



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

(43) Date of publication:
12.08.2020 Bulletin 2020/33

(51) Int Cl.:
F15B 11/02 ^(2006.01) **E02F 9/22** ^(2006.01)
F15B 11/00 ^(2006.01) **F15B 11/17** ^(2006.01)

(21) Application number: **18864823.2**

(86) International application number:
PCT/JP2018/032788

(22) Date of filing: **04.09.2018**

(87) International publication number:
WO 2019/069612 (11.04.2019 Gazette 2019/15)

(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

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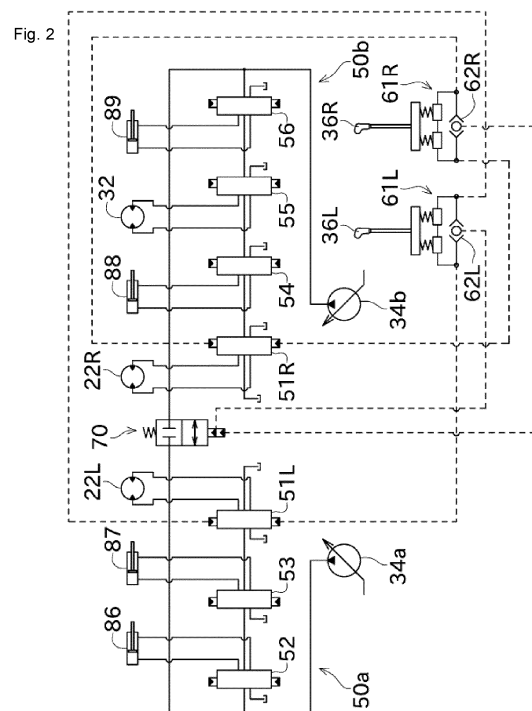
(30) Priority: **05.10.2017 JP 2017194799**

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(54) **WORK VEHICLE**

(57) A first hydraulic circuit (50a) introduces operating oil from a hydraulic pump (34a) to a hydraulic motor (22L) and a first actuator (e.g., first work machine (86)). A second hydraulic circuit (50b) introduces operating oil from a hydraulic pump (34b) to a hydraulic motor (22R) and a second actuator (e.g., third work machine (88)). Left and right hydraulic motors (22L, 22R) drive left and right crawler traveling devices, respectively. If both of instruction signal values for traveling speeds of the left and right crawler traveling devices designated with left and right traveling manipulation levers (36L, 36R) are equal to or higher than a predetermined threshold, a confluent valve (70) enters a confluent state where the two hydraulic circuits (50a, 50b) are connected to each other. In cases other than this, the confluent valve (70) enters an interruption state where the connection between the two hydraulic circuits (50a, 50b) is interrupted.



Description

Technical Field

[0001] The present invention relates to a work vehicle capable of driving an actuator while traveling.

Background Art

[0002] There has been known a work vehicle that includes two traveling motors for driving left and right traveling units, two hydraulic pumps, and two actuators and that is capable of driving the actuators while traveling. Patent Literatures 1 and 2 (hereinafter, referred to as PTLs 1 and 2) disclose this type of work vehicle.

[0003] PTL 1 discloses a work machine including: a hydraulic actuator group including work actuators for actuating work attachments and left and right traveling motors, the hydraulic actuator group being divided into a first group including one of the left and right traveling motors and a second group including the other of the left and right traveling motors; a first pump and a second pump functioning as hydraulic pressure sources; and a straight traveling valve for switching a passage of oil ejected from a pump. When a manipulation for traveling and a manipulation for a work are not performed simultaneously, the straight traveling valve supplies streams of oil ejected from different pumps to the two groups, respectively. When a manipulation for traveling and a manipulation for a work are performed in combination, oil ejected from a certain one of the pumps is supplied to the two traveling motors, and oil ejected from the other of the pumps is supplied to the work actuator(s). The straight traveling valve has a communication path via which both pump lines communicate with each other and a control valve for opening and closing the communication path. During a large traveling manipulation period in which an amount of manipulation for traveling is large, if a pressure for work is higher than a pressure for traveling, the control valve opens the communication path. Meanwhile, if the pressure for work is lower than the pressure for traveling, the control valve closes the communication path.

[0004] PTL 1 states that the above configuration provides the following effects. That is, in a case where a manipulation for a work is performed during high-speed traveling, if a pressure for the work is higher than a pressure for traveling, oil in the work side is supplied to the traveling side through the communication path, thereby making it possible to prevent sudden deceleration. Conversely, if a pressure for traveling is higher than a pressure for the work, the communication path is closed, thereby making it possible to prevent very sudden deceleration that might otherwise be caused by a phenomenon that oil moves from the traveling side to the work side.

[0005] PTL 2 discloses a work vehicle including: a work-purpose hydraulic actuator and left and right paired travel-purpose hydraulic motors; pilot-type direction se-

lector valves respectively provided to the work-purpose hydraulic actuator and the left and right travel-purpose hydraulic actuators; and two hydraulic pumps for supplying operating oil to the work-purpose hydraulic actuator and the left and right travel-purpose hydraulic actuators via the pilot-type direction selector valves. The work vehicle includes a confluent valve. In order to supply operating oil to the work-purpose hydraulic actuator and the travel-purpose hydraulic motors simultaneously, the confluent valve causes streams of operating oil ejected from the two hydraulic pumps to converge into one stream. The direction selector valve for the work-purpose actuator is subjected to a pilot pressure that is reduced according to the amount of manipulation on a traveling manipulation tool.

[0006] PTL 2 states that the above configuration provides the following effects. That is, while the work vehicle is driven to travel by the left and right travel-purpose hydraulic motors in a state where streams of operating oil from the two hydraulic pumps are caused to converge into one stream, reducing a pilot pressure given to the direction selector valve at the time when the work-purpose hydraulic actuator is driven limits the flow rate of operating oil supplied to the work-purpose hydraulic actuator. This inhibits a sudden reduction in the amount of operating oil supplied to the travel-purpose hydraulic motors. Consequently, a sudden deceleration of the traveling work vehicle hardly occurs.

Citation List

Patent Literature

[0007]

PTL 1: Japanese Patent Application Laid-Open No. 2006-329341

PTL 2: Japanese Patent Application Laid-Open No. 2011-196436

Summary of Invention

Technical Problem

[0008] However, with the configuration of PTL 1, it is necessary to compare the pressure for work with the pressure for traveling. This makes the hydraulic control circuit complicated.

[0009] Meanwhile, with the configuration of PTL 2, in a case where the work-purpose hydraulic actuator is driven while a steering manipulation is performed, the following phenomenon may occur. That is, even if unevenness occurs between pressures of the two traveling motors, the confluent valve causes streams of operating oil ejected from the two hydraulic pumps to converge into one stream, and consequently the flow rates of the two hydraulic pumps are limited by a so-called pump horsepower control. This reduces the flow rates of both of the

two hydraulic pumps, thereby reducing the traveling speed and the work speed of the work-purpose hydraulic actuator. In addition, with the configuration of PTL 2, the flow rate of the operating oil supplied to the work-purpose hydraulic actuator is limited according to the amount of manipulation of the traveling manipulation tool. Therefore, when the work speed is reduced, it is sometimes difficult to enhance the work efficiency.

[0010] In view of the above circumstances, some aspects of the present invention were made. An object of an aspect of the present invention is to provide a work vehicle whose work speed is hardly reduced even when a manipulation for causing a work machine to perform a work and a manipulation for causing left and right traveling units to travel at a speed equal to or close to a maximum speed are performed in combination.

Solution to Problem and Advantageous Effects of Invention

[0011] The problem to be solved by some aspects of the present invention has been described above. Next, the following will describe solutions to this problem and effects achieved by the solutions.

[0012] According to an aspect of the present invention, a work vehicle including the following features is provided. That is, the work vehicle includes a first traveling unit, a first traveling motor, a first actuator, a first hydraulic pump, a first hydraulic circuit, a first manipulation member, a second traveling unit, a second traveling motor, a second actuator, a second hydraulic pump, a second hydraulic circuit, a second manipulation member, and a switching valve. The first traveling motor is configured to drive the first traveling unit. The first hydraulic circuit is configured to introduce operating oil from the first hydraulic pump to the first traveling motor and the first actuator. The first manipulation member is configured to give an instruction on a traveling speed of the first traveling unit. The second traveling unit is disposed opposite to the first traveling unit in a left-right direction. The second traveling motor is configured to drive the second traveling unit. The second hydraulic circuit is configured to introduce operating oil from the second hydraulic pump to the second traveling motor and the second actuator. The second manipulation member is configured to give an instruction on a traveling speed of the second traveling unit. The switching valve is configured to be switched between a first state where the switching valve connects the first hydraulic circuit and the second hydraulic circuit to each other and a second state where the switching valve interrupts connection between the first hydraulic circuit and the second hydraulic circuit. In a case where both of a first instruction value and a second instruction value are equal to or higher than a threshold, the switching valve is brought into the first state, and in cases other than this, the switching valve is brought into the second state, where the first instruction value corresponds to a value of an instruction signal for the traveling speed of the first

traveling unit designated by the instruction given with the first manipulation member and the second instruction value corresponds to a value of an instruction signal for the traveling speed of the second traveling unit designated by the instruction given with the second manipulation member.

[0013] With this configuration, when a steering manipulation is performed by designating different speeds with the two manipulation members, the switching valve is brought into the second state, thereby interrupting connection between the two hydraulic circuits. This makes it possible to achieve favorable steering performance. Meanwhile, if a manipulation for straight traveling, e.g., at a speed equal to or close to a maximum speed is performed with the two manipulation members, the switching valve is brought into the first state, thereby connecting the two hydraulic circuits to each other. Thus, for example, even in a case where such a manipulation for straight traveling and a manipulation for driving an actuator are performed simultaneously and the hydraulic pump in the hydraulic circuit including the actuator provides an ejection flow rate insufficient for the request given by the combined manipulations, the above configuration can reduce or prevent a reduction in the work speed of the actuator while maintaining a balance between speeds of the left and right traveling units, since the above configuration distributes operating oil to the two hydraulic circuits.

[0014] In the above-described work vehicle, the switching valve is preferably switched between the first state and the second state based on a switching signal that varies according to the values of the instruction signals.

[0015] With this configuration, it is possible to achieve a simple control.

[0016] The work vehicle described above preferably includes the following features. That is, a load sensing control is performed on each of the first traveling motor, the first actuator, the second traveling motor, and the second actuator.

[0017] Consequently, even in a case where unevenness occurs between the loads of the traveling motors and the actuators, it is possible to achieve the speeds of the traveling units and the work speeds favorably reflecting the amounts of manipulations for traveling and the work. Thus, either in a case where the switching valve is in the first state or in a case where the switching valve is in the second state, a favorable balance can be attained between the speeds of the traveling units and the work speeds of the actuators, thereby making it possible to achieve improvement in comprehensive operability.

Brief Description of Drawings

[0018]

[FIG. 1] A side view illustrating an overall structure of a revolving work vehicle according to one embodiment of the present invention.

[FIG. 2] A view schematically illustrating a hydraulic circuit of the revolving work vehicle.

[FIG. 3] A conceptual diagram for explaining a configuration relating to load sensing.

[FIG. 4] A view schematically illustrating a hydraulic circuit according to another embodiment.

Description of Embodiments

[0019] The following will describe embodiments of the present invention with reference to the drawings. FIG. 1 is a side view illustrating an overall structure of a revolving work vehicle 1 according to one embodiment of the present invention.

[0020] The revolving work vehicle (work vehicle) 1 shown in FIG. 1 includes a lower traveling body 11 and an upper revolving body 12.

[0021] The lower traveling body 11 includes crawler traveling devices 21 and hydraulic motors 22. As the crawler traveling devices, the left and right paired crawler traveling devices 21 are provided. As the hydraulic motors, the left and right hydraulic motors 22 are provided.

[0022] Each crawler traveling device 21 includes an endless crawler made of rubber, for example. The crawler is wound around a sprocket, which is connected to an output shaft of one of the hydraulic motors 22 disposed on the side on which its corresponding crawler traveling device 21 is disposed.

[0023] The hydraulic motors 22 are configured to be rotatable in forward and reverse directions so as to enable the revolving work vehicle 1 to travel forward and backward. The left and right hydraulic motors 22 are configured to be capable of being driven individually. This makes it possible for the revolving work vehicle 1 to travel straight or to be steered, for example.

[0024] The upper revolving body 12 includes a revolving frame 31, a revolving motor 32, an engine 33, a hydraulic pump unit 34, a steering unit 35, and a work device 13.

[0025] The revolving frame 31 is disposed above the lower traveling body 11. The revolving frame 31 is supported by the lower traveling body 11 such that the revolving frame 31 is turnable about a vertical axis. The revolving motor 32 can cause the revolving frame 31 to turn relative to the lower traveling body 11. The engine 33 is a diesel engine, for example. The hydraulic pump unit 34 is driven by the engine 33 so that the hydraulic pump unit 34 generates a hydraulic force that the revolving work vehicle 1 requires to travel and to perform work.

[0026] The steering unit 35 includes various manipulation members. The manipulation members include left and right paired traveling manipulation levers 36 and left and right paired work manipulation levers 37, for example. An operator can manipulate these manipulation members to give various instructions to the revolving work vehicle 1.

[0027] The work device 13 includes a boom 41, an arm 42, a bucket 43, a boom cylinder 44, an arm cylinder 45,

and a bucket cylinder 46.

[0028] The boom 41 is an elongated member having an end turnably supported by a front portion of the revolving frame 31. To the boom 41, the boom cylinder 44 is attached. Expansion and contraction of the boom cylinder 44 can turn the boom 41.

[0029] The arm 42 is an elongated member having an end turnably supported by a distal end of the boom 41. To the arm 42, the arm cylinder 45 is attached. Expansion and contraction of the arm cylinder 45 can turn the arm 42.

[0030] The bucket 43 is a container-shaped member having an end turnably supported by a distal end of the arm 42. To the bucket 43, the bucket cylinder 46 is attached. Expansion and contraction of the bucket cylinder 46 can turn the bucket 43 to perform a scooping motion or a damping motion.

[0031] Next, the following will describe a hydraulic circuit included in the revolving work vehicle 1. FIG. 2 is a view schematically illustrating the hydraulic circuit of the revolving work vehicle 1.

[0032] In the following explanation, the reference signs 21L, 21R, 22L, 22R, 36L, and 36R may be used to identify the left and right crawler traveling devices 21, the left and right hydraulic motors 22, and the left and right traveling manipulation levers 36. In the following explanation, each of a first work machine 86, a second work machine 87, a third work machine 88, and a fourth work machine 89 refers to any of the boom cylinder 44, the arm cylinder 45, the bucket cylinder 46, and a boom swing cylinder (not illustrated).

[0033] In the revolving work vehicle 1 of the present embodiment, the crawler traveling device 21L corresponds to a first traveling unit, and the crawler traveling device 21R corresponds to a second traveling unit. The hydraulic motor 22L corresponds to a first traveling motor, and the hydraulic motor 22R corresponds to a second traveling motor.

[0034] The above-described hydraulic pump unit 34 includes two variable displacement hydraulic pumps 34a and 34b. The revolving work vehicle 1 includes a first hydraulic circuit 50a and a second hydraulic circuit 50b. In cases other than a case where a confluent valve 70 (described later) is in a confluent state, the first hydraulic circuit 50a is supplied with operating oil from the hydraulic pump (first hydraulic pump) 34a disposed on a first side and the second hydraulic circuit 50b is supplied with operating oil from the hydraulic pump (second hydraulic pump) 34b disposed on a second side.

[0035] The first hydraulic circuit 50a is connected to the left hydraulic motor 22L, the first work machine 86, and the second work machine 87. The first work machine 86 and the second work machine 87 correspond to a first actuator. A direction selector valve 51L is disposed at a location between an ejection port of the hydraulic pump 34a and the hydraulic motor 22L, a direction selector valve 52 is disposed at a location between the ejection port of the hydraulic pump 34a and the first work machine 86, and a direction selector valve 53 is disposed at a

location between the ejection port of the hydraulic pump 34a and the second work machine 87.

[0036] The second hydraulic circuit 50b is connected to the right hydraulic motor 22R, the third work machine 88, the revolving motor 32, and the fourth work machine 89. The third work machine 88, the revolving motor 32, and the fourth work machine 89 correspond to a second actuator. A direction selector valve 51R is disposed at a location between an ejection port of the hydraulic pump 34b and the hydraulic motor 22R, a direction selector valve 54 is disposed at a location between the ejection port of the hydraulic pump 34b and the third work machine 88, a direction selector valve 55 is disposed at a location between the ejection port of the hydraulic pump 34b and the revolving motor 32, and a direction selector valve 56 is disposed at a location between the ejection port of the hydraulic pump 34b and the fourth work machine 89.

[0037] The direction selector valves 51L and 51R, which are respectively connected to the left and right hydraulic motors 22L and 22R, each include a spool. When the spool moves from a neutral position, where pressure oil is not supplied, toward one side, a corresponding one of the hydraulic motors 22L and 22R rotates in a forward direction. Meanwhile, when the spool moves from the neutral position toward the other side, the corresponding one of the hydraulic motors 22L and 22R rotates in a reverse direction. Each of the hydraulic motors 22L and 22R rotates at a speed that varies according to the amount by which the spool is displaced from the neutral position.

[0038] The paired traveling manipulation levers 36L and 36R can be used to individually give, to the left and right crawler traveling devices 21, an instruction to travel forward, to travel backward, or to stop. The traveling manipulation lever 36L corresponds to a first manipulation member, and the traveling manipulation lever 36R corresponds to a second manipulation member. The operator may tilt the traveling manipulation levers 36L and 36R forward from the neutral positions to give an instruction to travel forward. Meanwhile, the operator may tilt the traveling manipulation levers 36L and 36R rearward from the neutral positions to give an instruction to travel backward. A maximum traveling speed that can be designated by tilting the traveling manipulation levers 36L and 36R in the direction for forward traveling coincides with a maximum traveling speed that can be designated by tilting the traveling manipulation levers 36L and 36R in the direction for backward traveling.

[0039] The revolving work vehicle 1 includes remote control valves 61L and 61R, which are respectively disposed for the paired traveling manipulation levers 36L and 36R. Each of the remote controlling valves 61L and 61R has two output ports. Each of the remote control valves 61L and 61R is configured to feed, to one of the two ports corresponding to a direction (forward traveling/backward traveling) in which a corresponding one of the traveling manipulation levers 36L and 36R is manipulated, operating oil at a pressure corresponding

to the manipulation amount of the corresponding one of the traveling manipulation levers 36L and 36R. Pilot ports of the direction selector valves 51L and 51R receive pilot pressures directed thereto from the remote control valves 61L and 61R. In other words, each of the remote control valves 61L and 61R transmits operating oil as an instruction signal according to the manipulation of the corresponding one of the traveling manipulation levers 36L and 36R, and the pressure (pilot pressure) of the operating oil corresponds to the value of the instruction signal. Consequently, the spool of each of the direction selector valves 51L and 51R is displaced in the direction and the amount corresponding to the traveling direction and the traveling speed designated by the instruction given with the corresponding one of the traveling manipulation levers 36L and 36R. This can cause a corresponding one of the hydraulic motors 22L and 22R to rotate in the direction and at the speed designated by the operator's instruction.

[0040] Although not illustrated, the other direction selector valves, i.e., the direction selector valves 52 to 56 are connected to their respective remote control valves in similar manners to the above-described direction selector valves 51L and 51R. When the operator manipulates a manipulation member such as the above-described work manipulation lever 37, pilot pressures outputted from the remote control valves change. Thereby, the spools of the direction selector valves 52 to 56 are displaced to permit or inhibit supply of the operating oil. In this manner, it is possible to drive the first work machine 86, the second work machine 87, the third work machine 88, the revolving motor 32, and the fourth work machine 89 according to an instruction given by the operator.

[0041] The first hydraulic circuit 50a and the second hydraulic circuit 50b are connected to each other via the confluent valve (switching valve) 70. The confluent valve 70 is configured to be switched between a confluent state (first state) where the confluent valve 70 connects the first hydraulic circuit 50a and the second hydraulic circuit 50b to each other to allow streams of operating oil to converge into one and an interruption state (second state) where the confluent valve 70 interrupts connection between the first hydraulic circuit 50a and the second hydraulic circuit 50b.

[0042] The remote control valves 61L and 61R, which are disposed for the traveling manipulation levers 36L and 36R, are connected with shuttle valves 62L and 62R, respectively. Each of the shuttle valves 62L and 62R allows one of the two output ports of a corresponding one of the remote control valves 61L and 61R to be connected to the pilot port of the confluent valve 70, the one of the two output ports having a higher pressure than that of the other.

[0043] The confluent valve 70 has a spool movable between a confluent position, which corresponds to the confluent state, and an interruption position, which corresponds to the interruption state. From the two remote control valves 61L and 61R, streams of operating oil are

directed to the confluent valve 70, and then push the spool of the confluent valve 70 toward the confluent position. Against this, the confluent valve 70 is provided with a spring (biasing member) for biasing the spool toward the interruption position.

[0044] Thus, the configuration described above can be considered as below. That is, in a case where both of the pilot pressures for the traveling speeds designated by the left and right traveling manipulation levers 36L and 36R are equal to or higher than a predetermined threshold Pt, which is determined based on the spring, the confluent valve 70 is brought into the confluent state. Meanwhile, in cases other than this case, the confluent valve 70 is brought into the interruption state. The threshold Pt is set to have a value that is lower than but close to a pilot pressure generated when one of the left and right traveling manipulation levers 36L and 36R is solely manipulated to a manipulation limit in the direction for forward traveling or backward traveling.

[0045] With this configuration, in a case where both of the traveling manipulation levers 36L and 36R are manipulated to their manipulation limits in the direction for forward traveling or backward traveling within their manipulation strokes, the confluent valve 70 is switched to the confluent state. That is, when an instruction for forward traveling at a maximum speed, an instruction for backward traveling at a maximum speed, or an instruction for making a spin turn at a maximum speed is given, streams of operating oil ejected from the two hydraulic pumps 34a and 34b are caused to converge into one stream at a location between the first hydraulic circuit 50a and the second hydraulic circuit 50b.

[0046] For example, assume that the operator gives an instruction for forward traveling at a maximum speed and an additional instruction to drive the third work machine 88 and consequently a total amount of operating oil requested by the hydraulic motor 22R and the third work machine 88 exceeds a maximum ejection flow rate of the hydraulic pump 34b. Even in such a case, the present embodiment can achieve straight drivability in traveling, since the present embodiment can make the other hydraulic pump 34a eject operating oil toward the second hydraulic circuit 50b through the confluent valve 70 having been switched to the confluent state.

[0047] Meanwhile, for example, assume that the operator gives an instruction for steering by manipulating one of the traveling manipulation levers 36L and 36R to the limit position of its manipulation stroke in the direction for forward traveling and manipulating the other of the traveling manipulation levers 36L and 36R to an extent corresponding to approximately a half of its manipulation stroke in the direction for forward traveling. In this case, one of the pilot pressures for the two traveling speeds having been designated is lower than the threshold Pt, and thus the confluent valve 70 is brought into the interruption state. Consequently, even in a case where a manipulation for traveling and a manipulation for driving the third work machine 88 are performed simultaneously, it

is possible to achieve straight drivability in traveling.

[0048] Next, for example, assume that the operator manipulates both of the two traveling manipulation levers 36L and 36R to extents that are equal to each other and that correspond to approximately halves of their manipulation strokes in the direction for forward traveling. In this case, both of the pilot pressures for the two traveling speeds having been designated are lower than the threshold Pt, and thus the confluent valve 70 is brought into the interruption state. Since the traveling speeds having been designated are low, the flow rates requested by the left and right hydraulic motors 22L and 22R are both low. Thus, for example, even in a case where such a manipulation for traveling and a manipulation for driving the third work machine 88 are performed simultaneously, it is possible to deal with the total requested flow rate solely by the hydraulic pump 34b. Consequently, it is possible to achieve straight drivability in traveling.

[0049] Next, the following will describe a load sensing control with reference to FIG. 3. FIG. 3 is a conceptual diagram for explaining a configuration relating to load sensing.

[0050] A hydraulic circuit shown in FIG. 3 corresponds to a part of a hydraulic circuit included in the revolving work vehicle 1, the part primarily relating to a load sensing system. This type of load sensing system is publicly known. Since details of the load sensing system are disclosed in, e.g., PTL 2, the explanation given below is simplified.

[0051] FIG. 3 shows the two hydraulic circuits 50a and 50b in which the direction selector valves 51L, 51R, and 54 are opened in response to manipulations of the traveling manipulation levers 36L and 36R, for example. In order to simplify the explanation, FIG. 3 does not show parts of the two hydraulic circuits 50a and 50b, the parts relating to the direction selector valves that are closed.

[0052] Each of the direction selector valves 51L, 51R, and 52 to 56 has a meter-in passage for supplying operating oil to a corresponding one of the hydraulic actuators. The meter-in passage of each of the direction selector valves 51L, 51R, and 52 to 56 changes its passage area according to the displacement amount of the spool, thereby changing the traveling speed or the work speed. In FIG. 3, the phenomenon that the passage area of the meter-in passage changes in this manner is expressed by a symbol for a variable throttle valve. Of these variable throttle valves, variable throttle valves relating to the direction selector valves 51L, 51R, and 54 that are opened are illustrated in FIG. 3.

[0053] In the first hydraulic circuit 50a, pressure compensation valves 65 are respectively disposed at locations between the direction selector valve 51L, 52, and 53 and their corresponding hydraulic actuators (the hydraulic motor 22L, the first work machine 86, and the second work machine 87). Each pressure compensation valve 65 is configured to compensate a pressure at a location downstream of the variable throttle valve so that the pressure achieves a predetermined value. In the sec-

ond hydraulic circuit 50b, pressure compensation valves 65 are disposed at locations between the direction selector valves 51R, 54, 55, and 56 and their corresponding hydraulic actuators (the hydraulic motor 22R, the third work machine 88, the revolving motor 32, and the fourth work machine 89) in a similar manner.

[0054] The hydraulic circuits 50a and 50b respectively include load detection passages 67a and 67b for detecting loads of the above-described hydraulic actuators. In the first hydraulic circuit 50a, the pressure compensation valves 65 have downstream sides connected to the load detection passage 67a via check valves 66. In the second hydraulic circuit 50b, the pressure compensation valves 65 have downstream sides connected to the load detection passage 67b via check valves 66. The pressure compensation valves 65 in the first hydraulic circuit 50a are connected to the load detection passage 67a, and the pressure compensation valves 65 in the second hydraulic circuit 50b are connected to the load detection passage 67b.

[0055] While the confluent valve 70 is in the interruption state, the pressure compensation valves 65 in the first hydraulic circuit 50a are subjected to the largest load pressure (hereinafter, sometimes referred to as the maximum load pressure in the first hydraulic circuit 50a) among the load pressures of the hydraulic motor 22L, the first work machine 86, and the second work machine 87 via the load detection passage 67a. Meanwhile, the pressure compensation valves 65 in the second hydraulic circuit 50b are subjected to the largest load pressure (hereinafter, sometimes referred to as the maximum load pressure in the second hydraulic circuit 50b) among the load pressures of the hydraulic motor 22R, the third work machine 88, the revolving motor 32, and the fourth work machine 89 via the load detection passage 67b.

[0056] When the confluent valve 70 comes into the confluent state, the two hydraulic circuits 50a and 50b are connected to each other and at the same time the two load detection passages 67a and 67b are connected to each other. Thus, in this case, the pressure compensation valves 65 in the hydraulic circuits 50a and 50b are subjected to the largest load pressure in the two hydraulic circuits 50a and 50b, i.e., the largest load pressure among the load pressures of the hydraulic motors 22L and 22R, the first work machine 86, the second work machine 87, the third work machine 88, the revolving motor 32, and the fourth work machine 89.

[0057] Each of the two hydraulic pumps 34a and 34b is configured as a load sensing pump. While the confluent valve 70 is in the interruption state, an ejection pressure of the hydraulic pump 34a is regulated to be higher than the maximum load pressure in the first hydraulic circuit 50a by a predetermined pressure difference. Also, an ejection pressure of the hydraulic pump 34b is regulated to be higher than the maximum load pressure in the second hydraulic circuit 50b by the predetermined pressure difference. Meanwhile, while the confluent valve 70 is in the confluent state, the ejection pressures of the two hy-

draulic pumps 34a and 34b are regulated to be higher than a higher one of the maximum load pressure in the first hydraulic circuit 50a and the maximum load pressure in the second hydraulic circuit 50b by the predetermined pressure difference.

[0058] The load sensing pump may be configured in various ways. One example of the configuration of the load sensing pump can be achieved in a manner disclosed in PTL 2. That is, the load sensing pump is configured as a movable-swash-plate-type variable displacement pump having a movable swash plate whose inclination angle is controlled by an appropriate actuator. In addition, the actuator is subjected to a pressure of the pump and a maximum load pressure introduced thereto, and the actuator is provided with a spring based on which the above-described pressure difference is determined.

[0059] The load sensing control can be achieved in the above-described manner. Thus, the amounts of operating oil supplied to the hydraulic motors 22L and 22R, the first work machine 86, the second work machine 87, the third work machine 88, the revolving motor 32, and the fourth work machine 89 are determined by the displacement amounts of the spools of the direction selector valves 51L, 51R, and 52 to 56, and thus each of these elements can be free from being affected by the magnitudes of the loads of the other ones of the elements. As a result, while the confluent valve 70 is in the interruption state, it is possible to reliably enhance the steering operability. In addition, while the confluent valve 70 is in the confluent state, even if unevenness occurs between the load given by traveling and the load given by operation of the arm 42 when a manipulation for forward traveling, e.g., at a maximum speed and a manipulation of the arm 42 are performed simultaneously, it is possible to achieve a traveling speed and a work speed favorably reflecting the amounts of the manipulations. Consequently, it is possible to operate the work machine while maintaining a favorable balance between the traveling speeds of the crawler traveling devices 21L and 21R and the operation speed of the arm 42.

[0060] As described above, the revolving work vehicle 1 of the present embodiment includes the crawler traveling device 21L, the hydraulic motor 22L, the first actuator (e.g., the first work machine 86), the hydraulic pump 34a, the first hydraulic circuit 50a, the traveling manipulation lever 36L, the crawler traveling device 21R, the hydraulic motor 22R, the second actuator (e.g., the third work machine 88), the hydraulic pump 34b, the second hydraulic circuit 50b, the traveling manipulation lever 36R, and the confluent valve 70. The hydraulic motor 22L drives the crawler traveling device 21L. The first hydraulic circuit 50a introduces operating oil from the hydraulic pump 34a to the hydraulic motor 22L and the first actuator. The traveling manipulation lever 36L gives an instruction on a traveling speed of the crawler traveling device 21L. The crawler traveling device 21R is disposed opposite to the crawler traveling device 21L in a left-right direction. The hydraulic motor 22R drives the crawler

traveling device 21R. The second hydraulic circuit 50b introduces operating oil from the hydraulic pump 34b to the hydraulic motor 22R and the second actuator. The traveling manipulation lever 36R gives an instruction on a traveling speed of the crawler traveling device 21R. The confluent valve 70 can be switched between the confluent state where the confluent valve 70 connects the first hydraulic circuit 50a and the second hydraulic circuit 50b to each other and the interruption state where the confluent valve 70 interrupts connection between the first hydraulic circuit 50a and the second hydraulic circuit 50b. In a case where both of a first instruction value and a second instruction value are equal to or higher than the threshold Pt, the confluent valve 70 is brought into the confluent state, and in cases other than this, the confluent valve 70 is brought into the interruption state, where the first instruction value corresponds to a value of an instruction signal for the traveling speed of the crawler traveling device 21L designated by the instruction given with the traveling manipulation lever 36L and the second instruction value corresponds to a value of an instruction signal for the traveling speed of the crawler traveling device 21R designated by the instruction given with the traveling manipulation lever 36R.

[0061] With this configuration, when a steering manipulation is performed by designating moderately different speeds with the two traveling manipulation levers 36L and 36R, an instruction value(s) for at least one of the designated speeds becomes lower than the threshold Pt and accordingly the confluent valve 70 is brought into the interruption state. Consequently, connection between the two hydraulic circuits 50a and 50b is interrupted. As a result, it is possible to achieve favorable steering performance. Meanwhile, if a manipulation for straight traveling, e.g., at a speed equal to or close to a maximum speed is performed with the two traveling manipulation levers 36L and 36R, instruction values for both of the designated speeds become equal to or higher than the threshold Pt and accordingly the confluent valve 70 is brought into the confluent state. Consequently, the two hydraulic circuits 50a and 50b are connected to each other. Thus, for example, even in a case where such a manipulation for straight traveling and a manipulation for driving an actuator (e.g., the third work machine 88 in the hydraulic circuit 50b) are performed simultaneously and the hydraulic pump 34b in the hydraulic circuit 50b including the actuator provides an ejection flow rate insufficient for the request given by the combined manipulations, the above configuration can reduce or prevent a reduction in the work speed while maintaining a balance between the speeds of the left and right crawler traveling devices 21L and 21R, since the above configuration distributes operating oil to the two hydraulic circuits 50a and 50b.

[0062] In the revolving work vehicle 1 of the present embodiment, the instruction signal has a value of a pilot pressure.

[0063] With this configuration, it is possible to achieve

a simple control based on the pilot pressure.

[0064] In the revolving work vehicle 1 of the present embodiment, the load sensing control is performed on each of the hydraulic motor 22L, the first actuator, the hydraulic motor 22R, and the second actuator.

[0065] Consequently, even in a case where unevenness occurs between the loads of the hydraulic motors 22L and 22R and the actuators, it is possible to achieve the speeds of the crawler traveling devices 21L and 21R and the work speed favorably reflecting the amounts of manipulations for traveling and for the work. Thus, either in a case where the confluent valve 70 is in the confluent state or in a case where the confluent valve 70 is in the interruption state, a favorable balance can be attained between the speeds of the crawler traveling devices 21L and 21R and the work speeds of the actuators, thereby making it possible to achieve improvement in comprehensive operability.

[0066] Next, another embodiment will be described. FIG. 4 is a view schematically illustrating a hydraulic circuit according to another embodiment. In the description of the present embodiment, parts that are identical or similar to those of the above-described embodiment are given identical reference signs in the drawings, and description of these parts may be omitted.

[0067] In the embodiment shown in FIG. 4, remote control valves 61L and 61R each have two output ports respectively provided with pressure sensors 75. The pressure sensors 75 are electrically connected to a controller 76 of a revolving work vehicle 1. Thus, the pressure sensors 75 transmit electric signals as instruction signals according to manipulations of traveling manipulation levers 36L and 36R. The instruction signals correspond to detected pressure values (e.g., voltages) QL and QR from the pressure sensors 75.

[0068] In the present embodiment, a confluent valve 70 is configured as an electromagnetic valve, and is electrically connected to the controller 76.

[0069] The controller 76 is a known computer including a CPU, a ROM, and a RAM, for example. The ROM stores appropriate programs for performing a switching control of the confluent valve 70.

[0070] The controller 76 monitors values of pressures detected at the forward-traveling-side output ports of the remote control valves 61L and 61R and values of pressures detected at the backward-traveling-side output ports of the remote control valves 61L and 61R. If the detected pressure values at the two forward-traveling-side output ports or the detected pressure values at the two backward-traveling-side output ports are equal to or higher than a threshold Qt, the controller 76 outputs a valve open signal to the confluent valve 70 to open the confluent valve 70. In this manner, the controller 76 controls the confluent valve 70 to switch the confluent valve 70 to the confluent state. The threshold Qt is set to have a value that is lower than but close to a detected pressure value obtained when one of the left and right traveling manipulation levers 36L and 36R is solely manipulated

to its manipulation limit in a direction for forward traveling or backward traveling. In the present embodiment, the valve open signal from the controller 76 corresponds to a switching signal. The switching signal is switched from one mode to another mode according to the detected pressure value, which is the value of the instruction signal.

[0071] With this configuration, when an operator gives an instruction to travel forward or backward at a speed equal to or close to a maximum speed, the confluent valve 70 is brought into the confluent state. Consequently, it is possible to achieve straight drivability in forward traveling and backward traveling, in a similar manner to the embodiment shown in FIG. 2. However, if an instruction to make a spin turn at a speed equal to or close to a maximum speed is given, the confluent valve 70 is not brought into the confluent state. In this point, the present embodiment is different from the embodiment shown in FIG. 2.

[0072] In addition, according to the present embodiment, the threshold Q_t for the detected pressure value set for the controller 76 can be changed by way of software. Thus, the present embodiment can deal with various situations flexibly.

[0073] As described above, in the revolving work vehicle 1 of the present embodiment, the confluent valve 70 is switched between the confluent state and the interruption state based on the switching signal that varies according to the values of the instruction signals.

[0074] With this configuration, it is possible to achieve a simple control.

[0075] In addition, in the revolving work vehicle 1 of the present embodiment, the traveling manipulation lever 36L is configured to be capable of giving an instruction on a traveling speed and a traveling direction (forward traveling/backward traveling) of the crawler traveling device 21L. The traveling manipulation lever 36R is configured to be capable of giving an instruction on a traveling speed and a traveling direction (forward traveling/backward traveling) of the crawler traveling device 21R. In a case where both of a first instruction value and a second instruction value are equal to or higher than the threshold Q_t and a first instruction direction and a second instruction direction coincide with each other, the confluent valve 70 is brought into the confluent state, and in cases other than this, the confluent valve 70 is brought into the interruption state, where a first instruction speed and the first instruction direction are respectively a traveling speed and a traveling direction of the crawler traveling device 21L designated by the instruction given with the traveling manipulation lever 36L, a second instruction speed and the second instruction direction are respectively a traveling speed and a traveling direction of the crawler traveling device 21R designated by the instruction given with the traveling manipulation lever 36R, the first instruction value corresponds to a value of an instruction signal for the first instruction speed, and the second instruction value corresponds to a value of an instruction signal for the second instruction speed.

[0076] With this configuration, when a manipulation for forward traveling/backward traveling, e.g., at a speed equal to or close to a maximum speed is performed with the two traveling manipulation levers 36L and 36R, it is possible to achieve straight drivability.

[0077] Although preferred embodiments of the invention have been described above, the above-described configurations can be modified as below, for example.

[0078] The actuators (the first actuator and the second actuator) that are not the hydraulic motor 22L or 22R, each of which is driven by the hydraulic pumps 34a and 34b, may have any configurations, as long as they are usable for the works. Of the hydraulic circuits 50a and 50b, a hydraulic circuit to which each actuator is to be provided may also be determined in consideration of a requested flow rate and/or the like.

[0079] In the embodiment shown in FIG. 4, even in a case where an instruction to make a spin turn, e.g., at a maximum speed is given, the controller 76 may control the confluent valve 70 to switch the confluent valve 70 to the confluent state. For example, the controller 76 may perform the control in the following manner. That is, if a greater one of the detected values obtained by the pressure sensors 75 connected to the output ports of the one remote control valve 61L and a greater one of the detected values obtained by the two pressure sensors 75 connected to the output ports of the other remote control valve 61R are equal to or higher than the threshold Q_t , the controller 76 outputs a valve open signal to the confluent valve 70 to open the confluent valve 70.

[0080] In the embodiment shown in FIG. 4, the switching signal is an electric signal for opening or closing the confluent valve 70, which is an electromagnetic valve. Alternatively, operating oil may be transmitted as the switching signal.

[0081] The present invention is applicable not only to the revolving work vehicle but also to work vehicles having other various configurations and other various purposes. For example, the work vehicle may include, as a traveling unit, a traveling device configured to travel with wheels, instead of the traveling device configured to travel with the crawlers.

Reference Signs List

[0082]

1	revolving work vehicle (work vehicle)
21L	crawler traveling device (first traveling unit)
21R	crawler traveling device (second traveling unit)
22L	hydraulic motor (first traveling motor)
22R	hydraulic motor (second traveling motor)
32	revolving motor (example of second actuator)
34a	hydraulic pump (first hydraulic pump)
34b	hydraulic pump (second hydraulic pump)
36L	traveling manipulation lever (first manipulation member)
36R	traveling manipulation lever (second manipula-

tion member)
 50a first hydraulic circuit
 50b second hydraulic circuit
 70 confluent valve (switching valve)
 86 first work machine (example of first actuator)
 87 second work machine (example of first actuator)
 88 third work machine (example of second actuator)
 89 fourth work machine (example of second actuator)

Claims

1. A work vehicle comprising:

a first traveling unit;
 a first traveling motor configured to drive the first traveling unit;
 a first actuator;
 a first hydraulic pump;
 a first hydraulic circuit configured to introduce operating oil from the first hydraulic pump to the first traveling motor and the first actuator;
 a first manipulation member configured to give an instruction on a traveling speed of the first traveling unit;
 a second traveling unit disposed opposite to the first traveling unit in a left-right direction;
 a second traveling motor configured to drive the second traveling unit;
 a second actuator;
 a second hydraulic pump;
 a second hydraulic circuit configured to introduce operating oil from the second hydraulic pump to the second traveling motor and the second actuator;
 a second manipulation member configured to give an instruction on a traveling speed of the second traveling unit; and
 a switching valve configured to be switched between a first state where the switching valve connects the first hydraulic circuit and the second hydraulic circuit to each other and a second state where the switching valve interrupts connection between the first hydraulic circuit and the second hydraulic circuit, wherein
 in a case where both of a first instruction value and a second instruction value are equal to or higher than a threshold, the switching valve is brought into the first state, and in cases other than this, the switching valve is brought into the second state, where the first instruction value corresponds to a value of an instruction signal for the traveling speed of the first traveling unit designated by the instruction given with the first manipulation member and the second instruction value corresponds to a value of an instruction signal for the traveling speed of the second

traveling unit designated by the instruction given with the second manipulation member.

2. The work vehicle according to claim 1, wherein the switching valve is switched between the first state and the second state based on a switching signal that varies according to the values of the instruction signals.
3. The work vehicle according to claim 1 or 2, wherein a load sensing control is performed on each of the first traveling motor, the first actuator, the second traveling motor, and the second actuator.

Fig. 1

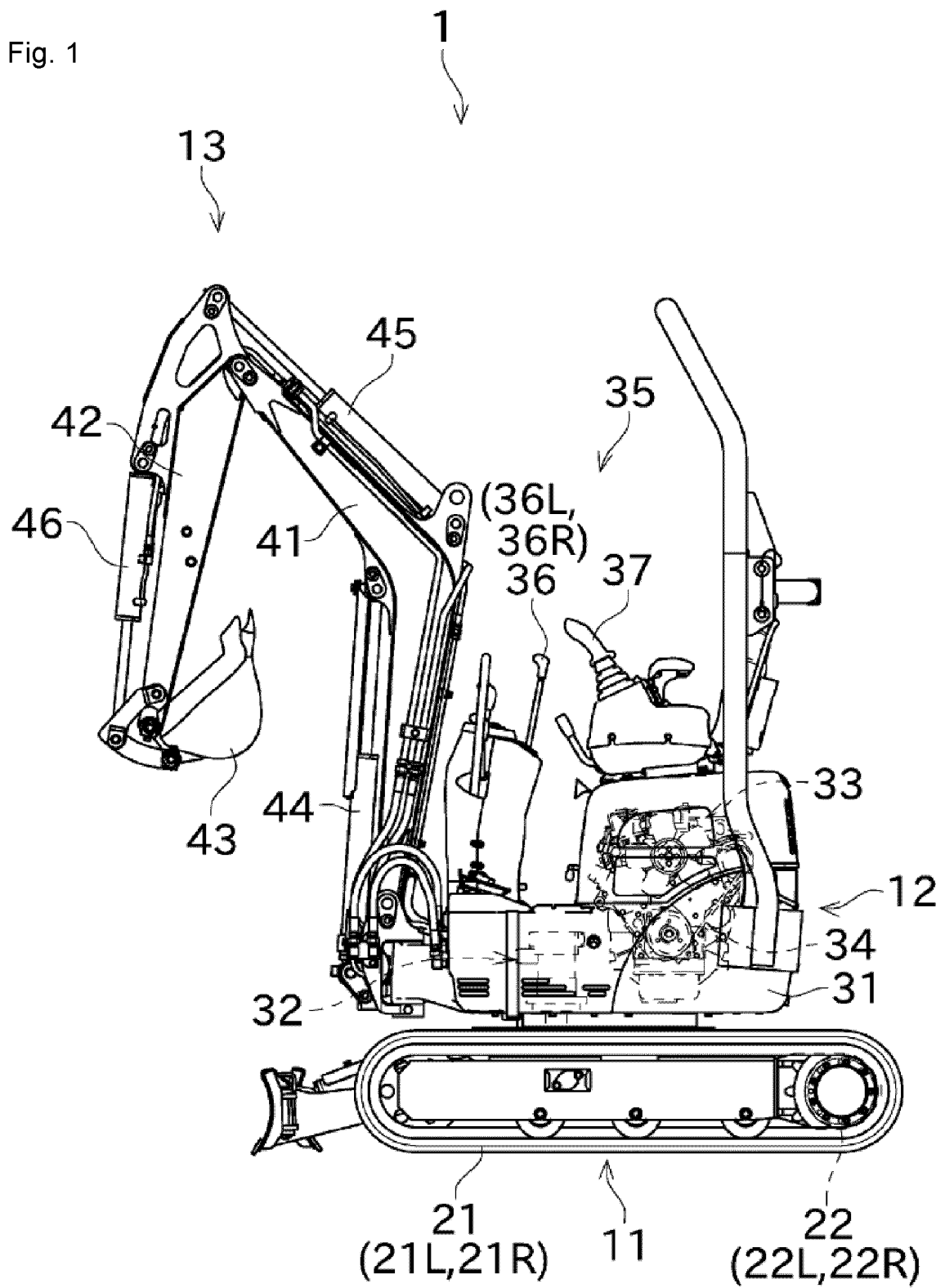


Fig. 2

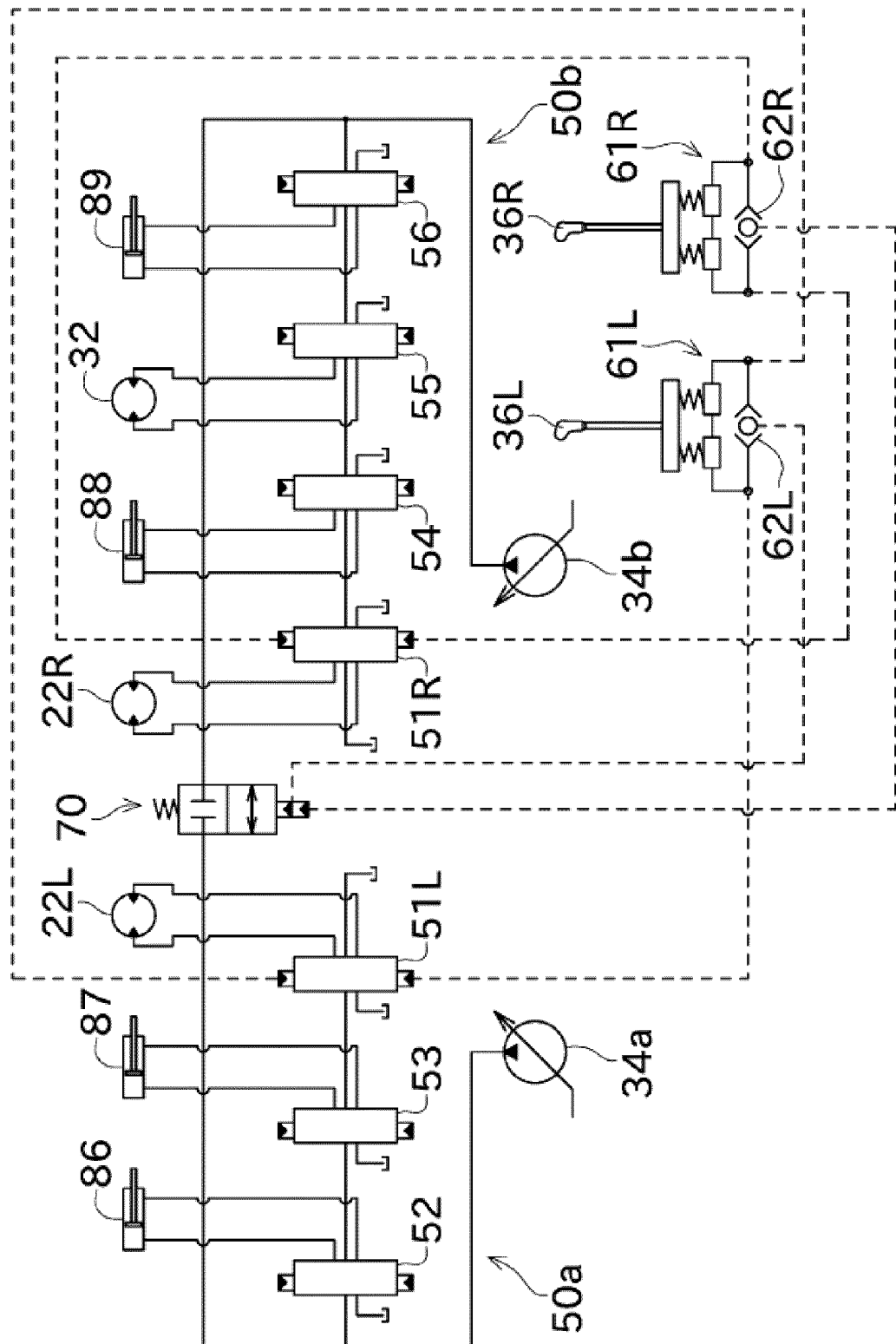


Fig. 3

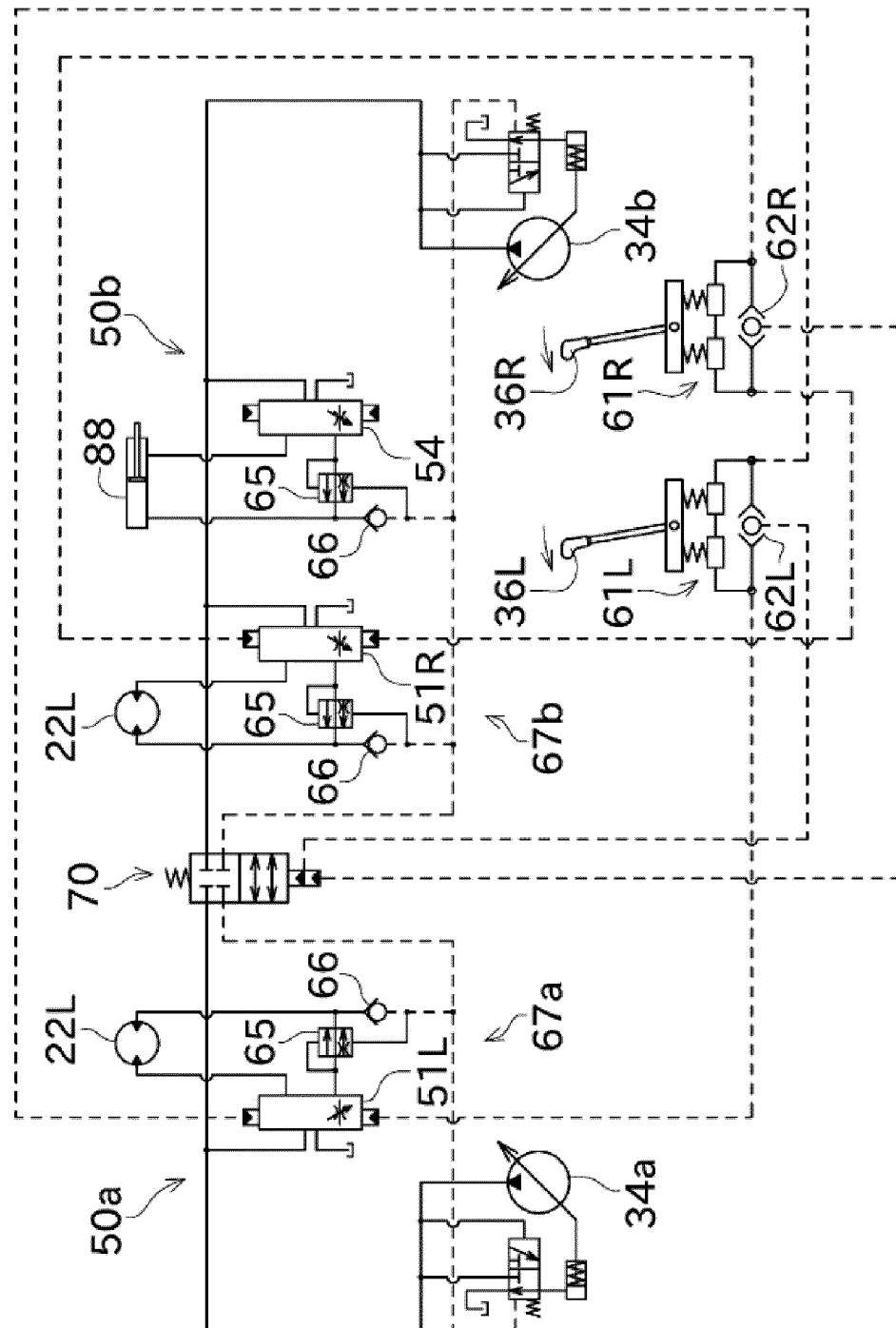
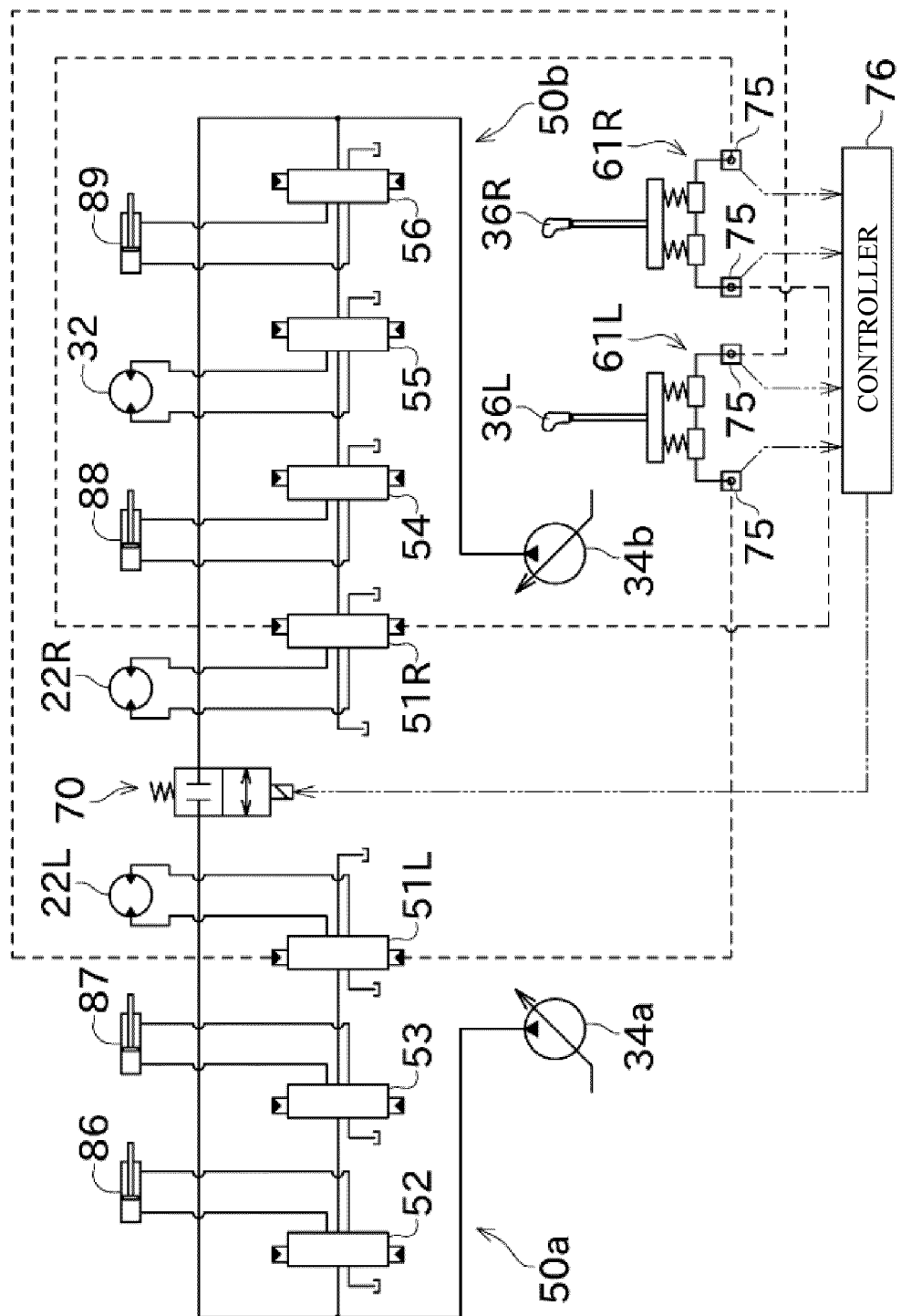


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/032788

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F15B11/02 (2006.01) i, E02F9/22 (2006.01) i, F15B11/00 (2006.01) i,
F15B11/17 (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. F15B11/02, E02F9/22, F15B11/00, F15B11/17, B62D11/04

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 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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	JP 2010-78047 A (SUMITOMO (S.H.I.) CONSTRUCTION MACHINERY CO., LTD.) 08 April 2010, paragraphs [0016]-[0021], [0037]-[0054], fig. 1, 2, 5, 6 (Family: none)	1-3
Y	JP 2010-83434 A (AICHI CORPORATION KK) 15 April 2010, paragraph [0030], fig. 1-4 (Family: none)	1-3



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search
21.09.2018

Date of mailing of the international search report
09.10.2018

Name and mailing address of the ISA/
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Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/032788

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-306200 A (SHIN CATERPILLAR MITSUBISHI LTD.) 09 November 2006, paragraphs [0005]-[0021], fig. 1 (Family: none)	1-3
Y	JP 2011-17427 A (KAYABA INDUSTRY CO., LTD.) 27 January 2011, paragraph [0012] & US 2011/0265467 A1, paragraph [0014] & WO 2011/004879 A1 & KR 10-2011-0093935 A & CN 102388227 A	3

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- JP 2011196436 A [0007]