(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 686 440 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
29.07.2020 Bulletin 2020/31

(21) Application number: **19872249.8**

(22) Date of filing: **06.08.2019**

(51) Int Cl.:
F15B 11/00 *(2006.01)* ***E02F 9/22*** *(2006.01)*
F15B 11/16 *(2006.01)*

(86) International application number:
PCT/JP2019/030975

(87) International publication number:
WO 2020/105230 (28.05.2020 Gazette 2020/22)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **20.11.2018 JP 2018217345**

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(54) **FLUID PRESSURE CONTROL DEVICE**

(57) A first circuit system (HC1) of the fluid pressure control device (100) includes the neutral cut valve (110) being configured to make the first neutral passage (11) and the tank (T) communicate with each other or block communication between the first neutral passage (11) and the tank (T), the first external output passage (14) through which the working fluid is able to be supplied to outside, the first external output passage (14) being in communication with the downstream side of the first control valve (12) and the upstream side of the neutral cut valve (110) in the first neutral passage (11), and the second external output passage (15) through which the working fluid guided via the neutral cut valve (110) is able to be supplied to the outside. The neutral cut valve (110) is switched among the first position (P1) at which the working fluid is enabled to be guided to the tank T, the second position (P2) at which the working fluid is disabled to be supplied to the outside through the second external output passage (15), and the third position (P3) at which the working fluid is enabled to be supplied to the outside through the second external output passage (15).

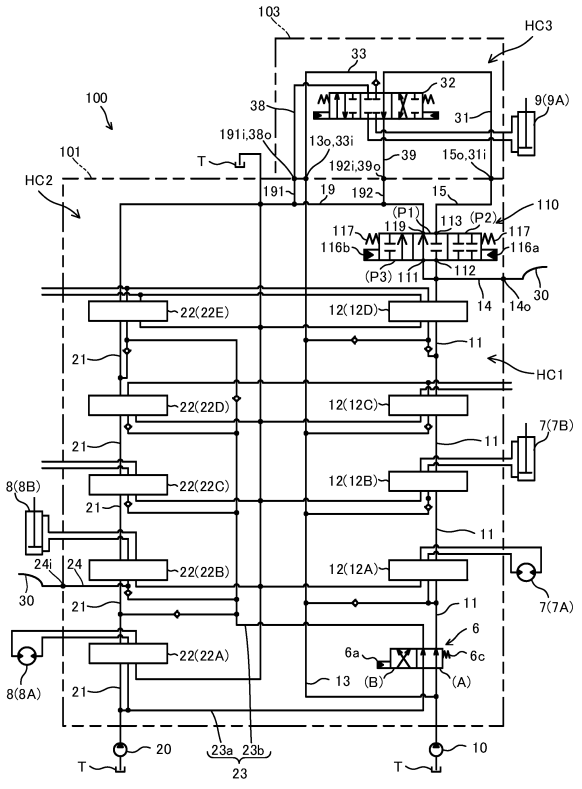

FIG. 1

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Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] JP2016-204826A discloses a fluid pressure control device including: a first circuit system with a plurality of control valves connected to a first pump; and a second circuit system with a plurality of control valves connected to a second pump. The fluid pressure control device according to JP2016-204826A is provided with a neutral cut valve adapted to make a first neutral passage and a tank communicate with each other or block the communication therebetween, and an external output passage that is in communication with an upstream side of the neutral cut valve and through which a working fluid discharged from the first pump can be supplied to the outside. Thus, the working fluid can be drawn out from the first circuit system to the outside through the external output passage.

SUMMARY OF INVENTION

[0003] As described above, in the fluid pressure control device according to JP2016-204826A, the working fluid can be drawn out to a circuit system different from the first circuit system through the external output passage. However, the first circuit system is provided with only one external output passage. Thus, the fluid pressure control device has a problem that a circuit system other than the circuit system connected to the external output passage cannot be additionally connected to the first circuit system, meaning that a degree of freedom in terms of circuit system expansion is low.

[0004] An object of the present invention is to provide a fluid pressure control device with a high degree of freedom in terms of circuit system expansion.

[0005] According to one aspect of the present invention, a fluid pressure control device for controlling an actuator driven by a working fluid discharged from a pump, includes a main circuit system including a main control valve that is connected to the pump and configured to control a main actuator, the main circuit system includes a main neutral passage through which the working fluid from the pump returns to a tank when the main control valve is at a neutral position; a neutral cut valve provided on a downstream side of the main control valve in the main neutral passage, the neutral cut valve being configured to make the main neutral passage and the tank communicate with each other or block communication between the neutral passage and the tank; a first external output passage through which the working fluid discharged from the pump is able to be supplied to outside, the first external output passage being in communication with the downstream side of the main control valve and an upstream side of the neutral cut valve in the main neutral passage; and a second external output passage through which the working fluid discharged from the pump and guided via the neutral cut valve is able to be supplied to the outside, and the neutral cut valve is switched among a first position at which the working fluid discharged from the pump is enabled to be guided to the tank, a second position at which the working fluid discharged from the pump is disabled to be supplied to the outside through the second external output passage and the working fluid discharged from the pump is disabled to be guided to the tank, and a third position at which the working fluid discharged from the pump is enabled to be supplied to the outside through the second external output passage and the working fluid discharged from the pump is disabled to be guided to the tank.

BRIEF DESCRIPTION OF DRAWINGS

[0006]

FIG. 1 is a circuit diagram illustrating a fluid pressure control device according to a first embodiment of the present invention.

FIG. 2 is a schematic perspective view of a main valve block and a sub valve block.

FIG. 3 is a circuit diagram illustrating a fluid pressure control device according to a second embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

<First embodiment>

[0007] A fluid pressure control device 100 according to a first embodiment of the present invention will be described with reference to FIG. 1 and FIG. 2.

[0008] For example, the fluid pressure control device 100 is used for a working machine such as a power excavator. Here, a case where the working machine is a power excavator will be described. However, the fluid pressure control device 100 can be applied to other working machines such as a wheel loader. In the fluid pressure control device 100, working oil is used as a working fluid. However, other types of fluid such as working water may be used as the working fluid.

[0009] Although not elaborated in the figure, the power excavator includes a traveling unit of a crawler type, a swiveling unit that is provided on an upper part of the traveling unit to be able to swivel, and an excavating unit that is provided to the swiveling unit. The traveling unit includes a pair of left and right crawlers. The power excavator travels with the pair of left and right crawlers driven. The excavating unit includes a boom that is pivotally attached to the swiveling unit, an arm that is pivotally attached to the boom, and a bucket that is pivotally attached to the arm.

[0010] As illustrated in FIG. 1, the power excavator includes an engine (not illustrated), a first pump 10 and a second pump 20 serving as hydraulic pressure pumps that is driven by the engine to discharge the working oil, a fluid pressure control device 100 that controls actuators for driving the traveling unit, the swiveling unit, and the excavating unit by using the working oil discharged from the first pump 10 and the second pump 20, and a tank T to which the working oil returns from the fluid pressure control device 100.

[0011] The fluid pressure control device 100 controls a plurality of actuators that are driven by the working oil discharged from the first pump 10 and the second pump 20. Examples of the plurality of actuators include traveling unit driving hydraulic motors 7A and 8A, a swiveling unit driving hydraulic motor (not illustrated), an arm driving hydraulic cylinder (not illustrated), a bucket driving hydraulic cylinder 7B, an auxiliary attachment driving hydraulic cylinder 8B, an additional attachment driving hydraulic cylinder 9A, and the like.

[0012] Examples of the auxiliary attachment and the additional attachment include a breaker and crusher attached instead of the bucket, an offset device that causes a sliding movement of the boom in a left and right direction, a dozer blade attached to the swiveling unit, and the like.

[0013] The fluid pressure control device 100 includes: a first circuit system HC1 that is connected to the first pump 10 and receives working oil supplied from the first pump 10; a second circuit system HC2 that is connected to the second pump 20 and receives working oil supplied from the second pump 20; and a third circuit system HC3 that is connected to the first circuit system HC1 and receives working oil supplied from the first pump 10 via a neutral cut valve 110 described later. As will be described later, a straight traveling control valve 6 is switched so that the working oil discharged from the first pump 10 is also supplied to the second circuit system HC2 and the working oil discharged from the second pump 20 is also supplied to the first circuit system HC1 and the third circuit system HC3.

[0014] As illustrated in FIG. 1 and FIG. 2, the fluid pressure control device 100 includes: a main valve block 101 including the first circuit system HC1 and the second circuit system HC2 serving as a main circuit system; and a sub valve block 103 including the third circuit system HC3 serving as a sub circuit system. As illustrated in FIG. 2, the sub valve block 103 can be attached to the main valve block 101 by using a plurality of bolts 105. The main valve block 101 may be formed by stacking and fastening a plurality of valve blocks, or may be formed by a single valve block.

[0015] The main valve block 101 has bolt attachment holes 115, for attaching the bolts 105, opening in the outer surface. The sub valve block 103 is fixed to the main valve block 101 with the sub valve block 103 placed on the main valve block 101, shaft portions of the bolts 105 inserted through bolt insertion holes 135 of the sub valve block 103, and tip portions of the shaft portions of the bolts 105 screwed to the bolt attachment holes 115.

[0016] The sub valve block 103 is provided adapted to control the hydraulic cylinder 9A for driving the additional attachment. Conventionally, to control the hydraulic cylinder 9A for driving the additional attachment, the third circuit system HC3 has been required to be connected to a new hydraulic pump different from the first pump 10 or the second pump 20, with the sub valve block 103 provided to be separate from the main valve block 101.

[0017] On the other hand, according to the present embodiment, the sub valve block 103 can be attached on the main valve block 101, whereby an installation area of the fluid pressure control device 100 can be reduced. Furthermore, no pipe needs to be provided between the main valve block 101 and the sub valve block 103, whereby an installation space of the fluid pressure control device 100 can be made small. Furthermore, as will be described later, no new hydraulic pump needs to be connected to the sub valve block 103 because the working oil from the first pump 10 is supplied to the sub valve block 103 through the main valve block 101. All things considered, according to the present embodiment, the number of parts and cost can be reduced compared with a case where the sub valve block 103 connected with the new hydraulic pump is provided to be separate from the main valve block 101.

[0018] As illustrated in FIG. 1, the first circuit system HC1 includes: a first neutral passage 11 serving as a main neutral passage that guides the working oil discharged from the first pump 10 to the tank T; first control valves 12 serving as a plurality of main control valves connected in series with the first neutral passage 11; a first parallel passage 13 that is branched off from the first neutral passage 11 more on the upstream side than the straight traveling control valve 6 described later; and a discharge passage 19 connected to the tank T. The plurality of first control valves 12 are connected in series through the first neutral passage 11, and are connected in parallel through the first parallel passage 13.

[0019] The first control valves 12, which are main control valves adapted to control the actuator provided to the first circuit system HC1, include a first traveling control valve 12A, a bucket control valve 12B, a boom first speed control valve 12C, and an arm second speed control valve 12D. The working oil discharged from the first pump 10 is guided to the first traveling control valve 12A, the bucket control valve 12B, the boom first speed control valve 12C, and the arm second speed control valve 12D in this order from the upstream side.

[0020] The first traveling control valve 12A is adapted to control supplying/discharging of the working oil to/from the traveling unit driving hydraulic motor 7A, provided on the left side of the vehicle body of the power excavator. The bucket control valve 12B is adapted to control supplying/discharging of the working oil to/from the bucket driving hydraulic cylinder 7B. The boom first speed control valve 12C is adapted to control supplying/discharging

of the working oil to/from a boom driving hydraulic cylinder (not illustrated). The arm second speed control valve 12D is adapted to control supplying/discharging of the working oil to/from an arm driving hydraulic cylinder (not illustrated). The main actuators (such as the hydraulic motor 7A and the hydraulic cylinder 7B) controlled using the first control valves 12 are also collectively referred to as a first actuator 7.

[0021] As described above, the first circuit system HC1 includes the plurality of first control valve 12 that are connected to the first pump 10, and are used adapted to control the plurality of first actuators 7. The discharge passage 19 guides the working oil discharged from the first actuator 7 via the first control valve 12 to the tank T.

[0022] In the first circuit system HC1, the working oil discharged from the first pump 10 returns to the tank T through the first neutral passage 11, when the straight traveling control valve 6 described later is at a normal position (A), the neutral cut valve 110 described later is at a first position (P1), and all the first control valves 12 are at neutral positions. When at least one of the plurality of first control valve 12 is at a drive position, the communication between the first pump 10 in the first neutral passage 11 and the tank T is blocked.

[0023] In the first circuit system HC1, the working oil discharged from the first pump 10 can be supplied to the first control valves 12B to 12D through the first parallel passage 13, even when the communication between the first pump 10 in the first neutral passage 11 and the tank T is blocked due to any one of the first control valves 12A to 12C being switched to the drive position.

[0024] The first circuit system HC1 further includes: the neutral cut valve 110 that is provided on the downstream side (the downstream side of the arm second speed control valve 12D) of all the first control valves 12 in the first neutral passage 11, and adapted to make the first neutral passage 11 and the tank T communicate with each other or block the communication therebetween; a first external output passage 14; a first external output passage 14 through which the working oil discharged from the first pump 10 can be supplied to the outside, the first external output passage 14 being in communication with the downstream side of all the first control valves 12 in the first neutral passage 11 (thus, the downstream side of the arm second speed control valve 12D) and the upstream side of the neutral cut valve 110; and a second external output passage 15 through which the working oil discharge from the first pump 10 and guided via the neutral cut value 110 can be supplied to the outside.

[0025] The first external output passage 14 is connected to a first external output port 14o opening in the outer surface of the main valve block 101. The second external output passage 15 is connected to a second external output port 15o opening in the outer surface of the main valve block 101. The first parallel passage 13 is connected to an output port 13o opening in the outer surface of the main valve block 101.

[0026] The first circuit system HC1 further includes branch passages 191 and 192 branched off from the discharge passage 19 guiding the working oil to the tank T. The branch passages 191 and 192 are respectively connected to introduction ports 191i and 192i opening in the outer surface of the main valve block 101.

[0027] The neutral cut valve 110 is a pilot switching valve with a spool switched among the first position (P1), the second position (P2), and the third position (P3) in accordance with pilot pressure supplied to a first pilot pressure chamber 116a and a second pilot pressure chamber 116b. The pilot pressure applied to the first pilot pressure chamber 116a and the second pilot pressure chamber 116b is controlled on the basis of an operation state of the power excavator, an operation position of a dedicated operation member (not illustrated) for operating the neutral cut valve 110, and the like.

[0028] The neutral cut valve 110 is maintained at the first position (P1) by biasing force from a centering spring 117, when no pilot pressure is applied to each of the first pilot pressure chamber 116a and the second pilot pressure chamber 116b.

[0029] The neutral cut valve 110 includes: a first inlet port 111 and a second inlet port 112 that are in communication with the downstream side of the arm second speed control valve 12D in the first neutral passage 11; a tank port 119 that is in communication with the discharge passage 19; and an outlet port 113 that is in communication with the second external output passage 15.

[0030] When the neutral cut valve 110 is at the first position (P1), the first inlet port 111 and the tank port 119 communicate with each other, and the communication between the second inlet port 112 and the outlet port 113 is blocked. When the first inlet port 111 and the tank port 119 communicate with each other, the working oil guided to the first neutral passage 11 is guided to the discharge passage 19 via the neutral cut valve 110.

[0031] Thus, the neutral cut valve 110 at the first position (P1) disables the supplying of the working oil, discharged from the first pump 10, to the outside of the main valve block 101 through the second external output passage 15, and enables the working oil, discharged from the first pump 10, to be guided to the tank T through the discharge passage 19.

[0032] When the neutral cut valve 110 is at the second position (P2), the communication between first inlet port 111 and the tank port 119 is blocked, and the communication between the second inlet port 112 and the outlet port 113 is blocked.

[0033] Thus, the neutral cut valve 110 at the second position (P2) disables the supplying of the working oil, discharged from the first pump 10, to the outside of the main valve block 101 through the second external output passage 15, and disables the working oil, discharged from the first pump 10, to be guided to the tank T through the discharge passage 19.

[0034] When the neutral cut valve 110 is at the third position (P3), the communication between the first inlet port 111 and tank port 119 is blocked, and the second

inlet port 112 and the outlet port 113 communicate with each other. When the second inlet port 112 and the outlet port 113 communicate with each other, the working oil guided to the first neutral passage 11 is guided to the second external output passage 15 via the neutral cut valve 110.

[0035] Thus, the neutral cut valve 110 at the third position (P3) enables the working oil, discharged from the first pump 10, to be supplied to the outside of the main valve block 101 through the second external output passage 15, and disables the guiding of the working oil, discharged from the first pump 10, to the tank T through the discharge passage 19.

[0036] As described above, the first position (P1) is a position with which the first neutral passage 11 and the tank T communicate with each other, and the second position (P2) and the third position (P3) are position with which the communication between the first neutral passage 11 and the tank T is blocked. The third position (P3) is a position with which the first neutral passage 11 and a third neutral passage 31 of the third circuit system HC3 described later communicate with each other, and the first position (P1) and the second position (P2) are positions at which the communication between the first neutral passage 11 and the third neutral passage 31 is blocked.

[0037] In the present embodiment, the sub valve block 103 is adapted to be attached to the main valve block 101 so that the working oil discharged from the first pump 10 can be further supplied to the third circuit system HC3 through the first circuit system HC1. When the sub valve block 103 is not attached, the ports (13o, 15o, 191i, and 192i) opening in the outer surface of the main valve block 101 are closed by plugs. When the sub valve block 103 is attached, the ports (13o, 15o, 191i, and 192i) opening in the outer surface of the main valve block 101 are connected to the ports (33i, 31i, 38o, and 39o) opening in the outer surface of the sub valve block 103.

[0038] The third circuit system HC3 includes: a third neutral passage 31 that guides the working oil, guided via the neutral cut valve 110 and through the second external output passage 15 in the first circuit system HC1, to the tank T; a third control valve 32 serving as a sub control valve that is connected to the third neutral passage 31 and is adapted to control the third actuator 9 serving as the sub actuator; a third parallel passage 33 that guides the working oil, guided through the first parallel passage 13 in the first circuit system HC1, to the third control valve 32; and discharge passages 38 and 39 that are in communication with the discharge passage 19 in the first circuit system HC1. The third neutral passage 31 is connected to the second external output passage 15 in the first circuit system HC1, and functions as a second external input passage to which the working oil is guided through the first circuit system HC1.

[0039] In the circuit system formed by connecting the third circuit system HC3 to the first circuit system HC1, the first neutral passage 11, the second external output passage 15, and the third neutral passage 31 function as a neutral passage through which the working oil discharged from the first pump 10 returns to the tank T. Specifically, in the circuit system formed by connecting the third circuit system HC3 to the first circuit system HC1, the plurality of first and the third control valves 12 and 32 are connected in series through the first neutral passage 11, the second external output passage 15, and the third neutral passage 31 serving as the neutral passage, and are connected in parallel through the first parallel passage 13 and the third parallel passage 33.

[0040] The third control valve 32 is adapted to control supplying/discharging of the working oil to/from the hydraulic cylinder 9A serving as the third actuator 9 driving the additional attachment in accordance with the pilot pressure applied to the pilot pressure chamber. Thus, the third circuit system HC3 includes the third control valve 32 adapted to control the third actuator 9, using the working oil discharged from the first pump 10 and supplied through the main valve block 101. The third control valve 32 is an open center type control valve adapted to make the third neutral passage 31 and the discharge passage 39 communicate with each other while being at the neutral position, for guiding the working oil, guided to the third neutral passage 31, to the tank T.

[0041] The third neutral passage 31 is connected to the external input port 31i opening in the outer surface of the sub valve block 103. The external input port 31i of the sub valve block 103 is connected to the second external output port 15o of the main valve block 101.

[0042] The third parallel passage 33 is connected to the input port 33i opening in the outer surface of the sub valve block 103. The input port 33i of the sub valve block 103 is connected to the output port 13o of the main valve block 101.

[0043] The discharge passage 38 to which the working oil is guided from the hydraulic cylinder 9A via the third control valve 32 is connected to a draw out port 38o opening in the outer surface of the sub valve block 103. The draw out port 38o of the sub valve block 103 is connected to the introduction port 191i of the main valve block 101.

[0044] The discharge passage 39 to which the working oil is guided from the third neutral passage 31 via the third control valve 32 is connected to a draw out port 39o opening in the outer surface of the sub valve block 103. The draw out port 39o of the sub valve block 103 is connected to the introduction port 192i of the main valve block 101.

[0045] In the third circuit system HC3, when the third control valve 32 is at the neutral position, the working oil supplied from the first circuit system HC1 returns to the tank T through the third neutral passage 31 and the discharge passage 39.

[0046] The second circuit system HC2 includes: a second neutral passage 21 serving as a main neutral passage through which the working oil discharged from the second pump 20 is guided to the tank T; second control valves 22 serving as plurality of main control valves con-

nected in series with the second neutral passage 21; a second parallel passage 23 branched off from the second neutral passage 21 more on the upstream side than the second control valve 22; and a discharge passage 19 connected to the tank T. The plurality of second control valves 22 are connected in series through the second neutral passage 21, and are connected in parallel through the second parallel passage 23.

[0047] The second control valves 22 that are main control valves adapted to control actuators provided in the second circuit system HC2 include: a second traveling control valve 22A, an auxiliary corresponding control valve 22B, a swiveling control valve 22C, a boom second speed control valve 22D, and an arm first speed control valve 22E. The working oil discharged from the second pump 20 is guided to the second traveling control valve 22A, the auxiliary corresponding control valve 22B, the swiveling control valve 22C, the boom second speed control valve 22D, and the arm first speed control valve 22E in this order from the upstream side.

[0048] The second traveling control valve 22A is adapted to control supplying/discharging of the working oil to/from the traveling unit driving hydraulic motor 8A provided on the right side of the vehicle body of the power excavator. The auxiliary corresponding control valve 22B is adapted to control supplying/discharging of the working oil to/from the auxiliary attachment driving hydraulic cylinder 8B. The swiveling control valve 22C is adapted to control supplying/discharging of the working oil to/from a swiveling unit driving hydraulic motor (not illustrated). The boom second speed control valve 22D is adapted to control supplying/discharging of working oil to and from a boom driving hydraulic cylinder (not illustrated). The arm first speed control valve 22E is adapted to control supplying/discharging of the working oil to/from an arm driving hydraulic cylinder (not illustrated). The main actuators (such as the hydraulic motor 8A and the hydraulic cylinder 8B) controlled by using the second control valves 22 will be also collectively referred to as a second actuator 8.

[0049] As described above, the second circuit system HC2 includes the plurality of second control valves 22 that is connected to the second pump 20 and is adapted to control the plurality of second actuators 8. The working oil discharged from the second actuator 8 via the second control valve 22 is guided to the tank T through the discharge passage 19. The discharge passage 19 is used as a common passage through which the working oil in the first circuit system HC1 and second circuit system HC2 is guided to the tank T.

[0050] In the second circuit system HC2, the working oil discharged from the second pump 20 returns to the tank T through the second neutral passage 21 when all the second control valves 22 are at the neutral positions. On the other hand, when at least one of the plurality of second control valve 22 is at the drive position, the communication between the second pump 20 in the second neutral passage 21 and the tank T is blocked.

[0051] In the second circuit system HC2, the working oil discharged from the second pump 20 can be supplied to the second control valve 22B to 22E through the second parallel passage 23, even when the communication between the second pump 20 in the second neutral passage 21 and the tank T is blocked due to any one of the second control valve 22A to 22D being switched to the drive position.

[0052] The second circuit system HC2 includes a first external input passage 24 through which the working oil, supplied from the outside, is guided to the upstream side of a predetermined second control valve 22 (the auxiliary corresponding control valve 22B in the present embodiment). The first external input passage 24 is connected to the first external input port 24i opening in the outer surface of the main valve block 101.

[0053] The first circuit system HC1 further includes the straight traveling control valve 6 connected to a point that is more on the downstream side than the point where the first parallel passage 13 is branched off from the first neutral passage 11 and more on the upstream side than the first traveling control valve 12A. The straight traveling control valve 6 is connected with a second parallel passage 23. The second parallel passage 23 includes a second parallel upstream side passage 23a that connects the second pump 20 and the straight traveling control valve 6 with each other, and a second parallel downstream side passage 23b that connects the straight traveling control valve 6 and the second control valves 22B to 22E to each other.

[0054] The straight traveling control valve 6 is switched between two positions that are a normal position (A) illustrated on the right side in FIG. 1 and a straight traveling position (B) illustrated on the left side in FIG. 1. The straight traveling control valve 6 is switched to the straight traveling position B when the working oil is supplied to the pilot pressure chamber 6a. The straight traveling control valve 6 is held at the normal position A by the biasing force from a return spring 6c, when no pilot pressure is applied to the pilot pressure chamber 6a.

[0055] When the straight traveling control valve 6 is at the normal position (A), the second parallel upstream side passage 23a of the second parallel passage 23 is connected to the second parallel downstream side passage 23b of the second parallel passage 23, and the first neutral passage 11 more on the downstream side than the straight traveling control valve 6 is connected to the first pump 10. Thus, the working oil discharged from the first pump 10 is guided to the first control valves 12 through the first neutral passage 11 and the first parallel passage 13. The working oil discharged from the second pump 20 is guided to the second control valves 22 through the second neutral passage 21 and the second parallel passage 23.

[0056] In a state where the neutral cut valve 110 is at the third position (P3), the working oil discharged from the first pump 10 is also guided to the third control valve 32 through the first neutral passage 11, via the neutral

cut valve 110, and through the second external output passage 15 and the third neutral passage 31. The working oil discharged from the first pump 10 is also guided to the third control valve 32 through the first parallel passage 13 and the third parallel passage 33.

[0057] When the straight traveling control valve 6 is at the straight traveling position (B), the second parallel upstream side passage 23a of the second parallel passage 23 is connected to the first neutral passage 11 more on the downstream side than the straight traveling control valve 6, and the second parallel downstream side passage 23b is connected to the first pump 10. Thus, the working oil discharged from the first pump 10 is guided to the first control valves 12B to 12D through the first parallel passage 13, and is guided to the second control valves 22B to 22E through the second parallel downstream side passage 23b of the second parallel passage 23. The working oil discharged from the second pump 20 is guided to the first control valve 12A through the first neutral passage 11 more on the downstream side than the straight traveling control valve 6, and is guided to the second control valve 22A through the second neutral passage 21.

[0058] In a state where the neutral cut valve 110 is at the third position (P3), the working oil discharged from the first pump 10 is also guided to the third control valve 32 through the first parallel passage 13 and the third parallel passage 33. The working oil discharged from the second pump 20 is also guided to the third control valve 32 through the first neutral passage 11, via the neutral cut valve 110, and through the second external output passage 15 and the third neutral passage 31.

[0059] In the power excavator traveling in a state with the excavating unit not driven, the pilot pressure chamber 6a is at tank pressure, and the straight traveling control valve 6 is maintained at the normal position (A). Thus, when only the traveling unit driving hydraulic motors 7A and 8A are operated, the working oil discharged from the first pump 10 is supplied to the first traveling control valve 12A and the working oil discharged from the second pump 20 is supplied to the second traveling control valve 22A.

[0060] On the other hand, when the excavating unit actuator is driven while the traveling unit driving hydraulic motors 7A and 8A are driven, the pilot pressure is applied to the pilot pressure chamber 6a, so that the straight traveling control valve 6 is switched to the straight traveling position (B). Thus, when the traveling unit driving hydraulic motors 7A and 8A and an actuator other than the hydraulic motors 7A and 8A are concurrently operated, the working oil discharged from the second pump 20 is supplied to the first traveling control valve 12A and the second traveling control valve 22A. Meanwhile, the working oil discharged from the first pump 10 is supplied to the other first control valves 12B to 12D, the other second control valves 22B to 22E, and the third control valve 32. Thus, the circuit for traveling and the circuit for a purpose other than traveling are independent from each other, whereby the vehicle body can reliably travel straight.

[0061] Next, an operation of the neutral cut valve 110 will be described.

[0062] The neutral cut valve 110 has the spool positioned at the first position (P1), in a state where the first pilot pressure chamber 116a and the second pilot pressure chamber 116b are each connected to the tank T and no working oil is supplied into the first pilot pressure chamber 116a or the second pilot pressure chamber 116b. In this state, the first inlet port 111 and the tank port 119 communicate with each other, and the communication between the second inlet port 112 and the outlet port 113 is blocked.

[0063] Thus, the working oil that has flowed to the first inlet port 111 through the first neutral passage 11 is discharged to the tank T through the tank port 119.

[0064] When the working oil is supplied to the first pilot pressure chamber 116a in this state, the spool is moved by the pressure of the working oil supplied to the first pilot pressure chamber 116a against the biasing force from the centering spring 117, to switch to the second position (P2). Thus, the communication between the first inlet port 111 and the tank port 119 is blocked. The communication between the second inlet port 112 and the outlet port 113 remain to be blocked.

[0065] The first external output port 14o is constantly in communication with the first neutral passage 11 regardless of the position of the neutral cut valve 110. However, in a state where the neutral cut valve 110 is at the first position (P1), the first neutral passage 11 and the tank T are in communication with each other as described above, whereby the first external output port 14o is also in communication with the tank T. Thus, the working oil discharged from the first pump 10 returns to the tank T without being supplied to the outside through the first external output port 14o.

[0066] On the other hand, in a state where the neutral cut valve 110 is at the second position (P2), the communication between the first neutral passage 11 and the tank T is blocked. Thus, the working oil that has flowed into the first neutral passage 11 that is on the downstream side of the arm second speed control valve 12D and is on the upstream side of the neutral cut valve 110, is entirely supplied to the outside of the main valve block 101 through the first external output passage 14.

[0067] As described above, in the fluid pressure control device 100, the working oil supplied from the first pump 10 to the first circuit system HC1 can be supplied to the outside through the first external output port 14o, by switching the neutral cut valve 110 to the second position (P2).

[0068] Thus, in the fluid pressure control device 100, for example, the working oil supplied from the first pump 10 to the first circuit system HC1 can be adapted to drive a newly added actuator (not illustrated) or can join the circuit for driving any of the first actuator 7, the second actuator 8, and the third actuator 9, through the first ex-

ternal output port 14o.

[0069] Now, an example of a case is described where the working oil supplied to the outside through the first external output port 14o joins a flow path of the auxiliary attachment driving hydraulic cylinder 8B.

[0070] The first external output port 14o and the first external input port 24i are connected to each other through an external pipe 30, outside the main valve block 101. Specifically, the first external output passage 14 is connected to the first external input passage 24 through the external pipe 30.

[0071] In this state, the working oil is supplied to the pilot pressure chamber of the auxiliary corresponding control valve 22B adapted to control supplying/discharging of the working oil to/from the hydraulic cylinder 8B, and to the first pilot pressure chamber 116a of the neutral cut valve 110. Thus, when the auxiliary corresponding control valve 22B is operated, the working oil discharged from the first pump 10 is supplied to the auxiliary corresponding control valve 22B through the first external output passage 14, the external pipe 30, and the first external input passage 24, in addition to the working oil discharged from the second pump 20.

[0072] Thus, in the present embodiment, the working oil discharged from the first pump 10 is guided to the outside through the first external output passage 14 of the first circuit system HC1, and is guided to the upstream side of the auxiliary corresponding control valve 22B through the first external input passage 24 of the second circuit system HC2 to join the working oil discharged from the second pump 20.

[0073] The neutral cut valve 110 may be adapted to make the first neutral passage 11 and the tank T communicate with each other or block the communication therebetween in accordance with pilot pressure Pp adapted to control the auxiliary corresponding control valve 22B. In this case, the spring load of the centering spring 117 may be set so that the spool of the neutral cut valve 110 is maintained at the first position (P1) in a state where the pilot pressure Pp is low, and the spool of the neutral cut valve 110 is switched to the second position (P2) in a state where the pilot pressure Pp is high.

[0074] With this configuration, the hydraulic cylinder 8B is driven by the working oil discharged from the second pump 20 only, when the operation amount of the auxiliary corresponding control valve 22B is small. The hydraulic cylinder 8B is driven by the working oil discharged from the first pump 10 in addition to the working oil discharged from the second pump 20, when the operation amount of the auxiliary corresponding control valve 22B is large.

[0075] Thus, by increasing the operation amount of the auxiliary corresponding control valve 22B, the flow rate of the working oil for the auxiliary corresponding control valve 22B can be increased, whereby the speed of the operation of the hydraulic cylinder 8B controlled by the auxiliary corresponding control valve 22B can be increased.

[0076] Although not elaborated in the figure, in a case where the working oil is supplied to a circuit system for driving a newly added actuator through the first external output passage 14, the neutral cut valve 110 may be switched to the second position (P2) when the additional actuator is driven.

[0077] On the other hand, when the working oil is supplied to the second pilot pressure chamber 116b of the neutral cut valve 110, the spool is moved by the pressure of the working oil supplied to the second pilot pressure chamber 116b against the biasing force from the centering spring 117, to switch to the third position (P3). As a result, the second inlet port 112 and the outlet port 113 communicate with each other, and the communication between the first inlet port 111 and the tank port 119 is blocked.

[0078] In a state where the neutral cut valve 110 is at the third position (P3), the third neutral passage 31 of the third circuit system HC3 is in communication with the first neutral passage 11 of the first circuit system HC1. The third parallel passage 33 of the third circuit system HC3 is constantly in communication with the first parallel passage 13 of the first circuit system HC1.

[0079] Thus, in the state where the neutral cut valve 110 is at the third position (P3), the plurality of first and third control valves 12 and 32 are connected in series through the first neutral passage 11, the second external output passage 15, and third neutral passage 31 serving as the neutral passage, and is connected in parallel through the first parallel passage 13 and the third parallel passage 33.

[0080] Thus, in the state where the neutral cut valve 110 is at the third position (P3), the working oil discharged from the first pump 10 can be supplied to the third control valve 32 through the first parallel passage 13 and the third parallel passage 33, even when the communication between the first pump 10 in the first neutral passage 11 and the tank T is blocked with any of or all of the first control valves 12A to 12D being switched to the drive position.

[0081] Thus, with the sub valve block 103 attached to the main valve block 101, the third actuator 9 that can be driven, similarly to the first actuator 7, using the working oil discharged from the first pump 10 or the second pump 20 can be easily added.

[0082] The embodiment described above can provide the following effects.

[0083] By switching the neutral cut valve 110 to the second position (P2), the working oil discharged from the first pump 10 can be supplied to the outside of the main valve block 101 through the first external output passage 14. By switching the neutral cut valve 110 to the third position (P3), the working oil discharged from the first pump 10 can be supplied to the outside of the main valve block 101 through the second external output passage 15.

[0084] Thus, the working oil supplied to the first circuit system HC1 from the first pump 10 can be supplied not

only to the first external output passage 14, but can also be supplied to the outside through the second external output passage 15, whereby the fluid pressure control device 100 with a high degree of freedom in terms of circuit system expansion can be provided.

<Second embodiment>

[0085] A fluid pressure control device 200 according to a second embodiment of the present invention will be described with reference to FIG. 3. The points different from the first embodiment will be mainly described below, and the configuration that is the same as or corresponding to the configurations described in the first embodiment will be denoted with the same reference numerals and the description thereof will be omitted.

[0086] In the example described in the first embodiment, the third circuit system HC3 includes the third control valve 32 of an open center type. On the other hand, in the second embodiment, the third circuit system HC32 includes a third control valve 232 of a closed center type.

[0087] In the second embodiment, the configurations of the first circuit system HC1 and the second circuit system HC2 are similar to those in the first embodiment, but the configuration of the third circuit system HC32 is different from that in the first embodiment. Thus, the second embodiment is similar to the first embodiment in the configuration of the main valve block 101, but is different from the first embodiment in the configuration of the sub valve block 203.

[0088] The sub valve block 203 including the third circuit system HC32 includes an inlet block B30 through which the working oil from the first circuit system HC1 is taken in, and valve blocks B31 and B32 adapted to control the additional attachment driving third actuator 9. The inlet block B30 also serves as an outlet block for discharging the working oil to the tank T. The valve block B31 has a configuration similar to that of the valve block B32. Thus, the valve block B32 is partially omitted in the drawing. The number of valve blocks can be changed as appropriate in accordance with the number of actuators to be added.

[0089] The third circuit system HC32 includes: a plurality of third control valves 232 adapted to control a plurality of third actuators 9; a supply passage 231 serving as a second external input passage connected to the second external output passage 15 of the first circuit system HC1; a tank passage 239 connected to the tank T; and a load pressure passage 241 to which the highest load pressure among those of the plurality of third actuators 9 is guided. The supply passage 231 is for guiding the working oil that has been discharged from the first pump 210 and supplied thereto through the first neutral passage 11, the neutral cut valve 110, and the second external output passage 15 to the third control valve 232. The third control valve 232 is adapted to control the third actuator 9 by the working oil discharged from the first pump 210 and supplied to the supply passage 231 through the main valve block 101.

[0090] The inlet block B30 is provided with a discharge pressure output port 231p connected to the supply passage 231 and a load pressure output port 241p connected to the load pressure passage 241. The inlet block B30 is provided with a relief valve 261 connected to the supply passage 231. When the neutral cut valve 110 is at the third position (P3), the relief valve 261 defines the maximum pressure of the circuit formed by connecting the third circuit system HC3 of the sub valve block 203 to the first circuit system HC1 of the main valve block 101.

[0091] The valve blocks B31 and B32 each include a third control valve 232 connected to the supply passage 231, and a pressure compensation valve 234 provided between the third control valve 232 and the third actuator 9.

[0092] The present embodiment employs a load sensing system of an after orifice type, with the pressure compensation valve 234 provided on the downstream side of a meter in throttle portion of the third control valves 232. In such a load sensing system, when more than one of the third actuator 9 are concurrently operated, the pressure compensation valve 234 functions to adjust loads among the third actuators 9.

[0093] The pressure compensation valve 234 is provided with pressure on the downstream side of the meter in throttle portion provided to the third control valve 232 and the highest load pressure among those of the plurality of third actuators 9. The pressure compensation valve 234 is for compensation with which the pressure on the downstream side of the meter in throttle portion becomes higher than the highest load pressure of the third actuators 9 by a predetermined amount.

[0094] Thus, in the present embodiment, the hydraulic oil with the flow rate corresponding to the operation amount of the spool of the third control valve 232 regardless of a difference in load pressure among the third actuators 9, when the plurality of third control valve 232 are concurrently driven.

[0095] The first pump 210 and the second pump 220 are variable capacity piston pumps, with the discharge capacity varying in accordance with a change in the inclination of a swash plate made by a regulator (not illustrated). The discharge capacity of the first pump 210 and the second pump 220 are controlled by what is known as load sensing control, so that a predetermined value is obtained as a difference between the pump discharge pressure guided to the regulator (not illustrated) and the maximum load pressure of the third actuators 9.

[0096] The maximum load pressure of the third actuators 9 is guided to the regulator (not illustrated) of the first pump 210 and second pump 220 from the load pressure output port 241p through a pipe and the like. The pump discharge pressure is guided to the regulator (not illustrated) of the first pump 210 and second pump 220 from the discharge pressure output port 231p through a pipe and the like.

[0097] In the second embodiment, the output port 13o

and the introduction ports 191i and 192i not used in the main valve block 101 are closed by the sub valve block 203. With the unused ports (13o, 191i, and 192i) closed by the sub valve block 203, a closing member such as a plug needs not to be additionally provided, whereby the number of parts can be reduced.

[0098] Such a second embodiment can be provided an advantageous effect that is similar to that of the first embodiment.

[0099] As described above, the main valve block 101 according to the second embodiment is similar to that in the first embodiment. Thus, the main valve block 101 is compatible with any of open center type (see FIG. 1) and of closed center type (see FIG. 3) third control valves 32 and 232 in the sub valve blocks 103 and 203. With the neutral cut valve 110 as well as the predetermined ports (15o, 13o, 191i, and 192i) provided, the main valve block 101 featuring high versatility can be provided.

[0100] Modifications as described below also fall within the scope of the present invention. Configurations illustrated in the modifications can be combined with configurations illustrated in the above-described embodiments. Configurations illustrated in different embodiments described above can be combined. Configurations illustrated in different modifications described below can be combined.

<Modification 1>

[0101] In the examples described in the embodiments, the first actuator 7 and the first control valve 12 are each provided in a plurality. However, the present invention is not limited to this. It suffices if at least one first actuator 7 and at least one first control valve 12 are provided. In the example described in the embodiment, the second actuator 8 and the second control valve 22 are each provided in a plurality. However, the present invention is not limited to this. It suffices if at least one second actuator 8 and at least one second control valve 22 are provided.

< Modification 2>

[0102] In the examples described in the embodiments, the first neutral passage 11 of the first circuit system HC1 is provided with the neutral cut valve 110. However, the present invention is not limited to this. A neutral cut valve having a function similar to that of the neutral cut valve 110 may be provided to the second neutral passage 21 instead of or in addition to the neutral cut valve 110 provided to the first neutral passage 11.

[0103] Specifically, the second circuit system HC2 may be provided with first and second external output passages similar to the first external output passage 14 and the second external output passage 15 of the first circuit system HC1 described in the above embodiments, a sub valve block similar to the sub valve block 103 described in the embodiments may be attached to the main valve block 101, and a circuit system of the sub valve block may be connected to the second circuit system HC2. Furthermore, in the second circuit system HC2, a first external output passage similar to the first external output passage 14 described in the embodiment may be provided, a first external input passage similar to the first external input passage 24 described in the embodiments may be provided to the first circuit system HC1, and the passages may be connected to each other through an external pipe. In this case, the speed of the operation of the first actuator 7 can be increased with the working oil of the second circuit system HC2 joined to the first circuit system HC1, by using the neutral cut valve provided to the second circuit system HC2.

[0104] The configuration, actions and effects of the embodiments of the present invention configured as described above will be described collectively.

[0105] The fluid pressure control device 100, 200 is a fluid pressure control device for controlling an actuator driven by a working fluid discharged from the pump (first pump 10, 210, second pump 20, 220). The fluid pressure control device 100, 200 includes the main circuit system (first circuit system HC1, second circuit system HC2) including the main control valve (first control valve 12, second control valve 22) that is connected to the pump (first pump 10, 210, second pump 20, 220) and configured to control the main actuator (first actuator 7, second actuator 8). The main circuit system (first circuit system HC1, second circuit system HC2) includes the main neutral passage (first neutral passage 11, second neutral passage 21) through which the working fluid from the pump (first pump 10, 210, second pump 20, 220) returns to the tank T when the main control valve (first control valve 12, second control valve 22) is at the neutral position, the neutral cut valve 110 provided on the downstream side of the main control valve (first control valve 12, second control valve 22) in the main neutral passage (first neutral passage 11, second neutral passage 21), the neutral cut valve 110 being configured to make the main neutral passage (first neutral passage 11, second neutral passage 21) and the tank T communicate with each other or block communication between the main neutral passage (first neutral passage 11, second neutral passage 21) and the tank T, the first external output passage 14 through which the working fluid discharged from the pump (first pump 10, 210, second pump 20, 220) is able to be supplied to outside, the first external output passage 14 being in communication with the downstream side of the main control valve (first control valve 12, second control valve 22) and the upstream side of the neutral cut valve 110 in the main neutral passage (first neutral passage 11, second neutral passage 21), and the second external output passage 15 through which the working fluid discharged from the pump (first pump 10, 210, second pump 20, 220) and guided via the neutral cut valve 110 is able to be supplied to the outside. The neutral cut valve 110 is switched among the first position (P1) at which the working fluid discharged from the pump (first pump 10, 210, second pump 20, 220) is enabled to be guided to the tank T, the

second position (P2) at which the working fluid discharged from the pump (first pump 10, 210, second pump 20, 220) is disabled to be supplied to the outside through the second external output passage 15 and the working fluid discharged from the pump (first pump 10, 210, second pump 20, 220) is disabled to be guided to the tank T, and the third position (P3) at which the working fluid discharged from the pump (first pump 10, 210, second pump 20, 220) is enabled to be supplied to the outside through the second external output passage 15 and the working fluid discharged from the pump (first pump 10, 210, second pump 20, 220) is disabled to be guided to the tank T.

[0106] With this configuration, the working oil supplied to the main circuit system (first circuit system HC1, second circuit system HC2) from the pump (first pump 10, 210, second pump 20, 220) can be supplied not only to the first external output passage 14, but can also be supplied to the outside through the second external output passage 15. Thus, the fluid pressure control device 100, 200 with a high degree of freedom in terms of circuit system expansion can be provided.

[0107] The fluid pressure control device 100, 200 includes the first circuit system HC1 and the second circuit system HC2 as the main circuit system. One of the first circuit system HC1 and the second circuit system HC2 is provided with the neutral cut valve 110 and the first external output passage 14, and another of the first circuit system HC1 and the second circuit system HC2 is provided with the first external input passage 24 connected to the first external output passage 14 through the external pipe 30.

[0108] With this configuration, since the working fluid can be supplied from one of the first circuit system HC1 and the second circuit system HC2 to the other through the external pipe 30, the speed of the operation of the actuator (first actuator 7, second actuator 8) provided to the other of the first circuit system HC1 and the second circuit system HC2 can be increased.

[0109] The fluid pressure control device 100, 200 further includes the main valve block 101 including the main circuit system (first circuit system HC1 and second circuit system HC2), the sub circuit system (third circuit system HC3, HC32) including the sub control valve (third control valve 32, 232) adapted to control a sub actuator (third actuator 9) by the working fluid discharged from the pump (first pump 10, 210, second pump 20, 220) and supplied to the sub control valve through the main valve block 101, and the sub valve block 103, 203 including the sub circuit system (third circuit system HC3, HC32). The sub circuit system (third circuit system HC3, HC32) includes the second external input passage (third neutral passage 31, supply passage 231) connected to the second external output passage 15, and the sub valve block 103, 203 is attachable to the main valve block 101.

[0110] With this configuration, the sub valve block 103, 203 can be attached to the main valve block 101, whereby the installation area of the fluid pressure control device 100, 200 can be made smaller than that in a case where the sub valve block 103, 203 is provided to be separated from the main valve block 101. Furthermore, no pipe needs to be provided between the main valve block 101 and the sub valve block 103, 203, whereby the installation space of the fluid pressure control device 100, 200 can be made small.

[0111] 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.

[0112] This application claims priority based on Japanese Patent Application No.2018-217345 filed with the Japan Patent Office on November 20, 2018, the entire contents of which are incorporated into this specification.

Claims

1. A fluid pressure control device for controlling an actuator driven by a working fluid discharged from a pump, comprising:
a main circuit system including a main control valve that is connected to the pump and configured to control a main actuator, wherein
the main circuit system includes:

a main neutral passage through which the working fluid from the pump returns to a tank when the main control valve is at a neutral position;
a neutral cut valve provided on a downstream side of the main control valve in the main neutral passage, the neutral cut valve being configured to make the main neutral passage and the tank communicate with each other or block communication between the neutral passage and the tank;
a first external output passage through which the working fluid discharged from the pump is able to be supplied to outside, the first external output passage being in communication with the downstream side of the main control valve and an upstream side of the neutral cut valve in the main neutral passage; and
a second external output passage through which the working fluid discharged from the pump and guided via the neutral cut valve is able to be supplied to the outside, and
the neutral cut valve is switched among
a first position at which the working fluid discharged from the pump is enabled to be guided to the tank,
a second position at which the working fluid discharged from the pump is disabled to be supplied to the outside through the second external output passage and the working fluid discharged from the pump is disabled to be guided to the

tank, and
a third position at which the working fluid discharged from the pump is enabled to be supplied to the outside through the second external output passage and the working fluid discharged from the pump is disabled to be guided to the tank.

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

a first circuit system and a second circuit system serving as the main circuit system, wherein
one of the first circuit system and the second circuit system is provided with the neutral cut valve and the first external output passage, and
another one of the first circuit system and the second circuit system is provided with a first external input passage connected to the first external output passage through an external pipe.

3. The fluid pressure control device according to claim 1 or 2, further comprising:

a main valve block including the main circuit system;
a sub circuit system including a sub control valve adapted to control a sub actuator by the working fluid discharged from the pump and supplied to the sub control valve through the main valve block; and
a sub valve block including the sub circuit system, wherein
the sub circuit system includes a second external input passage connected to the second external output passage, and
the sub valve block is attachable to the main valve block.

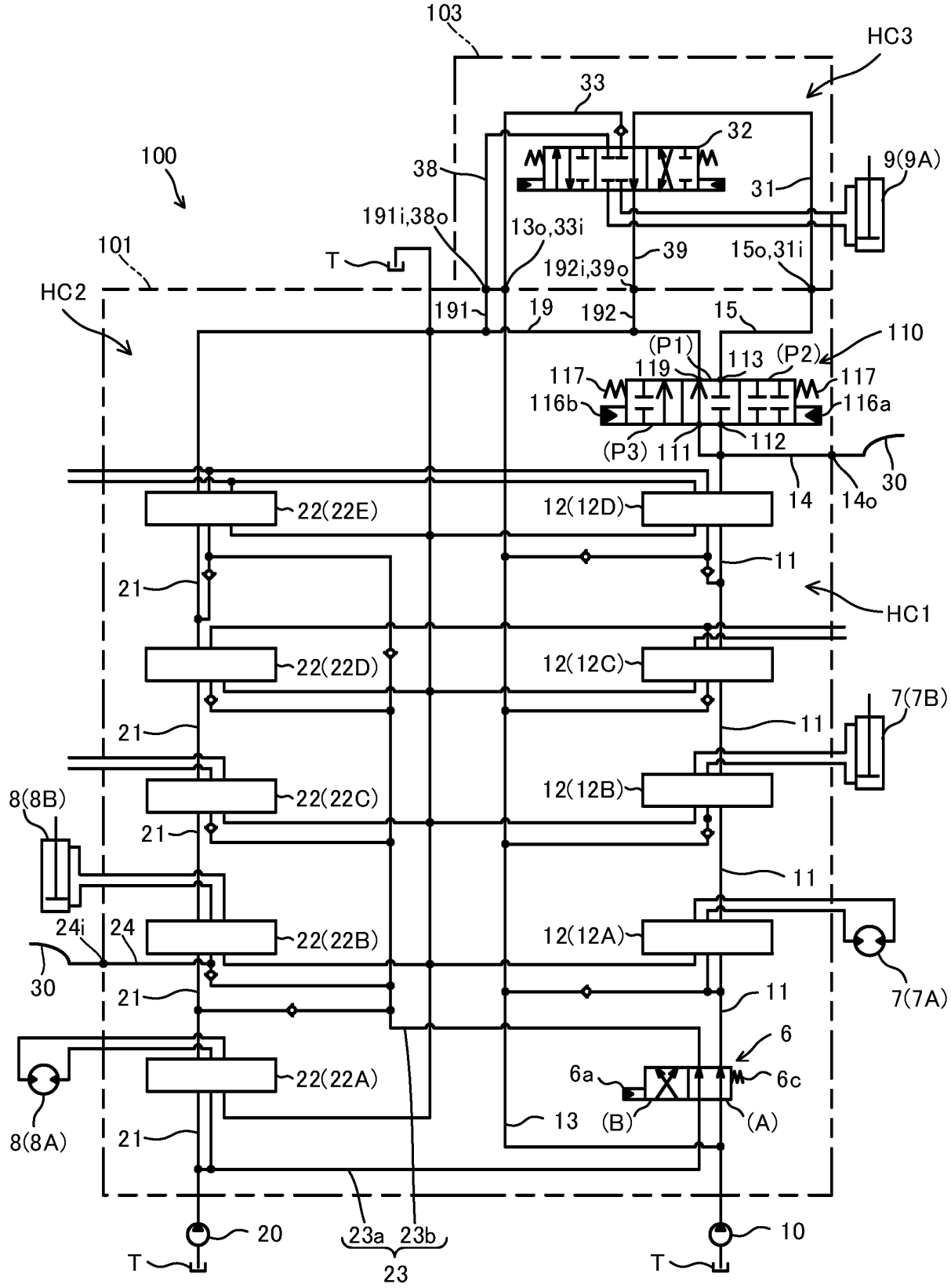
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FIG. 1

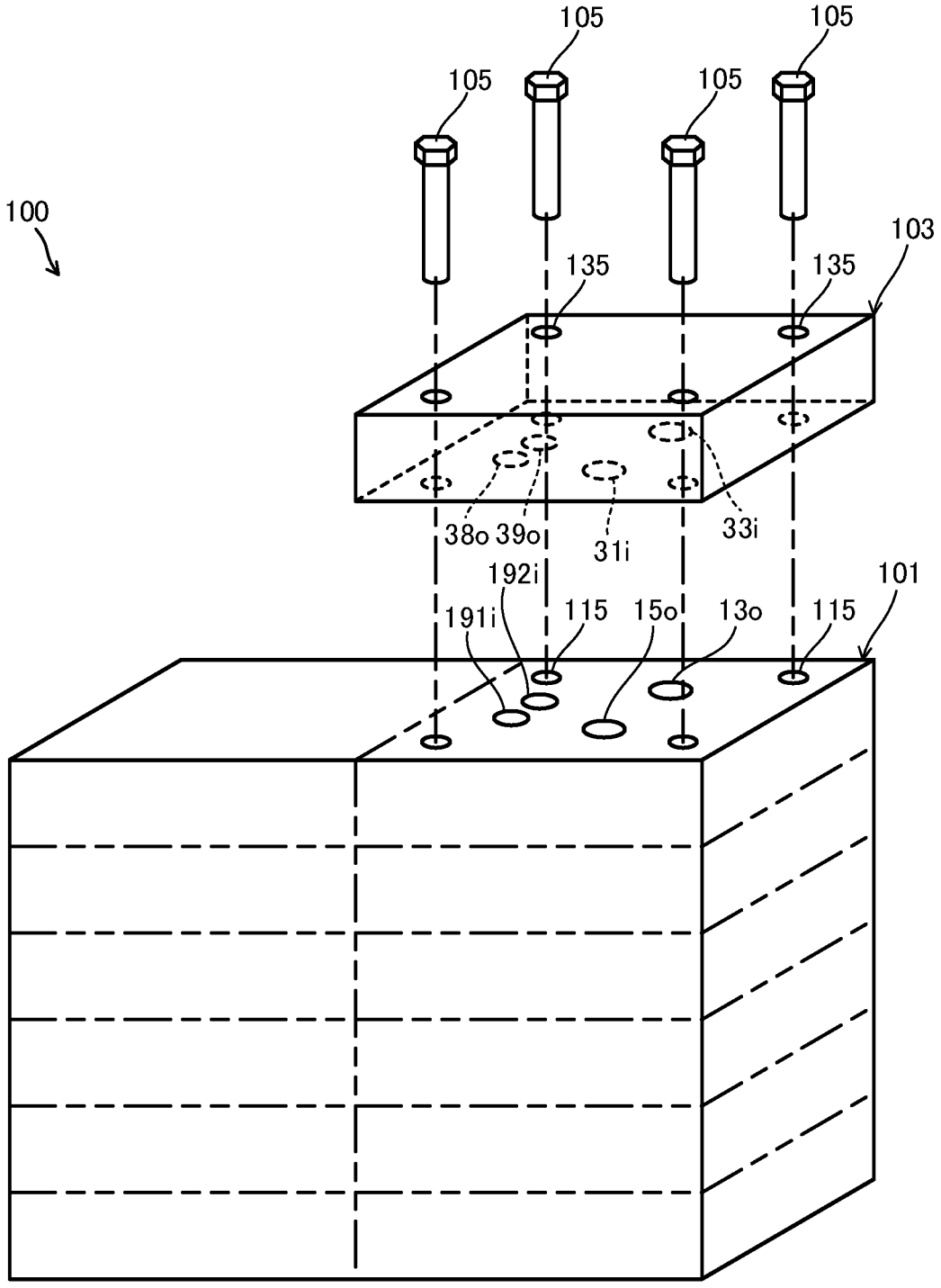
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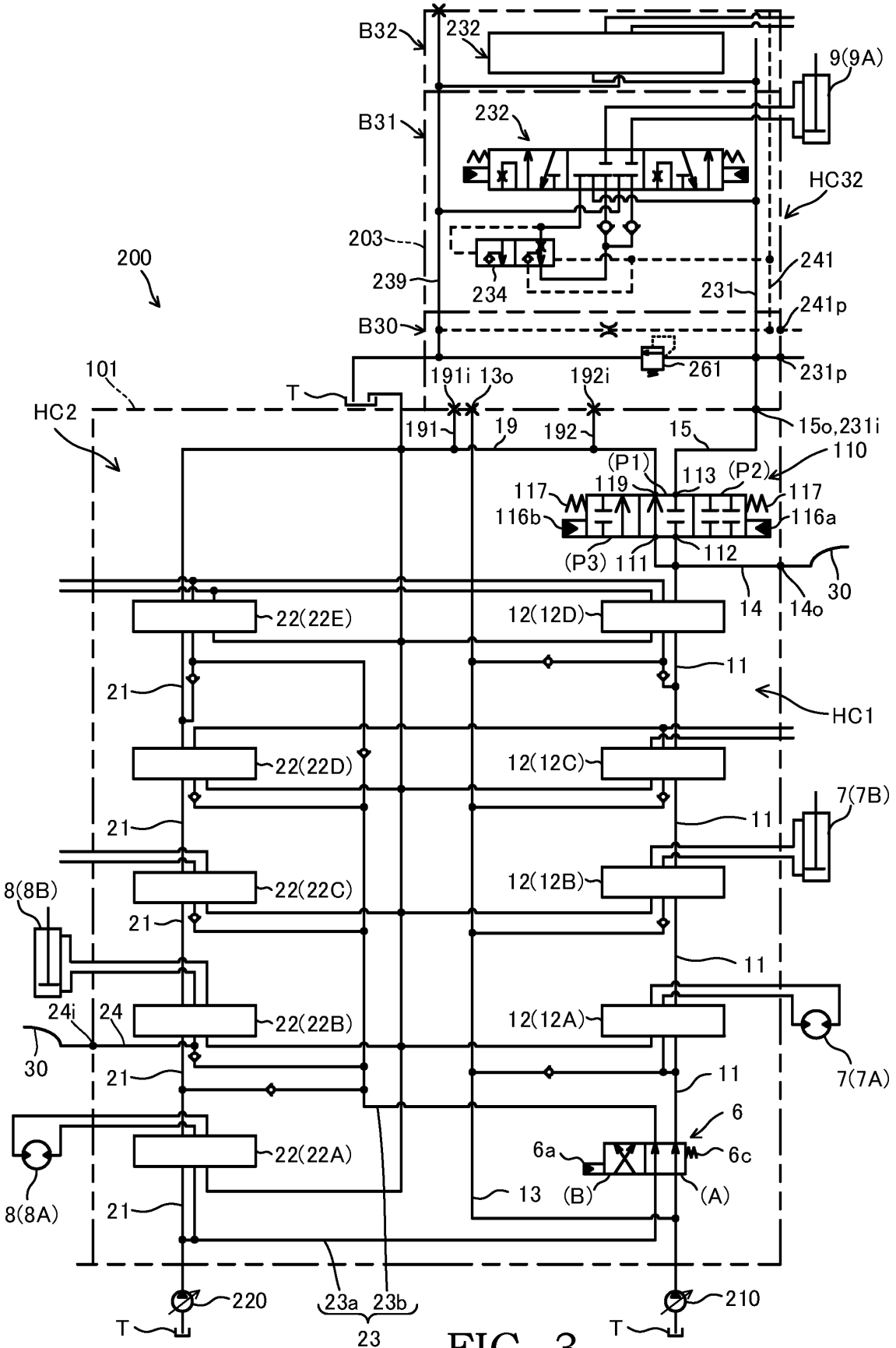
FIG. 2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12(12B)
8(8B)
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(A)
8(8A)
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23b
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23

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/030975

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F15B11/00(2006.01)i, E02F9/22(2006.01)i, F15B11/16(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F15B11/00-11/22, F15B21/14

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 9-235759 A (SHIN CATERPILLAR MITSUBISHI LTD.) 09 September 1997, paragraphs [0031]-[0038], fig. 1 (Family: none)	1-2 3
Y A	JP 4-312630 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 04 November 1992, paragraphs [0008]-[0020], fig. 1-4 (Family: none)	1-2 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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08.10.2019	21.10.2019

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

International application No.
PCT/JP2019/030975

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2001-153102 A (KAYABA INDUSTRY CO., LTD.) 08 June 2001, paragraphs [0013]-[0034], fig. 1, 2 (Family: none)	3
A	JP 11-257302 A (TOSHIBA MACHINE CO., LTD.) 21 September 1999, paragraphs [0027]-[0031], fig. 1 (Family: none)	3
A	JP 2016-204826 A (KYB CORPORATION) 08 December 2016, paragraphs [0020]-[0053], fig. 1 & US 2018/0094405 A1, paragraphs [0010]-[0043], fig. 1 & WO 2016/167128 A1 & EP 3284953 A1 & CN 107532619 A & KR 10-2017-0129849 A	1-3
A	GB 1546042 A (CATERPILLAR TRACTOR CO.) 16 May 1979, page 1, line 72 to page 3, line 4, drawings & US 4142445 A	1-3
A	WO 01/77532 A1 (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 18 October 2001, specification, page 8, line 5 to page 10, line 6, fig. 1 & US 2002/0134078 A1, paragraphs [0034]-[0041], fig. 1 & EP 1191233 A1 & JP 2001-295803 A	1-3
A	JP 11-230112 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 27 August 1999, paragraphs [0075]-[0094], fig. 1, 2 (Family: none)	1-3

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

REFERENCES CITED IN THE DESCRIPTION

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- JP 2018217345 A **[0112]**