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(71) Applicant: **KAYABA INDUSTRY CO., LTD.**
Minato-ku, Tokyo 105-6190 (JP)

(72) Inventors:
- **Fujii, Atsushi, c/o Kayaba Industry Co., Ltd.**
Minato-ku Tokyo 105-6190 (JP)
- **Kanno, Takeshi, c/o Kayaba Industry Co., Ltd.**
Minato-ku Tokyo 105-6190 (JP)

(74) Representative: **Grünecker, Kinkeldey,**
Stockmair & Schwanhäusser Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) Hydraulic control apparatus

(57) A driving loss of a pump is avoided to reduce a load of an engine driving the pump. At least a first circuit group and a second circuit group, each including switching valves 11 to 19 to switch supply of operating oil to actuators, an auxiliary switching valve 16 disposed in the first circuit group to switch supply of the operating oil to an auxiliary actuator, and at least two pumps supplying the operating oil to each of the first circuit group and the second circuit group are provided. A convergence flow passage 40 to converge the operating oil from the second circuit group to the first circuit group, a drain flow passage 43 branched from the convergence flow passage 40 to release the operating oil to a side of a reservoir, and a control valve 42 interposed in the branched portion are provided, wherein the control valve 42 is operated to be switched in accordance with a difference in pressures between the first circuit group and the second circuit group, and introduces the operating oil of the first circuit group to the drain flow passage 43 when supply pressure of the first circuit group is higher than supply pressure of the second circuit group.

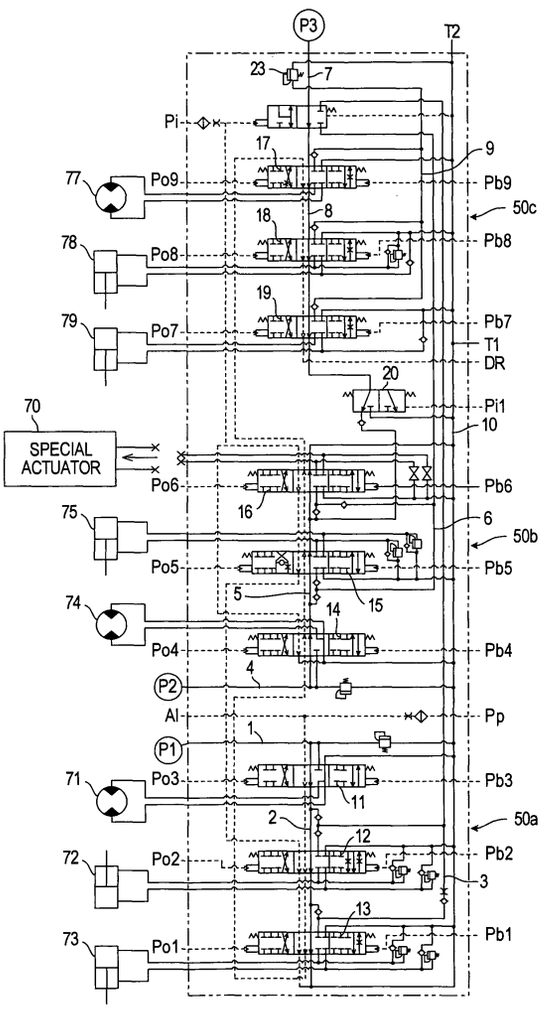

FIG.2

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a hydraulic control apparatus provided with a plurality of hydraulic circuit groups for use of a construction machine such as a hydraulic shovel.

The Related Art of the Invention

[0002] This type of hydraulic control apparatus is disclosed in Japanese Unexamined Patent Publication No. 2002 - 276607, which is shown in FIG. 2.

[0003] The hydraulic control apparatus is provided with a first to a third pump P1 to P3. The first to the third pump P1 to P3 each are connected to a first circuit system to a third circuit system 50a to 50c.

[0004] In the first circuit system 50a, a first to a third switching valve 11 to 13 of open center type are connected to a first supply flow passage 1 connected to the first pump P1. When the first to the third switching valve 11 to 13 are in a neutral position as shown in FIG. 2, the first pump P1 is communicated via a first neutral passage 2 with a tank flow passage 10 connected to a side of a tank (not shown).

[0005] When the first switching valve 11 is switched from the neutral position, hydraulic oil (operating oil) from the first pump P1 is supplied directly to an actuator 71 connected to the first switching valve 11. And when either one of the second switching valve 12 and the third switching valve 13 is switched from the neutral position, the hydraulic oil is similarly supplied via a first parallel passage 3 to an actuator 72 and an actuator 73 each connected to the switching valves 12 and 13. Note that the maximum discharge amount of the first pump P1 is set based upon the maximum amount demanded by three actuators 71 to 73 connected respectively to the first switching valve to the third switching valve 11 to 13.

[0006] In the second circuit system 50b, a fourth to a sixth switching valve 14 to 16 of open center type are connected to a second supply flow passage 4 connected to the second pump P2. When the fourth to the sixth switching valve 14 to 16 are in a neutral position as shown in FIG. 2, the second pump P2 is communicated via a second neutral flow passage 5 with the tank flow passage 10.

[0007] When the fourth switching valve 14 is switched from the neutral position, the hydraulic oil (operating oil) from the second pump P2 is supplied directly to an actuator 74 connected to the fourth switching valve 14. And when either one of the fifth switching valve 15 and the sixth switching valve 16 is switched from the neutral position, the hydraulic oil is similarly supplied via a second parallel flow passage 6 to an actuator 75 and an actuator 70 each connected to the switching valves 15 and 16.

[0008] The sixth switching valve 16 is an auxiliary switching valve, which is beforehand prepared for a construction machine (construction vehicle) using the special actuator 70. Namely in a case where only two actuators are controlled in the second circuit system 50b, the auxiliary switching valve 16 are not used and on the other hand, in a case where the special actuator 70 is added to the two actuators to provide three actuators in total connected to the second circuit system 50b, the special actuator 70 is connected to the auxiliary switching valve 16. And the special actuator 70 is adapted to be controlled by the auxiliary switching valve 16. Since the special actuator 70 is not regularly provided, the maximum discharge amount of the second pump P2 is set based upon the maximum amount demanded by the two actuators 74 and 75, which are connected respectively to the fourth and fifth switching valves 14 and 15.

[0009] In the third circuit system 50c, a seventh to a ninth switching valve 17 to 19 of open center type are connected to a third supply flow passage 7 connected to the third pump P3. When the seventh to the ninth switching valve 17 to 19 are in a neutral position as shown in FIG. 2, the third pump P3 is communicated via a third neutral flow passage 8 with the downstream side.

[0010] When the seventh switching valve 17 is switched from the neutral position, hydraulic oil (operating oil) from the third pump P3 is supplied directly to an actuator 77 connected to the seventh switching valve 17. And when either one of the eighth switching valve 18 and the ninth switching valve 19 is switched from the neutral position, the hydraulic oil is similarly supplied via a third parallel flow passage 9 to an actuator 78 and an actuator 79 each connected to the switching valves 18 and 19. Note that the maximum discharge amount of the third pump P3 is set based upon the maximum amount demanded by the three actuators 77 to 79 connected respectively to the seventh to the ninth switching valve 17 to 19.

[0011] And the downstream side of the third neutral flow passage 8 is connected to the second neutral flow passage 5 of the second circuit system 50b in order to converge and supply the hydraulic oil from the third circuit system 50c to the second circuit system 50b as needed. And a hydraulic pilot type of convergence switching valve 20 is provided midway along a flow passage connecting the third neutral flow passage 8 to the second neutral flow passage 5.

[0012] The convergence switching valve 20 is switched by an operator. When the convergence switching valve 20 is in a closed position, the third neutral flow passage 8 is communicated with the tank flow passage 10 and disconnected to the second neutral flow passage 5, so that the discharge oil from the third pump P3 is not supplied to the second circuit system 50b. In contrast to this, when the convergence switching valve 20 is switched to an opened position in FIG. 2, the third neutral flow passage 8 is communicated with the second

neutral flow passage 5 to supply the hydraulic oil from the third pump P3 to the second circuit system 50b.

[0013] Provision of such convergence switching valve 20 prevents a flow amount of hydraulic oil supplied to the special actuator 70 connected to the auxiliary switching valve 16 from being insufficient.

[0014] The hydraulic oil discharged from the second pump P2 is supplied to the auxiliary switching valve 16 and the maximum discharge amount of the second pump P2 is set based upon the maximum amount demanded from the actuators 74 and 75 connected respectively to the fourth and fifth switching valves 14 and 15. Accordingly, when the actuator 70 connected to the auxiliary switching valve 16 is activated, the special actuator 16 is possibly in short supply of the hydraulic oil. Therefore, in such case, the convergence switching valve 20 converges the discharge oil from the third pump P3 into the discharge oil from the second pump P2, thus compensating for the short supply of the hydraulic oil.

SUMMARY OF THE INVENTION

[0015] In a case where the hydraulic oil from the third pump P3 is supplied to the second circuit system 50b and the special actuator 70 connected to the auxiliary switching valve 16 is activated, when a load pressure in the special actuator 70 or the other actuator 74 or 75 in the second circuit system 50b is high and therefore, a pressure in the second circuit system 50b is high, a pressure in a supply flow passage 7 of the third pump P3 connected to the second circuit system 50b is increased. When the increased pressure goes beyond a predetermined pressure of a relief valve 23, the relief valve 23 opens.

[0016] The pumps P1 to P3 are driven by an engine (not shown) and, for example the pump P3 is controlled to maintain a constant relation between a pump discharge pressure and a pump flow amount so that horse power of the pump P3 does not go beyond a constant value.

[0017] When the pump pressure of the third pump P3 increases so much as to open the relief valve 23 thereof, the pump discharge amount is greatly reduced and the pump driving loss due to the relief is produced.

[0018] Especially in most of construction machines, a motion of each actuator becomes slow depending on an operation method required for each actuator, which greatly increases a pressure in the circuit connected to each actuator. Accordingly, a fuel economy of an engine for driving a pump deteriorates by a driving loss amount of the third pump P 3.

[0019] The present invention has an object of solving the foregoing problems.

[0020] A hydraulic control apparatus in the present invention is provided with at least a first circuit group and a second circuit group, each including a switching valve to switch supply of operating oil to an actuator, an auxiliary switching valve disposed in the first circuit group to switch supply of operating oil to an auxiliary actuator, at least two pumps supplying the operating oil respectively to the first circuit group and the second circuit group, a convergence flow passage to converge the hydraulic oil from the second circuit group to the first circuit group, a drain flow passage branched from the convergence flow passage to relieve the operating oil to a side of a reservoir, and a control valve interposed in the branched portion of the drain flow passage, wherein the control valve is operated to be switched in accordance with a difference in pressures between the first circuit group and the second circuit group, and introduces the operating oil of the first circuit group to the drain flow passage when supply pressure of the first circuit group is higher than supply pressure of the second circuit group.

[0021] According to the present invention, driving losses of the pump in the circuit group which converges the operating oil are avoided to secure a desired operation of the actuator for the auxiliary switching valve, as well as to reduce a load of the engine for pump driving, thereby improving a fuel economy.

[0022] These and other objects, features, aspects and advantages of the present invention will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The preferred embodiment according to the invention will be explained below referring to the drawings, wherein:

FIG. 1 is a circuit view of a hydraulic control apparatus in a hydraulic shovel in a preferred embodiment of the present invention; and

FIG. 2 is a circuit view of a conventional hydraulic control apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] The selected embodiment of the present invention will now be explained with reference to the drawings. It will be apparent to those skilled in the art from this disclosure that the following description of the embodiment of the present invention is provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

[0025] A preferred embodiment of the present invention will be explained with reference to the accompanying drawings.

[0026] FIG. 1 shows a circuit view of a hydraulic control apparatus in a hydraulic shovel. In FIG. 1, components substantially identical to those in FIG. 2 are re-

ferred to as identical numerals.

[0027] A hydraulic control apparatus of the present invention is provided with a first to a third pump P1 to P3, which are connected respectively to a first to a third circuit system 60A to 60C.

[0028] Note that in order to discern the first circuit system 60A and the second circuit system 60B over the third circuit system 60C which converges operating oil as needed, the first circuit system 60A and the second circuit system 60B are defined as a first circuit group and the third circuit system 60C is defined as a second circuit group.

[0029] In the first circuit system 60A (the first circuit group), a first switching valve to a third switching valve 11 to 13 of open center type are connected to a first supply flow passage 1 connected to the first pump P1. When the first to the third switching valve 11 to 13 are in a neutral position as shown in FIG. 1, the first pump P1 is communicated via a first neutral flow passage 2 with a tank flow passage 10.

[0030] When the first switching valve 11 is switched from the neutral position, hydraulic oil (the operating oil) from the first pump P1 is supplied directly to an actuator (for example, left hand driving motor for vehicle traveling) 31 connected to the switching valve 11. And when either one of the second switching valve 12 and the third switching valve 13 is switched, hydraulic oil is similarly supplied via a first parallel flow passage 3 to an actuator 32 and an actuator 33 each connected to the switching valves 12 and 13, namely a cylinder 32 for boom driving connected to the second switching valve 12 and a cylinder 33 for bucket driving connected to the third switching valve 13.

[0031] The maximum discharge amount of the first pump P1 is set based upon the maximum amount demanded by three actuators 31 to 33 connected respectively to the first switching valve to the third switching valve 11 to 13. In FIG. 1, a relief valve 21 opens when a circuit pressure (discharge pressure in the pump P1) in the first supply passage 1 rises up to more than a predetermined value to release the pressure, and each of pilot circuits Pa1, Pb1, Pa2, Pb2, Pa3, pb3 supplies a pilot pressure to switch the switching valves 11 to 13. And a DR indicates a drain circuit.

[0032] In the second circuit system 60B (the first circuit group), a fourth to a sixth switching valve 14 to 16 of open center type are connected to a second supply flow passage 4 connected to the second pump P2.

[0033] When the fourth to the sixth switching valve 14 to 16 are in a neutral position as shown in FIG. 1, the second pump P2 is communicated via a second neutral flow passage 5 with the tank flow passage 10. And when the fourth switching valve 14 is switched from the neutral position, the hydraulic oil (the operating oil) from the second pump P2 is supplied directly to an actuator (right hand driving motor for vehicle traveling) 34 connected to the fourth switching valve 14. And when either one of the fifth switching valve 15 and the sixth switching valve 16 is switched from the neutral position, the hydraulic oil is similarly supplied via a second parallel flow passage 6 to an actuator 35 and an actuator 36, namely a cylinder 35 for arm driving and a special actuator 30 each connected to the switching valves 15 and 16.

[0034] In this case, the sixth switching valve 16 serves as an auxiliary switching valve to control drive of the special actuator 30, which includes, for example, a breaker, a drilling nail or the like.

[0035] The maximum discharge amount of the second pump P2 is set based upon the maximum amount demanded by the two actuators 34 and 35 connected respectively to the fourth and fifth switching valves 14 and 15. In FIG. 1, a relief valve 22 opens when a circuit pressure, namely a discharge pressure in the pump P2 in the second supply flow passage 4 rises up to more than a predetermined value to release the pressure and each of pilot circuits Pa4, Pb4, Pa5, Pb5, Pa6, pb6 supplies a pilot pressure to switch the switching valves 14 to 16.

[0036] In the third circuit system 60C (the second circuit group), a seventh to a ninth switching valve 17 to 19 of open center type are connected to a third supply flow passage 7 connected to the third pump P3. When the seventh to the ninth switching valve 17 to 19 are in a neutral position as shown in FIG. 1, the third pump P3 is communicated via a third neutral flow passage 8 with a downstream passage 40.

[0037] When the seventh switching valve 17 is switched from the neutral position, the hydraulic oil from the third pump P3 is supplied directly to an actuator (driving motor for vehicle chassis turning) 37 connected to the switching valve 17. And when either one of the eighth switching valve 18 and the ninth switching valve 19 is switched from the neutral position, the hydraulic oil is similarly supplied via a third parallel flow passage 9 to an actuator 38 and an actuator 39, namely a cylinder 38 for blade driving connected to the eighth switching valve 18 and a cylinder 39 for swing driving connected the ninth switching valve 19.

[0038] Note that the maximum discharge amount of the third pump P3 is set based upon the maximum amount demanded by the three actuators 37 to 39 connected respectively to the seventh to the ninth switching valve 17 to 19. In FIG. 1, a relief valve 23 opens when a circuit pressure in the third supply flow passage 7, namely a discharge pressure of the pump P3 rises up to more than a predetermined value to release the pressure and each of pilot circuits Pa7, Pb7, Pa8, Pb8,Pa9, pb9 supplies a pilot pressure to switch the switching valves 17 to 19.

[0039] And the downstream passage 40 of the third neutral flow passage 8 is connected to a convergence flow passage 41 of the second circuit system 60B in order to converge and supply the hydraulic oil from the third circuit system 60C to the second circuit system 60B as needed. The convergence flow passage 41 is connected to the second neutral flow passage 5 upstream

of the auxiliary switching valve 16 and the second parallel flow passage 6. A drain flow passage 43 is provided to be branched from the downstream passage 40 of the third circuit system 60C and a switching control valve 42 is provided in a branch portion between the convergence flow passage 41 and the drain flow passage 43 for passage switching.

[0040] The switching control valve 42 connects the downstream passage 40 of the third circuit system 60C to the drain flow passage 43 when the discharge pressure in the second pump P2 of the second circuit system 60B is by a predetermined pressure higher than the discharge pressure in the third pump P3 of the third circuit system 60C and on the other hand, when by a predetermined pressure lower than that, connects the downstream passage 40 of the third circuit system 60C to the convergence flow passage 41.

[0041] The switching control valve 42 is adapted to serve as a pilot pressure switching valve to which a pilot passage 45 for introducing the discharge pressure from the third pump P3 as a pilot pressure and a pilot passage 46 for introducing the discharge pressure from the second pump P2 as a pilot pressure are connected, and is operated to be switched due to receiving these pilot pressures.

[0042] With such configuration, when the discharge pressure in the second pump P2 of the second circuit system 60B is generally equal to the discharge pressure in the third pump P3 of the third circuit system 60C, namely when the switching control valve 42 is switched to the side of the convergence flow passage 41, the hydraulic oil in the second pump P2 and the hydraulic oil in the third pump P3 are converged and supplied into the second neutral flow passage 5 and the second parallel flow passage 6 of the second circuit system 60B. When the auxiliary switching valve 16 is switched into any direction in this state, the converged operating oil is supplied into the actuator 30 connected to the auxiliary switching valve 16, thereby activating the actuator 30.

[0043] When a load pressure of the actuator 30, or the other actuator 34 or 35 of the second circuit system 60B during the activating of the actuator 30 connected to the auxiliary switching valve 16 is increased, the discharge pressure in the second pump P2 of the second circuit system 60B rises up. Although the discharge pressure in the third pump P3 of the third circuit system 60C rises up, when the discharge pressure in the second pump P2 of the second circuit system 60B is by a predetermined pressure higher than the discharge pressure in the third pump P3 of the third circuit system 60C, the switching control valve 42 is switched, thus releasing the discharge oil in the third pump P3 from the drain flow passage 43 to the tank flow passage 10.

[0044] Accordingly, even if the discharge pressure in the third pump P3 rises up, the discharge pressure does not reach a predetermined pressure of the relief valve 23, so that the relief valve 23 does not open. As a result, a driving loss of the third pump p3 caused by the relief of the discharge pressure in the third pump P3 by the relief valve 23 can be avoided to reduce a load of the engine for driving the pump, thus improving a fuel economy.

[0045] When a load pressure of the actuator 30 connected to the auxiliary switching valve 16, or the other actuator 34 or 35 of the second circuit system 60B is low, and therefore, the discharge pressure in the second pump P2 of the second circuit system 60B is lower than a predetermined pressure, the hydraulic pressure in the third pump P3 together with the hydraulic pressure in the second pump P2 is supplied via the switching control valve 42 to the actuator 30 connected to the auxiliary switching valve 16.

[0046] Accordingly, the hydraulic pressure in the third pump P3 can be appropriately supplied by the operating oil converged into the actuator 30 connected to the auxiliary switching valve 16, thereby securing a desired operation of the actuator 30.

[0047] Note that it is described that in the above-mentioned preferred embodiment, the first to the third circuit system 60A to 60C are provided, but the present invention may be provided with at least two circuit systems 60B and 60C. In this case the hydraulic oil may be supplied from the one circuit system 60C to the other circuit system 60B provided with the auxiliary switching valve 16.

[0048] The present invention is not limited to the above-described preferred embodiment, but it is apparent to those skilled in the art that the present invention includes various improvements and modifications within the scope of the technical concept of the present invention as defined in the appended claims.

Claims

1. A hydraulic control apparatus, comprising:

at least a first circuit group and a second circuit group, each including a switching valve to switch supply of operating oil to an actuator;

an auxiliary switching valve disposed in the first circuit group to switch supply of the operating oil to an auxiliary actuator;

at least two pumps supplying the operating oil respectively to the first circuit group and the second circuit group;

a convergence flow passage to converge the operating oil from the second circuit group to the first circuit group;

a drain flow passage branched from the convergence flow passage to release the operating oil to a side of a tank; and

a switching control valve interposed in the branched portion of the drain flow passage, wherein:

the switching control valve is operated to be switched in accordance with a difference in pressures between the first circuit group and the second circuit group, and introduces the operating oil of the first circuit group to the drain flow passage when supply pressure of the first circuit group is higher than supply pressure of the second circuit group.

2. The hydraulic control apparatus according to claim 1, wherein:

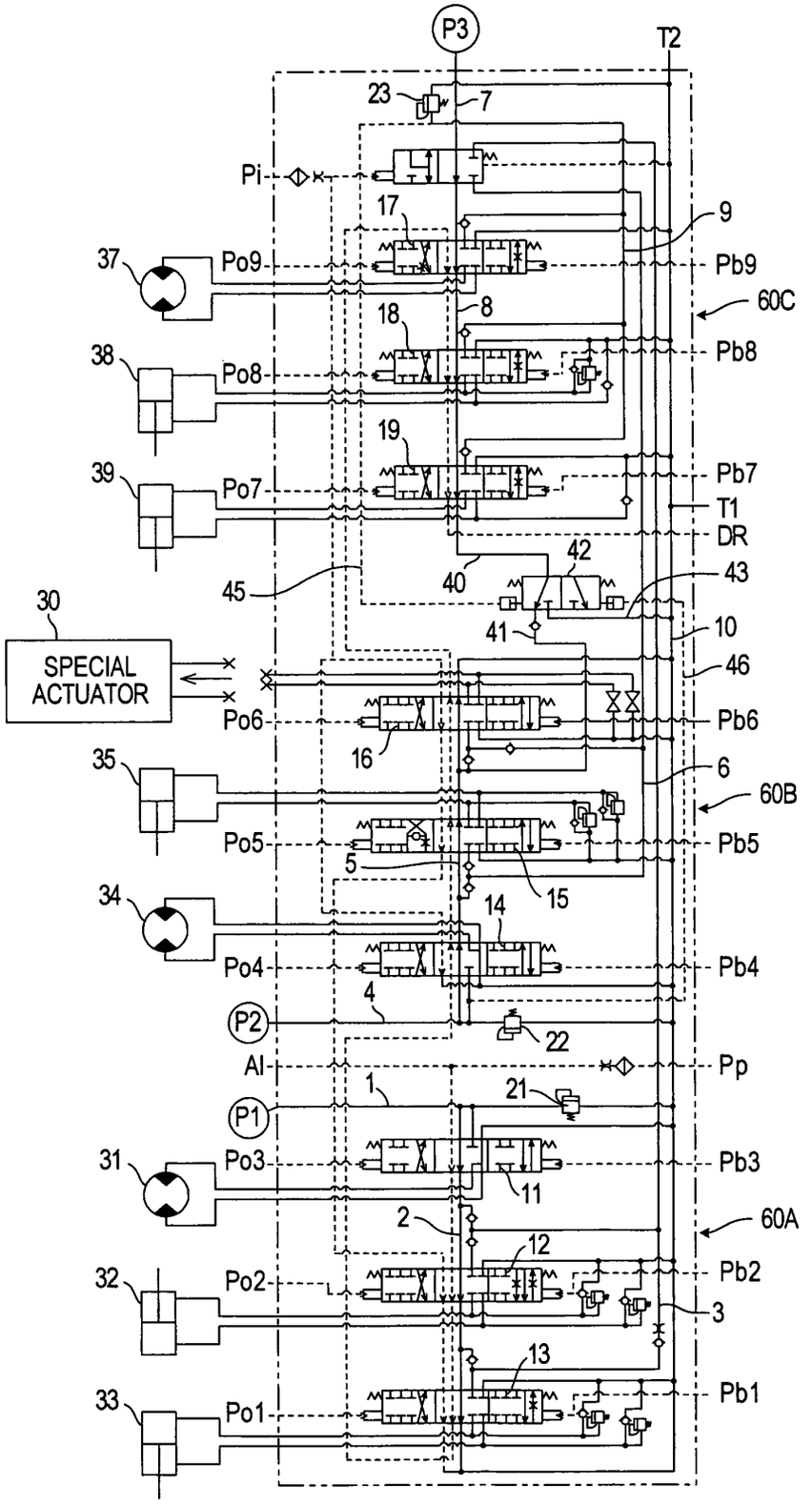
the switching control valve is adapted to introduce the operating oil in the convergence flow passage to the drain flow passage when the supply pressure of the first circuit group is higher by a predetermined value than the supply pressure of the second circuit group, and other than that, introduce the operating oil from the convergence flow passage to the first circuit group.

3. The hydraulic control apparatus according to claim 2, wherein:

the switching control valve is adapted to serve as a pilot pressure switching valve, which is operated to be switched by the supply pressure of the first circuit group and the supply pressure of the second circuit group as a pilot pressure.

4. The hydraulic control apparatus according to claim 1, wherein:

each of the switching valves in the first circuit group and the second circuit group includes a switching valve of open center type; and a plurality of the switching valves are arranged in series in each of the first circuit group and the second circuit group.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T2
23
7
Pi
17
9
37
Po9
Pb9
60C
18
8
38
Po8
Pb8
19
39
Po7
Pb7
T1
DR
42
40
43
45
30
41
10
SPECIAL ACTUATOR
46
Po6
Pb6
16
6
35
60B
Po5
Pb5
5
15
34
14
Po4
Pb4
4
P2
22
AI
Pp
1
21
P1
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Po3
Pb3
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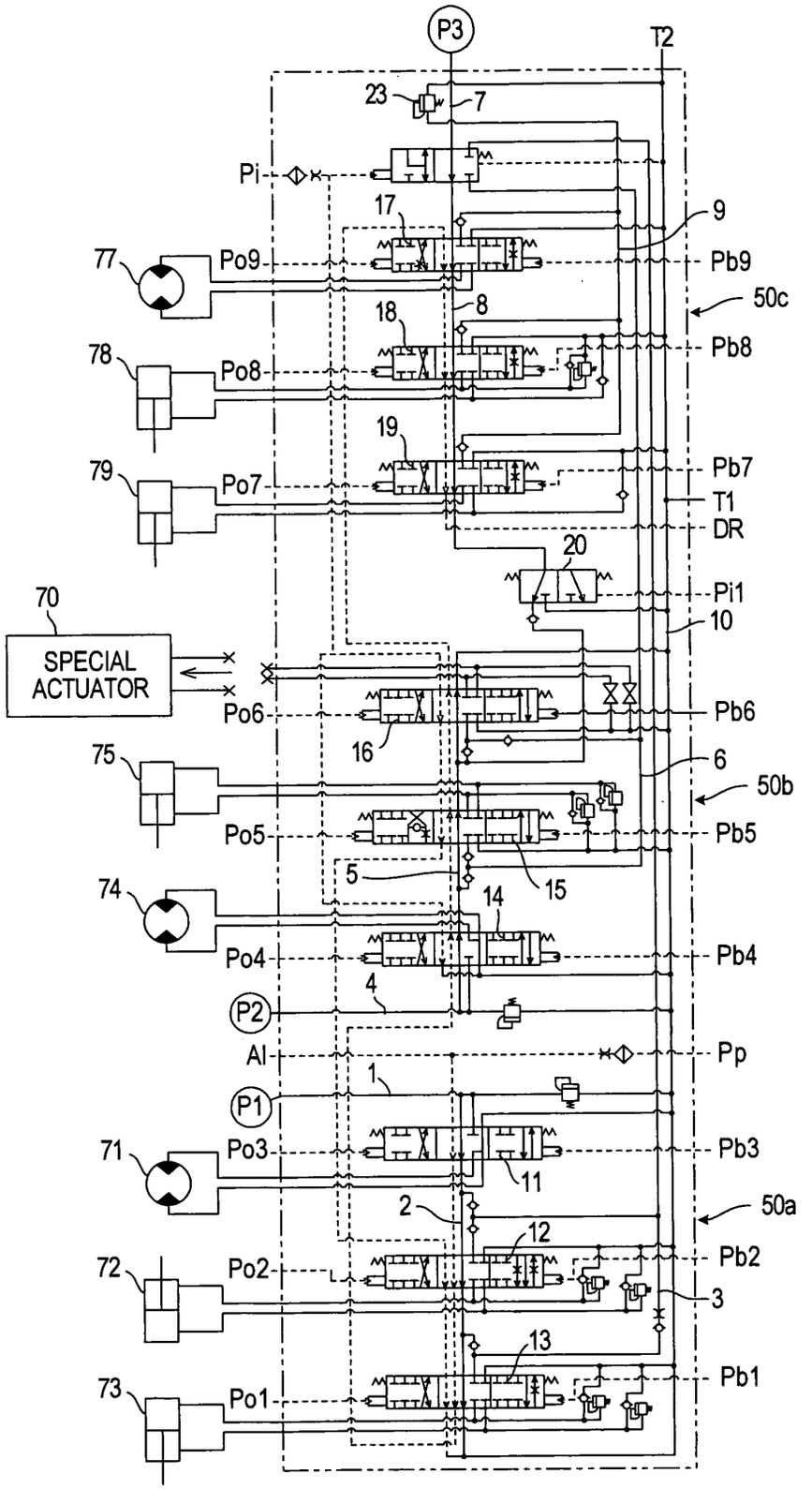
2
60A
12
32
Po2
Pb2
3
13
33
Po1
Pb1

FIG.1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9
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Pb9
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Po8
Pb8
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79
Po7
Pb7
T1
DR
20
Pi1
70
10
SPECIAL ACTUATOR
Po6
Pb6
16
6
75
50b
Po5
Pb5
5
15
74
14
Po4
Pb4
4
P2
Al
Pp
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P1
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Po3
Pb3
11
2
50a
12
72
Po2
Pb2
3
13
73
Po1
Pb1

FIG.2