75b.

[0059] In outer circumference of the pair of fourth control land parts 74a and 74b of the second spool 70, notches 70a and 70b respectively serving as the second rod side restrictor 60d and the second bottom side restrictor 60e are formed so as to respectively extend in the shaft direction of the second spool 70 and so as to respectively communicate with the second tank grooves 79a and 79b. The notches 70a and 70b respectively impart the resistance to the flows of the working oil discharged to the tank 9 from the rod side chamber 5 and the bottom-side chamber 6 through the second tank passage 17. In this embodiment, although a plurality of (two for each in FIG. 2) notches 70a and 70b are respectively formed along the circumferential direction of the second spool 70, the configuration is not limited thereto, and only a single notch may be formed. In a case in which the plurality of notches 70a and 70b are formed in the second spool 70, whole of the plurality of the notches 70a form the second rod side restrictor 60d shown in FIG. 1. Similarly, in a case in which the plurality of notches 70b are formed in the second spool 70, whole of the plurality of notches 70b form the second bottom side restrictor 60e.

[0060] Next, action of this embodiment will be described.

[0061] In the switch valve 30, with reference to the first land part 41, the land parts 42a, 43a, 44a, 45a and the grooves 46a, 47a, 48a, 49a in the first spool 40, which are provided on the one side in the shaft direction, and the land parts 42b, 43b, 44b, 45b and the grooves 46b, 47b, 48b, 49b in the first spool 40, which are provided on the other side in the shaft direction, are configured such that their respective functions are exchanged with each other between corresponding configurations (configurations forming the pair) in accordance with the moving direction of the hydraulic cylinder 1. In addition, with reference to the first downstream side port 32, the ports 33a, 34a, 35a, 36a, 37a, which are provided on the one side in the shaft direction, and the ports 33b, 34b, 35b, 36b, 37b, which are provided on the other side in the shaft direction, are configured such that their respective functions are exchanged with each other between corresponding configurations in accordance with the extension and the contraction of the hydraulic cylinder 1. Similarly, in the flow-combining control valve 60, with reference to the first control land part 71, the control land parts 72a, 73a, 74a, 75a and the grooves 76a, 77a, 78a, 79a in the second spool 70, which are provided on the one side in the shaft direction, and the control land parts 72b, 73b, 74b, 75b and the grooves 76b, 77b, 78b, 79b in the second spool 70, which are provided on the other side in the shaft direction, are configured such that their respective functions are exchanged with each other between corresponding configurations in accordance with the extension and the contraction of the hydraulic cylinder 1. In addition, in the flow-combining control valve 60, with reference to the second downstream side port 62, the ports 63a, 64a, 65a, 66a, 67a, which are provided on the one side in the shaft direction, and the ports 63b, 64b, 65b, 66b, 67b, which are provided on the other side in the shaft direction, are configured such that their respective functions are exchanged with each other between corresponding configurations in accordance with the extension and the contraction of the hydraulic cylinder 1. Thus, in the following, a case in which the hydraulic cylinder 1 is to be extended will be explained as an example, and for a case in which the hydraulic cylinder 1 is to be contracted, an explanation will be omitted appropriately.

[0062] The movement of the switch valve 30 will be described first.

[0063] When there is no operational input from the operator, the pilot pressure is not guided to neither of the pair of first pilot pressure chambers 50a and 50b of the switch valve 30. In this case, as shown in FIG. 2, the pair of first upstream side ports 33a and 33b and the first downstream side port 32 of the switch valve 30 are communicated via the pair of first pump grooves 46a and 46b. With such a configuration, the first neutral passage 10 is opened, and the working oil that has been discharged from the first pump 7 is guided to the tank 9.

[0064] When there is the operational input by the operator for the operation lever such that the hydraulic cylinder 1 is to be extended, the pilot pressure is guided to the one first pilot pressure chamber 50a of the switch valve 30 in accordance with the operational input. The first spool 40 is moved in accordance with the level of the pilot pressure, and the switch valve 30 is shifted to the first extending position 30B in accordance with the moved amount of the first spool 40 (see FIG. 1).

[0065] Specifically, as shown in FIG. 3, as the pilot pressure is guided to the first pilot pressure chamber 50a, the first spool 40 is moved to the right direction in the figure against the biasing force exerted by the centering spring 58. With such a configuration, the communications of the pair of first upstream side ports 33a and 33b with the first downstream side port 32 are shut off by the first land part 41 and the second land part 42a of the first spool 40. In addition, the one first upstream side port 33a is communicated with the first bridge port 34a via the first bridge groove 47a, and the first bridge port 34b is communicated with the first bottom side port 35b via the first bridge groove 47b. Furthermore, the first rod side port 35a is communicated with the connecting port 36a via the first connecting groove 48a, and the connecting port 36a is communicated with the first tank port 37a via the notch 40a and the first tank groove 49a.

[0066] Therefore, the working oil that has been discharged from the first pump 7 is guided to the first bridge passage 10c from the first pump passage 10a through the first bridge groove 47a of the first spool 40, and then, the working oil is guided to the bottom-side chamber 6 from the first bridge passage 10c through the first bridge groove 47b and the first bottom side passage 13a. The working oil in the rod side chamber 5 is discharged to the tank 9 by being guided to the first tank passage 16 from the first rod side passage 12a through the notch 40a. By doing so, the hydraulic cylinder 1 is extended. In addition, the part of the working oil in the rod side chamber 5 is guided to the combining port 66a of the flow-combining control valve 60 from the first rod side port 35a through the connecting port 36a and the first connecting passage 14.

[0067] As the moved amount of the first spool 40 to the right direction in FIG. 2 is increased, an opening area of the notch 40a to the connecting port 36a is increased, and the resistance imparted to the flow of the working oil is decreased. The notch 40a is formed to have the length along the shaft direction of the first spool 40 such that, along with the movement of the first spool 40 to the right direction in FIG. 2, the communication between the first rod side port 35a and the connecting port 36a is established before the communication between the first tank port 37a and the connecting port 36a is established.

[0068] In a case in which the communication between the first tank port 37a and the connecting port 36a is established first by the notch 40a, and subsequently, the communication between the first rod side port 35a and the connecting port 36a is established, as the first spool 40 is moved during this period, the opening area of the notch 40a to the connecting port 36a is increased. Thus, the resistance imparted by the notch 40a to the flow of the working oil is reduced, and it becomes more difficult to effectively suppress a pressure change caused by the establishment of the communication between the rod side chamber 5 and the tank 9 by the establishment of the communication between the first rod side port 35a and the connecting port 36a. In contrast, as described in this embodiment, by employing the configuration in which the communication between the first rod side port 35a and the connecting port 36a is established first, as the notch 40a then comes to communicate with the connecting port 36a, it is possible to readily discharge the working oil in the rod side chamber 5 to the tank 9 through the notch 40a, which is in a state where the opening area to the connecting port 36a is relatively small. With such a configuration, the pressure change caused by the establishment of the communication between the rod side chamber 5 and the tank 9 is effectively relaxed by the notch 40a, and therefore, it is possible to allow the hydraulic cylinder 1 to extend stably.

[0069] Next, the movement of the flow-combining control valve 60 will be described.

[0070] In a case in which there is no operational input by the operator and in a case in which the operation amount of the operation lever for extending the hydraulic cylinder 1 is smaller than the predetermined amount, the pilot pressure is not supplied to the second pilot pressure chambers 80a and 80b of the flow-combining control valve 60, and the flow-combining control valve 60 is held at the second neutral position 60A by the biasing force exerted by the centering spring 88 (see FIG. 1). In this state, as shown in FIG. 2, the pair of second upstream side ports 63a and 63b and the second downstream side port 62 of the flow-combining control valve 60 are communicated via the pair of second pump grooves 76a and 76b. With such a configuration, the second neutral passage 11 is opened, and the working oil discharged from the second pump 8 is guided to the tank 9.

[0071] Therefore, in a case in which the operation amount of the operation lever for extending the hydraulic cylinder 1 is smaller than the predetermined amount, only the switch valve 30 is switched to the first extending position 30B (see FIG. 1), and the hydraulic cylinder 1 is extended only by the working oil supplied from the first

pump 7.

[0072] When the operation amount of the operation lever for extending the hydraulic cylinder 1 becomes equal to or greater than the predetermined amount, the pilot pressure is also guided to the one second pilot pressure chamber 80a of the flow-combining control valve 60. With such a configuration, the second spool 70 is moved in accordance with the level of the pilot pressure, and the flow-combining control valve 60 is shifted to the second extending position 60B in accordance with the moved amount of the second spool 70 (see FIG. 1).

[0073] Specifically, as the pilot pressure is guided to the second pilot pressure chamber 80a of the flow-combining control valve 60, the second spool 70 is moved to the right direction in the figure against the biasing force exerted by the centering spring 88. With such a configuration, the communications of the pair of second upstream side ports 63a and 63b with the second downstream side port 62 are shut off by the first control land part 71 and the second control land part 72a. In addition, the one second upstream side port 63a is communicated with the second bridge port 64a via the second bridge groove 77a, and the second bridge port 64b is communicated with the second bottom side port 65b via the second bridge groove 77b. Thus, the working oil discharged from the second pump 8 is guided to the second bridge passage 11c from the second pump passage 11a through the second bridge groove 77a of the second spool 70 and is guided to the second bottom side passage 13b from the second bridge passage 11c through the second bridge groove 77b. With such a configuration, the working oil discharged from the second pump 8 is guided to the bottom-side chamber 6 by being combined with the working oil that has been discharged from the first pump 7.

[0074] In addition, the combining port 66a is communicated with the second tank port 67a via the notch 70a and a second tank groove 79a. Thus, the part of the working oil in the rod side chamber 5 is guided to the flow-combining control valve 60 from the switch valve 30 through the first connecting passage 14 and is discharged to the tank 9 through the second tank passage 17.

[0075] As described above, when the working oil discharged from the first pump 7 and the working oil discharged from the second pump 8 are combined, the working oil that has been discharged from the hydraulic cylinder 1 is discharged to the tank 9 through the switch valve 30, and at the same time, discharged to the tank 9 also through the flow-combining control valve 60. Thus, the working oil that has been discharged from the hydraulic cylinder 1 is discharged to the tank 9 through the notch 40a (the first bottom side restrictor 30e) of the switch valve 30, and at the same time, discharged to the tank 9 through the notch 70a (the second bottom side restrictor 60e) of the flow-combining control valve 60. Therefore, the hydraulic cylinder 1 is extended at the speed corresponding to the resistance imparted to the working oil that has been discharged from the rod side chamber 5 by the notch 40a of the switch valve 30 and the notch 70a of the flow-combining control valve 60.

[0076] Here, for ease of understanding the present invention, a fluid pressure control device 300 according to a comparative example of the present invention will be described with reference to FIGs. 5 and 6. Configurations that are similar to those in the present embodiment are assigned the same reference signs, and descriptions thereof shall be omitted appropriately.

[0077] As shown in FIGs. 5 and 6, in the fluid pressure control device 300 according to the comparative example, the first connecting passage 14 and the second connecting passage 15 as described in this embodiment are not provided. As shown in FIG. 5, a switch valve 230 according to the comparative example differs from the configuration in the above-mentioned embodiment in that, at a first extending position 230B, the first rod side passage 12a is not communicated with the first connecting passage 14, and at a first contracting position 230C, the first bottom side passage 13a is not communicated with the second connecting passage 15.

[0078] In addition, in a flow-combining control valve 260 according to the comparative example, at a second extending position 260B, the second rod side passage 12b is communicated with the second tank passage 17. The part of the working oil in the rod side chamber 5 is discharged to the tank 9 from the second rod side passage 12b through the flow-combining control valve 260 and the second tank passage 17. In addition, in the flow-combining control valve 260, at a second contracting position 260C, the second bottom side passage 13b is communicated with the second tank passage 17. The part of the working oil in the bottom-side chamber 6 is discharged to the tank 9 from the second bottom side passage 13b through the flow-combining control valve 260 and the second tank passage 17.

[0079] Similarly to the above-mentioned embodiment, in the switch valve 230, at a first neutral position 230A, the first neutral passage 10 is opened, and the respective communications of the first rod side passage 12a and the first bottom side passage 13a with the first pump passage 10a and the first tank passage 16 are shut off. In addition, in the flow-combining control valve 260, at a second neutral position 260A, the second neutral passage 11 is opened, and the respective communications of the second rod side passage 12b and the second bottom side passage 13b with the second pump passage 11a and the second tank passage 17 are shut off.

[0080] A case in which the hydraulic cylinder 1 is to be extended will be described, as an example, with reference to an enlarged sectional view shown in FIG. 6. In the fluid pressure control device 300, the first rod side port 35a and the first tank port 37a of the switch valve 230 are adjacent with each other in the shaft direction, and other ports like the connecting port 36a in the above-mentioned embodiment are not provided between these ports. The notch 40a that communicates with the first

tank groove 49a is formed in a third land part 243a of a first spool 240 that closes the first rod side port 35a in a state in which the switch valve 230 has been switched to the first neutral position 230A. Similarly, the second rod side port 65a and the second tank port 67a of the flow-combining control valve 260 are adjacent with each other in the shaft direction. The notch 70a that communicates with the second tank groove 79a is formed in a third control land part 273a of a second spool 270 that closes the second rod side port 65a in a state in which the flow-combining control valve 260 has been switched to the second neutral position 260A.

[0081] As described above, in the fluid pressure control device 300 according to the comparative example, the working oil discharged from the second pump 8 is supplied to the bottom-side chamber 6 or the rod side chamber 5 through the second bottom side passage 13b or the second rod side passage 12b. The part of the working oil in the bottom-side chamber 6 or the rod side chamber 5 is discharged to the tank 9 from the second bottom side passage 13b or the second rod side passage 12b through the flow-combining control valve 260.

[0082] Here, in general, in the spool valve, in order to ensure the slidability of the spool, a small clearance is formed between the outer circumference of the spool and the inner circumference of the valve housing. Therefore, in a case in which the communication of the tank with the rod side chamber and the bottom-side chamber is controlled by the spool valve, even in a state in which the communication with the tank is shut off, there is a risk in that the working oil leaks out to the tank through the clearance formed around the outer circumference of the spool.

[0083] Furthermore, in the hydraulic cylinder, the load (the self weight) of the objects to be driven may act only on either of the rod side chamber or the bottom-side chamber. In such a case, in the load-holding state in which the supply/discharge of the working oil is stopped and the hydraulic cylinder is maintained at a stopped state, the working oil in the rod side chamber or the bottom-side chamber, on which the load pressure acts, tends to leak through the clearance formed around the outer circumference of the spool due to the influence of the load pressure. For example, in a case in which the hydraulic cylinder is provided to drive the boom, at the load-holding state, the self weight (the load) of the boom acts on the bottom-side chamber.

[0084] Thus, in the fluid pressure control device 300 according to the comparative example, when the switch valve 230 is switched to the first neutral position 230A to maintain the hydraulic cylinder 1 at the stopped state (the load-holding state), the load pressure acting on the bottom-side chamber 6 respectively acts on the switch valve 230 and the flow-combining control valve 260. Therefore, in the fluid pressure control device 300 according to the comparative example, there is a risk in that the working oil in the bottom-side chamber 6 leaks out through the clearance formed between the spool (the first spool 240, the second spool 270) and the spool hole (the first spool hole 31, the second spool hole 61) in each of the switch valve 230 and the flow-combining control valve 260. If the working oil in the bottom-side chamber 6, on which the load pressure acts, leaks out through the clearance, the hydraulic cylinder 1 is contracted in accordance with the leaked amount, and the load can no longer be held.

[0085] In addition, in the fluid pressure control device 300, in a state in which the flow-combining control valve 260 has been switched to the second neutral position 260A, the third control land part 273a closes the second rod side port 65a, and the notch 70a is formed in the third control land part 273a. Therefore, an amount of the third control land part 273a overlapped with the second spool hole 61 on the inner side of the wall portion W is smaller by an amount corresponding to the length of the notch 70a opposing to an wall portion W between the second rod side port 65a and the second tank port 67a. Thus, the working oil in the rod side chamber 5 tends to leak out even further to the tank 9 through the clearance formed around the outer circumference of the second spool 270.

[0086] In contrast, in this embodiment, as described above, even if the flow-combining control valve 60 is switched to the second extending position 60B, the second rod side passage 12b is not communicated with the tank 9 and is shut off. In addition, even if the flow-combining control valve 60 is switched to the second contracting position 60C, the second bottom side passage 13b is not communicated with the tank 9 and is shut off. In other words, the working oil in the rod side chamber 5 and the bottom-side chamber 6 is not discharged to the tank 9 through the second rod side passage 12b and the second bottom side passage 13b, respectively. As described above, because the second rod side passage 12b and the second bottom side passage 13b are not communicated with the tank 9 through the flow-combining control valve 60 (the second spool 70), the leakage of the working oil in the rod side chamber 5 and the bottom-side chamber 6 to the tank 9 from the clearance around the outer circumference of the second spool 70 of the flow-combining control valve 60 is suppressed.

[0087] In addition, As shown in FIG. 2, in a state in which the flow-combining control valve 60 has been switched to the second neutral position 60A, the second rod side port 65a is closed by the third control land part 73a of the second spool 70. As shown in FIG. 3, even in a state in which the flow-combining control valve 60 has been switched to the second extending position 60B, more specifically, even in a state in which the second spool 70 has completed a full stroke in the direction in which the flow-combining control valve 60 is switched to the second extending position 60B, the second rod side port 65a is completely closed by the third control land part 73a of the second spool 70. In this embodiment, the state in which the second spool 70 has completed the stroke in the direction in which the flow-combining control valve 60 is switched to the second extending position 60B is the state in which a second head portion 87 of the

second support member 85 provided on the end portion of the second spool 70 is in contact with the second cap 81b (the state shown in FIG. 3).

[0088] As described above, in the flow-combining control valve 60, the second rod side port 65a is completely closed by the third control land part 73a from the state in which the flow-combining control valve 60 is in the second neutral position 60A to the state in which the second spool 70 has completed the stroke such that the flow-combining control valve 60 is switched to the second extending position 60B. In other words, because the flow-combining control valve 60 has a configuration in which the communication between the second rod side passage 12b and the second tank passage 17 is shut off at the second extending position 60B, there is no need to provide the notch on the second tank port 67a side of the third control land part 73a. With such a configuration, the amount of the third control land part 73a overlapped with the second spool hole 61 in the shaft direction of the second spool 70 can be increased. Therefore, the leakage of the working oil from the second rod side port 65a to the second tank port 67a through the clearance between the third control land part 73a and the second spool hole 61 is suppressed.

[0089] In addition, in the flow-combining control valve 60, the combining ports 66a and 66b are respectively provided between the second rod side port 65a and the second tank port 67a and between the second bottom side port 65b and the second tank port 67b. In the flow-combining control valve 60, at the second neutral position 60A, the communication between the second rod side port 65a and the combining port 66a and the communication between the second bottom side port 65b and the combining port 66b are respectively shut off by the third control land parts 73a and 73b. Therefore, even if the load pressure acts on the second rod side port 65a and the second bottom side port 65b, the load pressure is shut off by the third control land parts 73a and 73b, and the load pressure is prevented from acting directly on the combining port 66a. Thus, in the load-holding state, the leakage of the working oil in the combining port 66a to the second tank port 67a due to the action of the load pressure is suppressed. Therefore, the leakage of the working oil in the second rod side port 65a to the second tank port 67a is further suppressed.

[0090] According to the embodiment mentioned above, the advantages described below are afforded.

[0091] In the fluid pressure control device 100, in the flow-combining control valve 60, the communication between the second rod side passage 12b and the second tank passage 17 is shut off at the second extending position 60B, and the communication between the second bottom side passage 13b and the second tank passage 17 is shut off at the second contracting position 60C. The flow-combining control valve 60 is configured such that the second rod side passage 12b and the second bottom side passage 13b are always in communication with the second tank passage 17. More specifically, even in a state in which the second spool 70 has completed the stroke in the direction in which the flow-combining control valve 60 is switched to the second extending position 60B, the second rod side port 65a, which is always in communication with the rod side chamber 5, is closed by the third control land part 73a. In addition, even in a state in which the second spool 70 has completed the stroke in the direction in which the flow-combining control valve 60 is switched to the second contracting position 60C, the second bottom side port 65b, which is always in communication with the bottom-side chamber 6, is closed by the third control land part 73b. Thus, the leakage of the working oil in the rod side chamber 5 and the bottom-side chamber 6 to the tank 9 through the clearance around the outer circumference of the second spool 70 is suppressed.

[0092] Next, a modification of the present invention will be described.

[0093] The modification shown in FIG. 4 will be described first.

[0094] In the above-mentioned embodiment, the second rod side passage 12b is shut off from the second tank passage 17 when the flow-combining control valve 60 is in the second extending position 60B, and the second bottom side passage 13b is shut off from the second tank passage 17 when the flow-combining control valve 60 is in the second contracting position 60C. In other words, in the above-mentioned embodiment, each of the rod side chamber 5 and the bottom-side chamber 6 corresponds to "the fluid pressure chamber" in the claims, and the present invention is applied to both of the control of the working oil to be supplied/discharged to/from the rod side chamber 5 and the control of the working oil to be supplied/discharged to/from the bottom-side chamber 6. In contrast, the present invention may only be applied to either one of the control of the working oil to be supplied/discharged to/from the rod side chamber 5 and the control of the working oil to be supplied/discharged to/from the bottom-side chamber 6. In the following, specific description will be given with reference to FIG. 4.

[0095] The modification shown in FIG. 4 is an example showing a configuration in which the present invention is only applied to the control of the flow of the working oil supplied/discharged to/from the bottom-side chamber 6. The fluid pressure control device 100 according to the modification shown in FIG. 4 is provided with, similarly to the above-mentioned embodiment, the first neutral passage 10, the second neutral passage 11, the first rod side passage 12a, the second rod side passage 12b, the first bottom side passage 13a (the first fluid pressure passage), the second bottom side passage 13b (the second fluid pressure passage), the second connecting passage 15 (the connecting passage), the first tank passage 16, and the second tank passage 17. On the other hand, the fluid pressure control device 100 according to the modification is not provided with the first connecting passage 14 in the above-mentioned embodiment.

[0096] A switch valve 130 according to the modification

has: a first neutral position 130A at which the first neutral passage 10 is opened; a first extending position 130B at which the first bottom side passage 13a is communicated with the first pump passage 10a and the first rod side passage 12a is communicated with the first tank passage 16; and a first contracting position 130C at which the first rod side passage 12a is communicated with the first pump passage 10a, the first bottom side passage 13a is communicated with the first tank passage 16, and the first bottom side passage 13a is communicated with the second connecting passage 15. In the modification, the first extending position 130B corresponds to "the first supply position", and the first contracting position 130C corresponds to "the first discharge position" in the claims.

[0097] A flow-combining control valve 160 according to the modification has: a second neutral position 160A at which the second neutral passage 11 is opened; a second extending position 160B at which the second bottom side passage 13b is communicated with the second pump passage 11a, and the second rod side passage 12b is communicated with the second tank passage 17; and a second contracting position 160C at which the second rod side passage 12b is communicated with the second pump passage 11a, and the second connecting passage 15 is communicated with the second tank passage 17. At the second neutral position 160A, similarly to the above-mentioned embodiment, the respective communications of the second rod side passage 12b, the second bottom side passage 13b, and the second connecting passage 15 with the second pump passage 11a and the second tank passage 17 are shut off. In addition, at the second contracting position 160C, the communication between the second bottom side passage 13b and the second tank passage 17 is shut off. In this modification, the second extending position 160B corresponds to "the second supply position", and the second contracting position 160C corresponds to "the second discharge position" in the claims.

[0098] In a case in which the hydraulic cylinder 1 is to be extended, when the flow-combining control valve 160 is switched to the second extending position 160B, similarly to the above-mentioned embodiment, the working oil discharged from the second pump 8 is guided to the bottom-side chamber 6 through the second bottom side passage 13b. On the other hand, in a case in which the hydraulic cylinder 1 is to be extended in the modification shown in FIG. 4, the part of the working oil in the rod side chamber 5 is guided to the second tank passage 17 from the second rod side passage 12b through the flow-combining control valve 160.

[0099] In a case in which the hydraulic cylinder 1 is to be contracted, when the flow-combining control valve 160 is switched to the second contracting position 160C, similarly to the above-mentioned embodiment, the working oil discharged from the second pump 8 is guided to the rod side chamber 5 through the second rod side passage 12b. In addition, similarly to the above-mentioned embodiment, the part of the working oil that has been discharged from the bottom-side chamber 6 is discharged to the tank 9 by being guided to the second tank passage 17 from the switch valve 130 through the second connecting passage 15 and the flow-combining control valve 160.

[0100] As described above, in the fluid pressure control device 100 according to the modification, the second bottom side passage 13b that is always in communication with the bottom-side chamber 6 of the hydraulic cylinder 1 is shut off from the tank 9 at both of the second neutral position 160A and the second contracting position 160C. In a case in which the hydraulic cylinder 1 is to be contracted, even if the flow-combining control valve 160 is switched to the second contracting position 160C, the part of the working oil in the bottom-side chamber 6 is not discharged to the tank 9 through the second bottom side passage 13b, but is discharged to the tank 9 through the switch valve 130, the second connecting passage 15, and the flow-combining control valve 160. Thus, similarly to the above-mentioned embodiment, the leakage of the working oil in the bottom-side chamber 6 to the tank 9 through the clearance around the outer circumference of the second spool 70 of the flow-combining control valve 160 is suppressed.

[0101] In the modification shown in FIG. 4, the present invention is applied to the control of the working oil to be supplied/discharged to/from the bottom-side chamber 6 serving as a load-side pressure chamber in the hydraulic cylinder 1 for driving the boom. In contrast, the present invention may be applied to the control of the flow of the working oil to be supplied/discharged to/from an anti-load-side pressure chamber (the rod side chamber 5 in the hydraulic cylinder 1 for driving the boom).

[0102] Next, another modification will be described.

[0103] In the above-mentioned embodiment, description has been given of the fluid pressure control device 100 that controls the flow of the working oil to the hydraulic cylinder 1 for driving the boom as the object to be driven. In contrast, the fluid pressure control device 100 may control the flow of the working oil to the hydraulic cylinder 1 for driving other objects to be driven such as the arm, the bucket, and so forth.

[0104] In addition, the fluid pressure control device 100 may be provided with an anti-drift valve serving as a poppet valve that prevents the working oil from being discharged to the tank 9 from the load-side pressure chamber on which the load pressure acts by shutting off the tank passage (the first tank passage 16, the second tank passage 17) in the load-holding state. With such a configuration, it is possible to reliably prevent the leakage of the working oil from the load-side pressure chamber by the anti-drift valve and to suppress the leakage of the working oil from the anti-load-side pressure chamber by the effect of the fluid pressure control device 100 according to the present invention.

[0105] The configurations, operations, and effects of the embodiments of the present invention will be collectively described below.

[0106] The fluid pressure control device 100 configured to be capable of combining the working oil that has been discharged from the first pump 7 and the working oil that has been discharged from the second pump 8 and of supplying the combined working oil to the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) of the hydraulic cylinder 1 includes: the first pump passage 10a configured to guide the working oil discharged from the first pump 7; the second pump passage 11a configured to guide the working oil discharged from the second pump 8; the switch valve 30, 130 configured to control the flow of the working oil from the first pump 7 to the hydraulic cylinder 1; the flow-combining control valve 60, 160 configured to control the flow of the working oil supplied from the second pump 8 to the hydraulic cylinder 1; the connecting passage (the first connecting passage 14, the second connecting passage 15) configured to connect the switch valve 30, 130 and the flow-combining control valve 60, 160; the first fluid pressure passage (the first rod side passage 12a, the first bottom side passage 13a) configured such that the switch valve 30, 130 and the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) of the hydraulic cylinder 1 are communicated; the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b) configured such that the flow-combining control valve 60, 160 and the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) of the hydraulic cylinder 1 are communicated; the first tank passage 16 connected to the switch valve 30, 130 and communicated with the tank 9; and the second tank passage 17 connected to the flow-combining control valve 60, 160 and communicated with the tank 9, wherein the switch valve 30, 130 has: the first supply position (the first extending position 30B, 130B, the first contracting position 30C) at which the first fluid pressure passage (the first rod side passage 12a, the first bottom side passage 13a) is communicated with the first pump passage 10a; and the first discharge position (the first contracting position 30C, 130C, the first extending position 30B) at which the first fluid pressure passage (the first rod side passage 12a, the first bottom side passage 13a) is communicated with the first tank passage 16 and the first fluid pressure passage (the first rod side passage 12a, the first bottom side passage 13a) is communicated with the connecting passage (the first connecting passage 14, the second connecting passage 15), and the flow-combining control valve 60, 160 has: the second supply position (the second extending position 60B, 160B, the second contracting position 60C) at which the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b) is communicated with the second pump passage 11a; and the second discharge position (the second contracting position 60C, 160C, the second extending position 60B) at which the connecting passage (the first connecting passage 14, the second connecting passage 15) is communicated with the second tank passage 17, and the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b) is shut off from the second tank passage 17.

[0107] In this configuration, when the switch valve 30, 130 is switched to the first supply position (the first extending position 30B, 130B, the first contracting position 30C) and the flow-combining control valve 60, 160 is switched to the second supply position (the second extending position 60B, 160B, the second contracting position 60C), the working oil that has been discharged from the first pump 7 is guided to the first fluid pressure passage (the first rod side passage 12a, the first bottom side passage 13a), and the working oil discharged from the second pump 8 is guided to the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b). By doing so, the working oil discharged from the first pump 7 and the working oil discharged from the second pump 8 are combined, and the combined working oil is supplied to the hydraulic cylinder 1. In addition, when the switch valve 30, 130 is switched to the first discharge position (the first contracting position 30C, 130C, the first extending position 30B), the working oil in the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) of the hydraulic cylinder 1 is discharged to the tank 9 through the first tank passage 16. Furthermore, when the flow-combining control valve 60, 160 is switched to the second discharge position (the second contracting position 60C, 160C, the second extending position 60B) in a state in which the switch valve 30, 130 has been switched to the first discharge position (the first contracting position 30C, 130C, the first extending position 30B), the working oil in the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) is discharged to the tank 9 through the second tank passage 17 by being guided to the flow-combining control valve 60, 160 through the switch valve 30, 130 and the connecting passage (the first connecting passage 14, the second connecting passage 15). On the other hand, even when the flow-combining control valve 60, 160 is switched to the second discharge position (the second contracting position 60C, 160C, the second extending position 60B), the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b) is not communicated with the tank 9 and is shut off. In other words, the working oil in the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) is not discharged to the tank 9 through the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b). As described above, because the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b) that is always in communication with the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) of the hydraulic cylinder 1 is not configured to communicate with the tank 9 by the flow-combining control valve 60, 160, the leakage of the working oil in the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) to the tank 9 from

the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b) through the clearance around the outer circumference of the spool (the second spool 70) of the flow-combining control valve 60, 160 is suppressed.

[0108] In addition, in the fluid pressure control device 100, the switch valve 30, 130 has: the first housing 100a; the first spool 40 received in the first spool hole 31 so as to be freely movable, the first spool hole 31 being formed in the first housing 100a; the first fluid pressure port (the first rod side port 35a, the first bottom side port 35b) configured to communicate with the first fluid pressure passage (the first rod side passage 12a, the first bottom side passage 13a) and to open to the first spool hole 31; the first tank ports 37a and 37b configured to communicate with the first tank passage 16 and to open to the first spool hole 31; the connecting ports 36a and 36b configured to communicate with the connecting passage (the first connecting passage 14, the second connecting passage 15) and to open to the first spool hole 31; the first rod side restrictor 30d and the first bottom side restrictor 30e (the notches 40a and 40b) provided in the first spool 40, the first rod side restrictor 30d and the first bottom side restrictor 30e (the notches 40a and 40b) being configured to impart the resistance to the flow of the working oil to be discharged to the tank 9 from the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) through the first fluid pressure passage (the first rod side passage 12a, the first bottom side passage 13a) in a state in which the switch valve 30, 130 has been switched to the first discharge position (the first contracting position 30C, 130C, the first extending position 30B), and the flow-combining control valve 60, 160 has: the second rod side restrictor 60d and the second bottom side restrictor 60e (the notch 70a, the notch 70b) provided in the second spool 70, the second rod side restrictor 60d and the second bottom side restrictor 60e (the notch 70a, the notch 70b) being configured to impart the resistance to the flow of the working oil to be discharged to the tank 9 from the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) through the first fluid pressure passage (the first rod side passage 12a, the first bottom side passage 13a) and connecting passage (the first connecting passage 14, the second connecting passage 15) in a state in which the flow-combining control valve 60, 160 has been switched to the second discharge position (the second contracting position 60C, 160C, the second extending position 60B), wherein, as the first spool 40 is moved in the direction in which the switch valve 30, 130 is switched to the first discharge position (the first contracting position 30C, 130C, the first extending position 30B), the communication between the first fluid pressure port (the first rod side port 35a, the first bottom side port 35b) and the connecting ports 36a and 36b is established before the establishment of the communication between the first tank ports 37a and 37b and the connecting ports 36a and 36b.

[0109] In this configuration, along with the movement of the first spool 40, the communication between the first fluid pressure port (the first rod side port 35a, the first bottom side port 35b) and the connecting ports 36a and 36b is established first, and subsequently, the communication between the first tank ports 37a and 37b and the connecting ports 36a and 36b is established via the first rod side restrictor 30d and the first bottom side restrictor 30e (the notches 40a and 40b). Thus, the pressure change caused by the establishment of the communication between the fluid pressure chamber (the rod side chamber 5, the bottom-side chamber 6) and the tank 9 is relaxed by the first rod side restrictor 30d and the first bottom side restrictor 30e (the notches 40a and 40b), and therefore, it is possible to stably move the hydraulic cylinder 1 at a desired speed.

[0110] In addition, in the fluid pressure control device 100, the flow-combining control valve 60, 160 has: the second housing 100b; the second spool 70 received in the second spool hole 61 so as to be freely movable, the second spool hole 61 being formed in the second housing 100b; and the second fluid pressure port (the second rod side port 65a, the second bottom side port 65b) configured to communicate with the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b) and to open to the second spool hole 61, and the flow-combining control valve 60, 160 having the second neutral position 60A, 160A at which the communication between the second tank passage 17 and the connecting passage (the first connecting passage 14, the second connecting passage 15) and the communication between the second tank passage 17 and the second fluid pressure passage (the second rod side passage 12b, the second bottom side passage 13b) are respectively shut off, the second spool 70 has the third control land parts 73a and 73b facing the second fluid pressure port (the second rod side port 65a, the second bottom side port 65b), the third control land parts 73a and 73b being configured so as to be slidably movable in the second spool hole 61, and the second fluid pressure port (the second rod side port 65a, the second bottom side port 65b) is closed by the third control land parts 73a and 73b of the second spool 70 from a state in which the flow-combining control valve 60, 160 is at the second neutral position 60A, 160A to a state in which the second spool 70 has completed the stroke in the direction in which the flow-combining control valve 60, 160 is switched to the second discharge position (the second contracting position 60C, 160C, the second extending position 60B).

[0111] In this configuration, in the flow-combining control valve 60, 160, the second fluid pressure port (the second rod side port 65a, the second bottom side port 65b) is closed by the third control land parts 73a and 73b at the second neutral position 60A, 160A, and the second fluid pressure port (the second rod side port 65a, the second bottom side port 65b) is closed by the third control land parts 73a and 73b even in a state in which the flow-combining control valve 60, 160 has been switched to

the second discharge position (the second contracting position 60C, 160C, the second extending position 60B) and in which the second spool 70 has completed the stroke. With such a configuration, the amount of the second spool 70 overlapped with the second spool hole 61 is ensured. Thus, it is possible to further suppress the leakage of the working oil in the second fluid pressure port (the second rod side port 65a, the second bottom side port 65b) to the tank 9 through the clearance around the outer circumference of the second spool 70.

[0112] Embodiments of this invention were described above, but the above embodiments are merely examples of applications of this invention, and the technical scope of this invention is not limited to the specific constitutions of the above embodiments.

[0113] This application claims priority based on Japanese Patent Application No.2019-55069 filed with the Japan Patent Office on March 22, 2019, the entire contents of which are incorporated into this specification.

Claims

1. A fluid pressure control device configured to combine working fluid discharged from a first pump and working fluid discharged from a second pump to supply the combined working fluid to a fluid pressure chamber of a fluid pressure actuator, the fluid pressure control device comprising:

a first pump passage configured to guide the working fluid discharged from the first pump;
a second pump passage configured to guide the working fluid discharged from the second pump;
a first spool valve configured to control a flow of the working fluid to be supplied from the first pump to the fluid pressure actuator;
a second spool valve configured to control the flow of the working fluid to be supplied from the second pump to the fluid pressure actuator;
a connecting passage connecting the first spool valve and the second spool valve;
a first fluid pressure passage configured to allow the first spool valve communicate with the fluid pressure chamber of the fluid pressure actuator;
a second fluid pressure passage configured to allow the second spool valve communicate with the fluid pressure chamber of the fluid pressure actuator;
a first tank passage connected to the first spool valve and communicated with a tank; and
a second tank passage connected to the second spool valve and communicated with the tank, wherein
the first spool valve has:

a first supply position at which the first fluid pressure passage is communicated with the first pump passage; and
a first discharge position at which the first fluid pressure passage is communicated with the first tank passage and the first fluid pressure passage is communicated with the connecting passage, and
the second spool valve has:

a second supply position at which the second fluid pressure passage is communicated with the second pump passage; and
a second discharge position at which the connecting passage is communicated with the second tank passage and the second fluid pressure passage is shut off from the second tank passage.

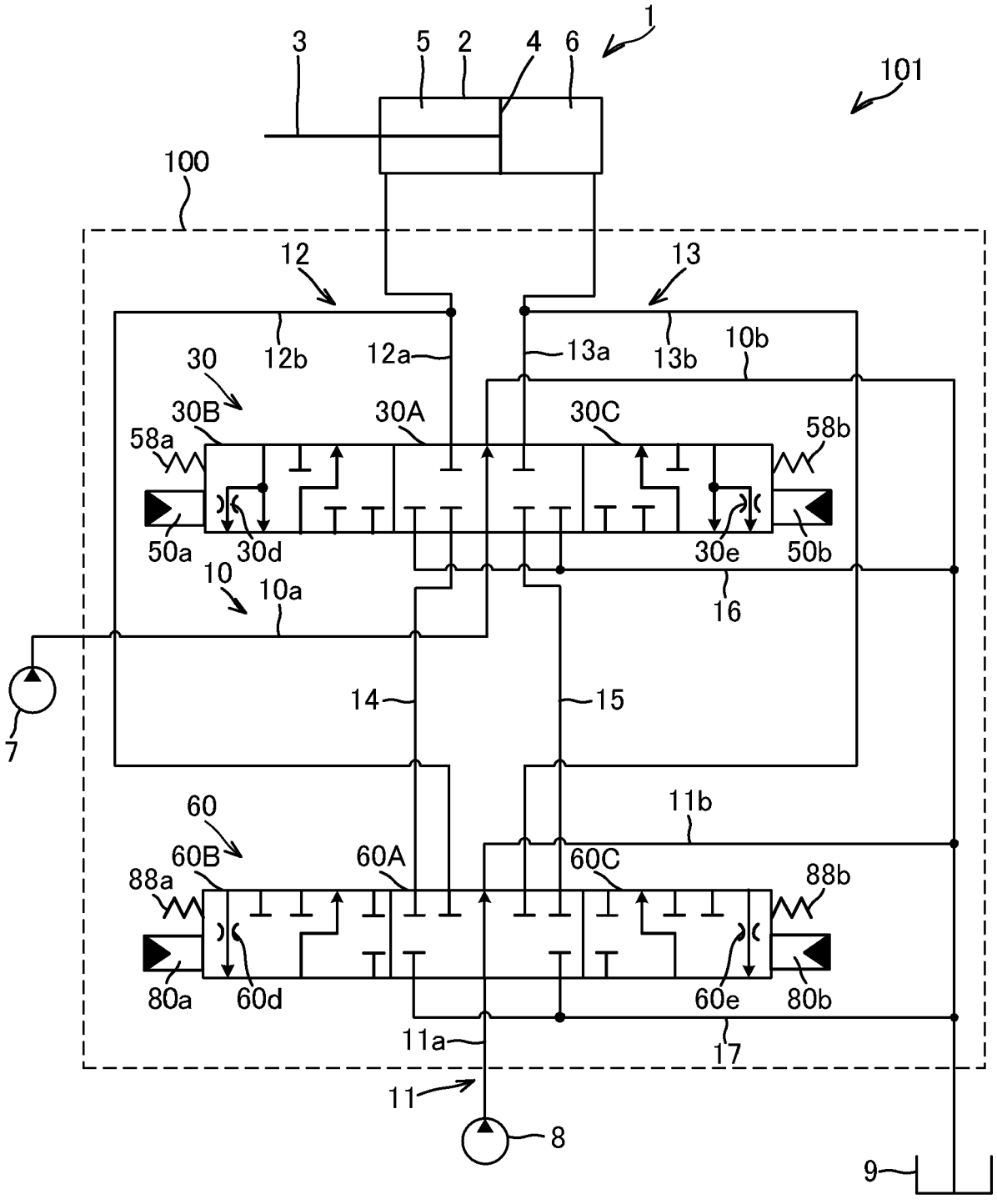
2. The fluid pressure control device according to claim 1, wherein
the first spool valve has:

a first housing;
a first spool received in a first spool hole so as to be freely movable, the first spool hole being formed in the first housing;
a first fluid pressure port communicating with the first fluid pressure passage and opening to the first spool hole;
a tank port communicating with the first tank passage and opening to the first spool hole;
a connecting port communicating with the connecting passage and opening to the first spool hole;
a connecting groove formed in the first spool, the connecting groove being configured such that the first fluid pressure port and the connecting port are communicated via the connecting groove along with movement of the first spool;
a tank groove formed in the first spool, the tank groove being configured such that the connecting port and the tank port are communicated via the tank groove along with movement of the first spool;
a land part provided between the connecting groove and the tank groove of the first spool, the land part being in sliding contact with the first spool hole; and
a first discharge restrictor formed in the land part so as to communicate with the tank groove, the first discharge restrictor being configured to impart resistance to the flow of the working fluid passing through the first discharge restrictor, wherein
as the first spool is moved in the direction in which the first spool valve is switched to the first discharge position, a communication between

the first fluid pressure port and the connecting port is established before an establishment of a communication between the tank port and the connecting port.

3. The fluid pressure control device according to claim 1, wherein
the second spool valve has:

a second housing;
a second spool received in a second spool hole so as to be freely movable, the second spool hole being formed in the second housing; and
a second fluid pressure port communicating with the second fluid pressure passage and opening to the second spool hole, the second spool valve having a neutral position at which a communication between the second tank passage and the connecting passage and a communication between the second tank passage and the second fluid pressure passage are respectively shut off,
the second spool has a control land part facing the second fluid pressure port, the control land part being in sliding contact with the second spool hole, and
the second fluid pressure port is closed by the control land part of the second spool from a state in which the second spool valve is at the neutral position to a state in which the second spool has completed a stroke in a direction in which the second spool valve is switched to the second discharge position.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58a
58b
50a
30d
30e
50b
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10a
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FIG. 1

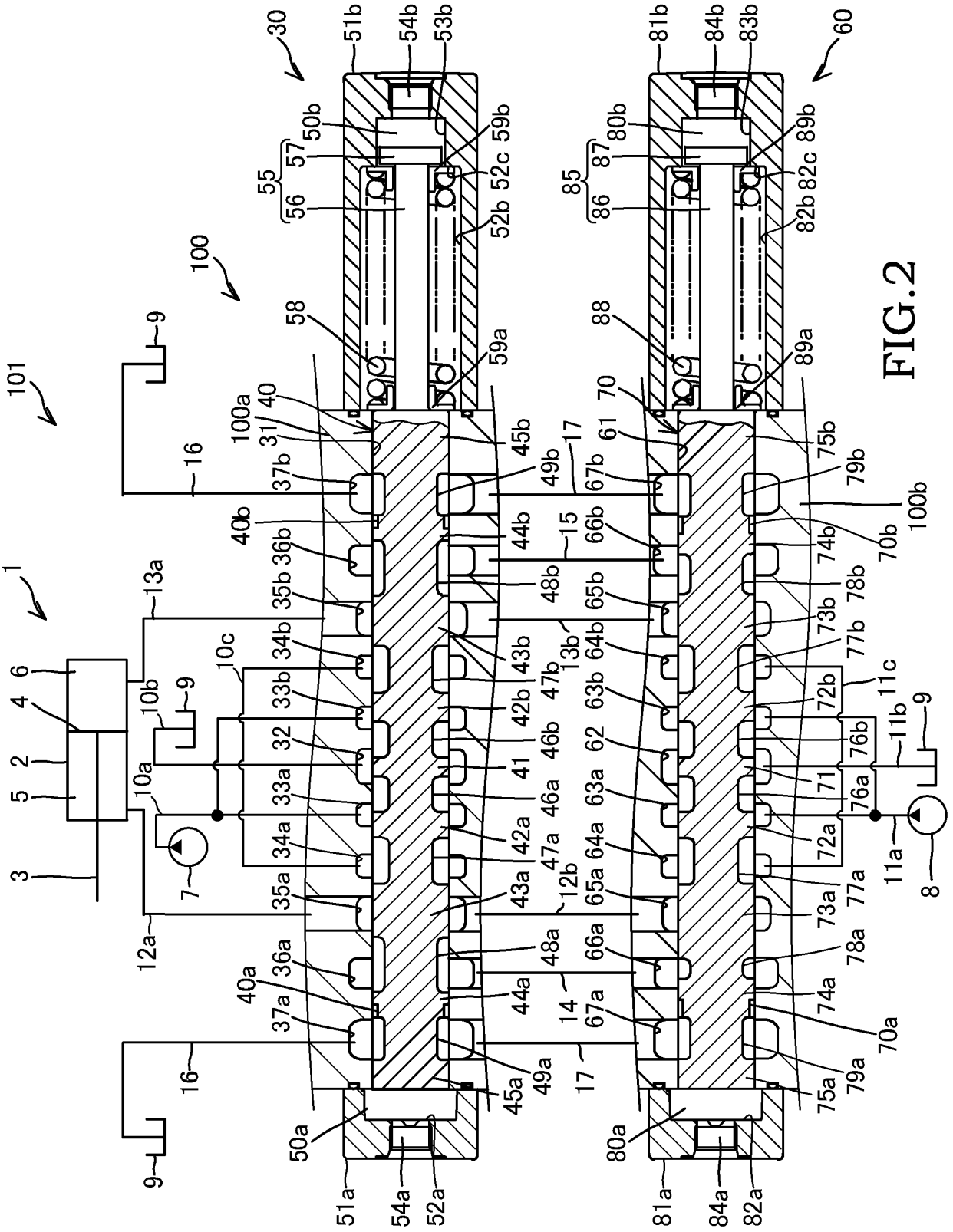


FIG.2

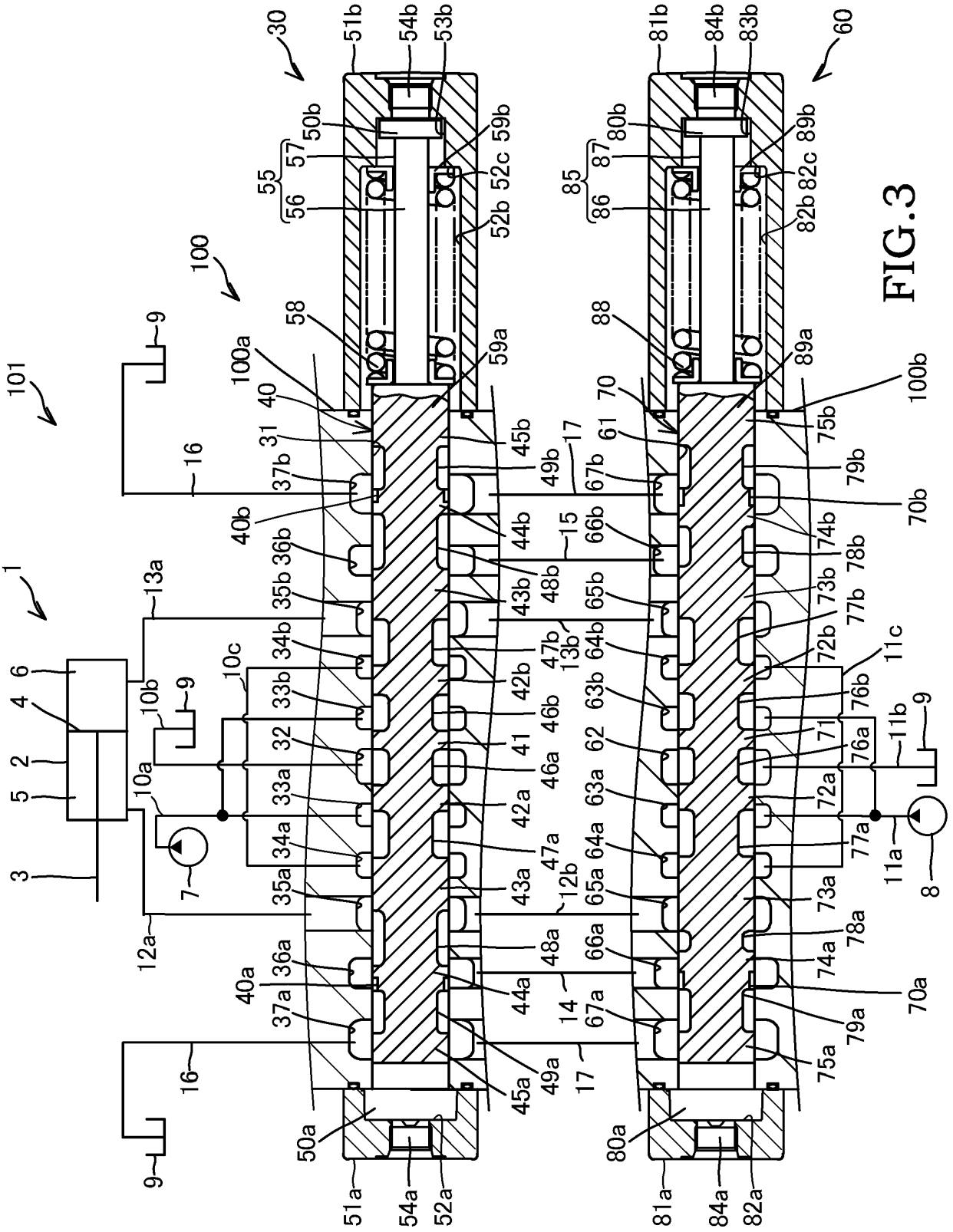
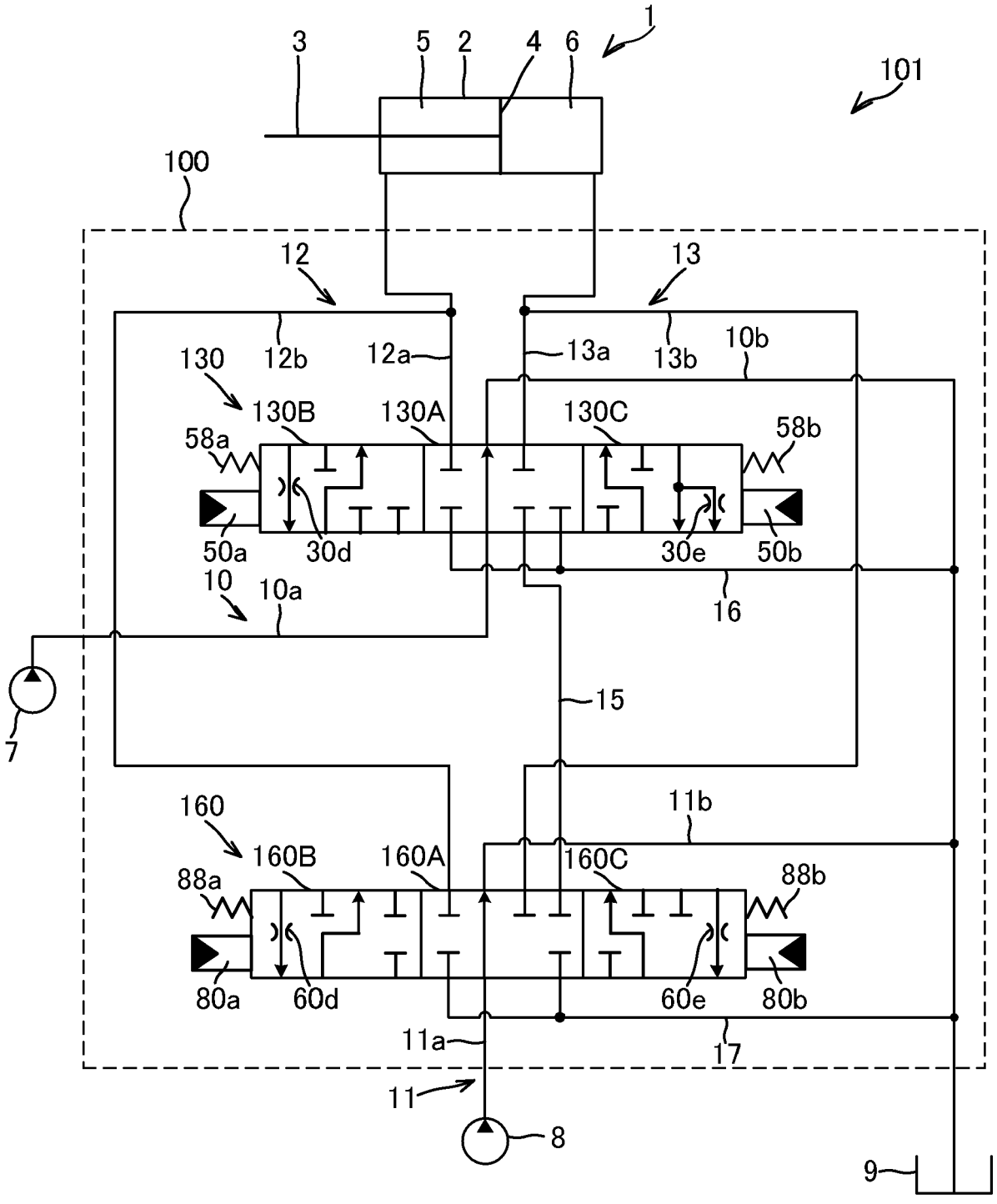


FIG.3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58b
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30d
30e
50b
10
10a
16
15
7
160
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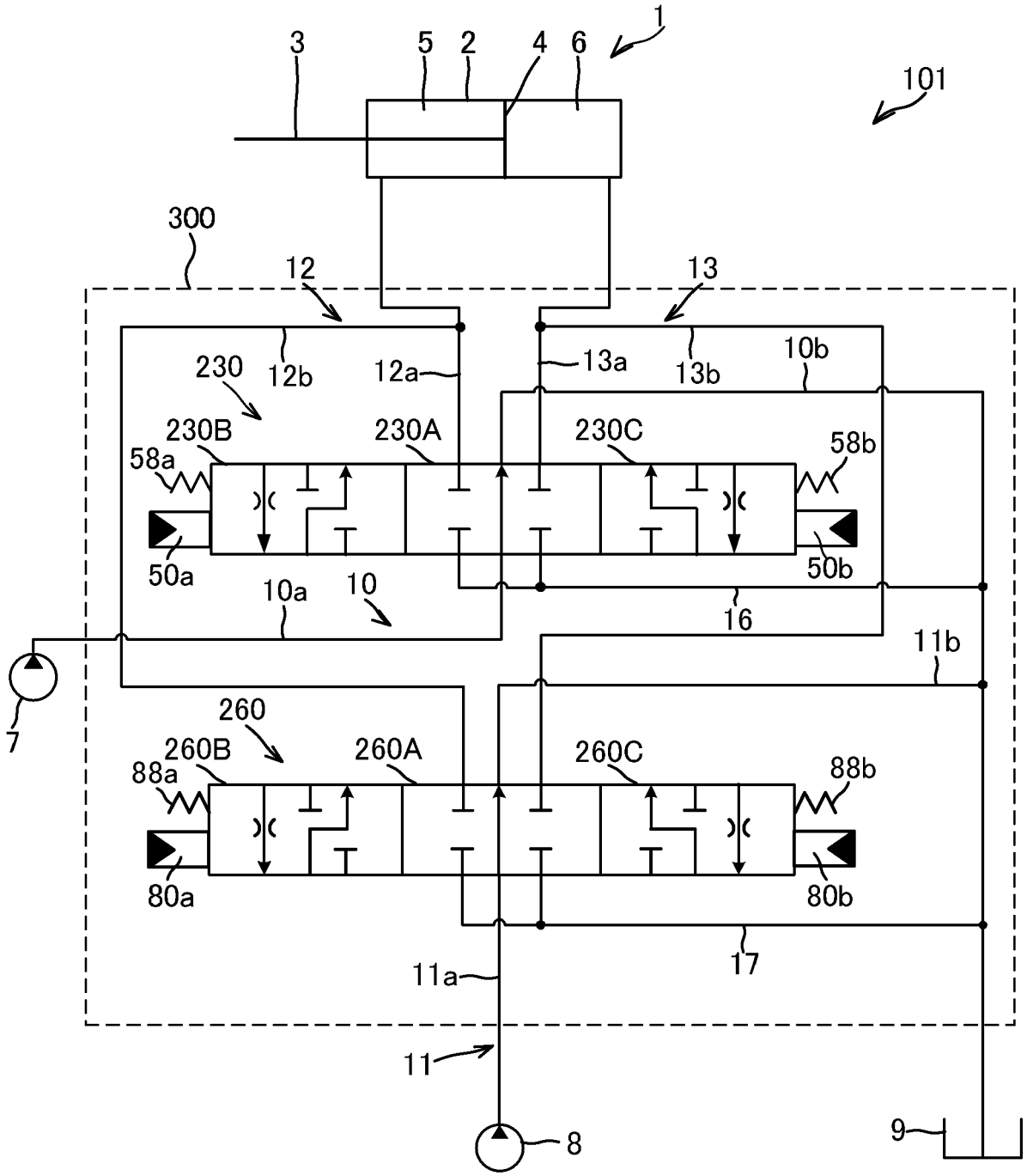
FIG.4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10a
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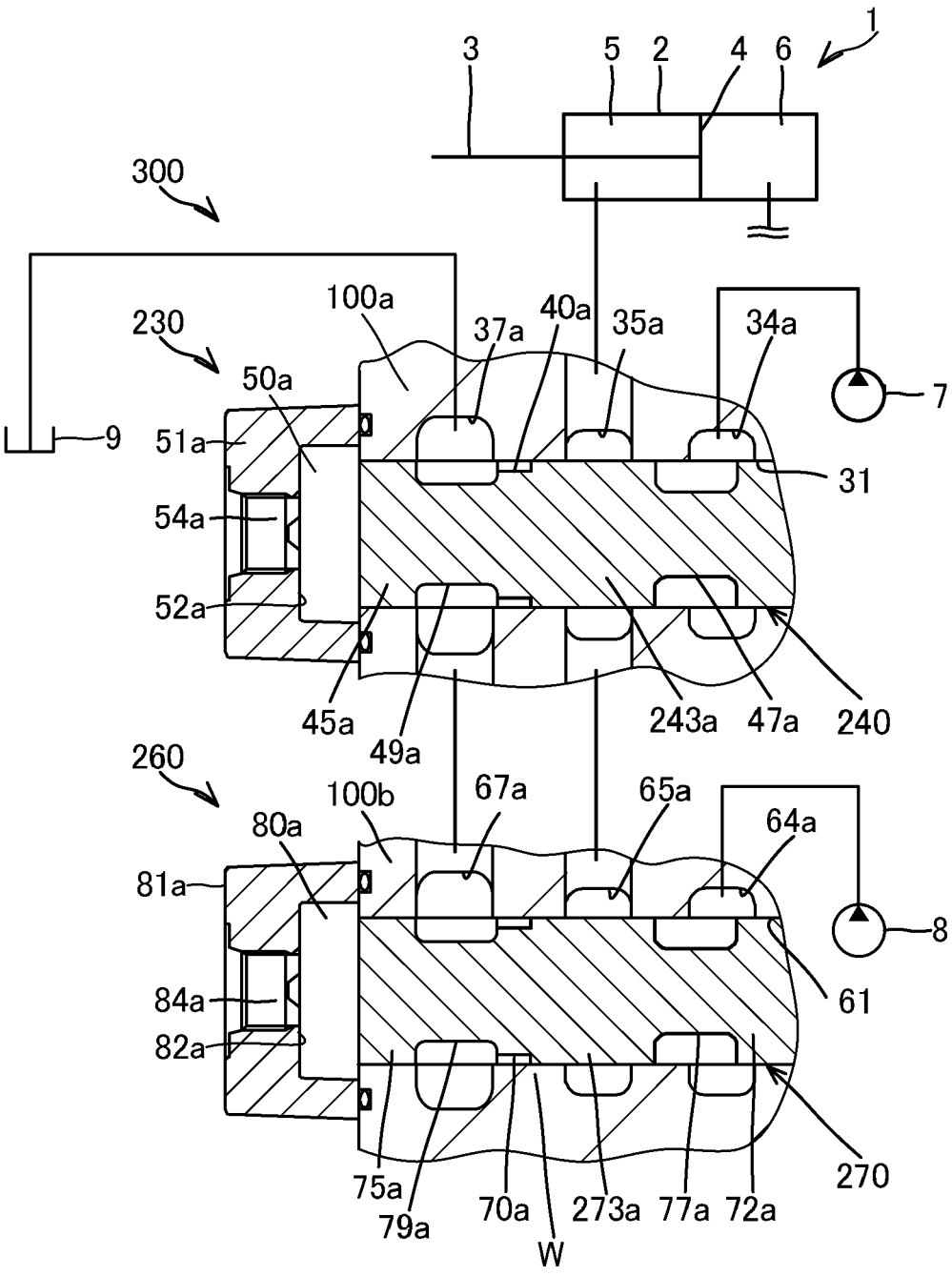
FIG.5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273a
77a
72a
270

FIG.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/008522

A. CLASSIFICATION OF SUBJECT MATTER
F15B 11/02(2006.01)i
FI: F15B11/02 M

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)
F15B11/02

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	1971–2020
Registered utility model specifications of Japan	1996–2020
Published registered utility model applications of Japan	1994–2020

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 2001-355613 A (TOSHIBA MACHINE CO., LTD.) 26.12.2001 (2001-12-26) paragraphs [0013]-[0026], fig. 1-4	1-3
A	JP 51-130775 A (NIPPON AIR BRAKE CO., LTD.) 13.11.1976 (1976-11-13) page 2, upper left column, line 5 to page 3, upper right column, line 15, fig. 1-4	1-3

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

☒ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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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	Date of mailing of the international search report
11 May 2020 (11.05.2020)	19 May 2020 (19.05.2020)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/008522

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2001-355613 A	26 Dec. 2001	(Family: none)	
JP 51-130775 A	13 Nov. 1976	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2001165106 A **[0002] [0005] [0007]**
- JP 2019055069 A **[0113]**