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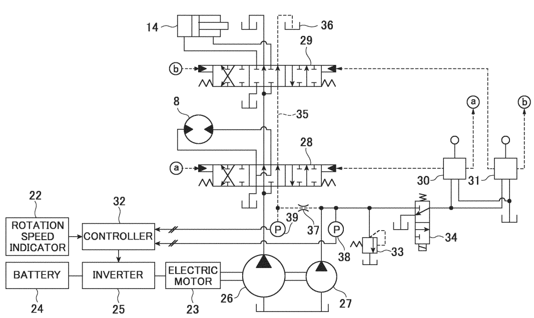
# (54) CONSTRUCTION MACHINERY

(57) A construction machine is provided which is capable of detecting an operation state of an operation device even if the idle rotation speed for a prime mover is set to a low value and is capable of setting the idle rotation speed for the prime mover to a low value. A hydraulic excavator includes an operation device that generates a pilot pressure corresponding to an operation amount of an operation lever and switches a control valve with the generated pilot valve, and a controller that controls an electric motor such that the rotation speed of the electric motor becomes an idle rotation speed set in advance when a no-operation state of the operation device continues. The hydraulic excavator further includes a hydraulic pressure signal line that is connected between the discharge side of a pilot pump and a tank and in which the control valve is interposed, a fixed restrictor provided between the discharge side of the pilot pump and the control valve in the hydraulic pressure signal line, and pressure sensors that individually detect the hydraulic pressures on the upstream side and the downstream side of the fixed restrictor. The controller detects an operation state of the operation device on the basis of results of detection of the pressure sensors.

FIG. 3




EP 3 995 632 A1

## Description

### Technical Field

**[0001]** The present invention relates to a construction machine having an auto idle control function.

### Background Art

**[0002]** A hydraulic excavator that is one of construction machines includes: a prime mover (particularly, for example, an engine or an electric motor); a hydraulic pump driven by the prime mover; a plurality of hydraulic actuators; a plurality of control valves that individually control the flow of hydraulic fluid from the hydraulic pump to the plurality of hydraulic actuators; and a plurality of operation devices that switch the plurality of control valves. In recent years, from the point of view of energy saving, noise reduction, and so forth, a hydraulic excavator is provided with an auto idle control function that decreases, when a no-operation state of the plurality of operation devices continues, the rotation speed of the prime mover from a standard rotation speed to an idle rotation speed (for example, refer to Patent Document 1).

**[0003]** The hydraulic excavator of Patent Document 1 includes: a pilot pump driven by a prime mover; a hydraulic signal line that is connected between the discharge side of the pilot pump and a tank and in which a plurality of control valves described above are interposed such that the hydraulic signal line is interrupted when one of the plurality of control valves is switched from its neutral position; a pilot relief valve provided on the discharge side of the pilot pump; a fixed restrictor provided between the discharge side of the pilot pump and the plurality of control valves in the hydraulic signal line; a pressure sensor that detects the hydraulic pressure on the downstream side of the fixed restrictor (in other words, between the fixed restrictor and the control valves); and a controller that detects an operation state of the plurality of operation devices on the basis of a result of detection of the pressure sensor.

**[0004]** When one of the plurality of operation devices is operated (i.e., when one of the plurality of control valves is switched from its neutral position), since the hydraulic signal line is placed into an interrupted state, the hydraulic pressure detected by the pressure sensor increases to near relief pressure of the pilot relief valve. When none of the operation devices is operated (i.e., when all of the control valves are in their neutral position), the hydraulic signal line is placed into a communication state, and therefore, the hydraulic pressure detected by the pressure sensor drops. The controller decides whether or not any one of the operation devices is operated depending upon whether or not the hydraulic pressure detected by the pressure sensor exceeds a threshold value set in advance.

**[0005]** The controller decides that none of the operation devices is operated when the hydraulic pressure detected by the pressure sensor is equal to or lower than the threshold value. Then, when the state in which none of the operation devices is operated continues for a predetermined period of time, the controller decreases the rotation speed of the prime mover to the idle rotation speed. Further, the controller decides that any one of the operation devices is operated when the hydraulic pressure detected by the pressure sensor exceeds the threshold value. Then, the controller controls the prime mover to keep or return the rotation speed of the prime mover at or to the standard rotation speed.

### Prior Art Document

### Patent Document

**[0006]** Patent Document 1: JP-2012-225050-A

### Summary of the Invention

### Problem to be Solved by the Invention

**[0007]** In the prior art described above, the pressure sensor for detecting the hydraulic pressure on the downstream side of the fixed restrictor is provided, and the hydraulic pressure detected by the pressure sensor is compared with a threshold value to detect an operation state of operation devices. However, the prior art described above has such room for improvement as described below.

**[0008]** The threshold value described above is necessary to be set higher than a hydraulic pressure that is detected by the pressure sensor when the rotation speed of the prime mover is the standard rotation speed and the hydraulic signal line is in a communication state (particularly, the hydraulic pressure is a pressure that is the sum of the tank pressure and the pressure loss in an intermediate portion of the hydraulic signal line from the pressure sensor to the tank, and increases if the fluid temperature is low). Further, the threshold value is necessary to be set lower than a hydraulic pressure that is detected by the pressure sensor when the rotation speed of the prime mover is the idle rotation speed and the hydraulic signal line is in an interrupted state.

**[0009]** However, if the rotation speed of the prime mover decreases to the idle rotation speed, then the discharge flow rate of the pilot pump decreases. The pilot relief valve has an override characteristic that the relief pressure decreases in proportion to the decrease in the flow rate of the fluid. Therefore, there is the possibility that, if the idle rotation speed for the prime mover is excessively low, then the hydraulic pressure detected by the pressure sensor may not exceed the threshold value when the rotation speed of the prime mover is the idle rotation speed and the hydraulic signal line is in an interrupted state. In other words, there is the possibility that detection of an operation state of the operation devices may be disabled. Accordingly, it is difficult to set the idle rotation speed for the prime mover to a low value.

**[0010]** The present invention has been made in view of such a circumstance as described above, and it is an object of the present invention to provide a construction machine that is capable of detecting an operation state of an operation device even if the idle rotation speed for a prime mover is set to a low value and is capable of setting the idle rotation speed for the prime mover to a low value.

Means for Solving the Problem

**[0011]** In order to achieve the object described above, according to the present invention, there is provided a construction machine that includes: a prime mover; a hydraulic pump driven by the prime mover; a hydraulic actuator; a control valve that controls flow of hydraulic fluid from the hydraulic pump to the hydraulic actuator; an operation device that generates a pilot pressure corresponding to an operation amount of an operation lever and switches the control valve with the generated pilot pressure; and a controller that controls, when a no-operation state of the operation device continues, a rotation speed of the prime mover to an idle rotation speed set in advance, the construction machine including: a pilot pump that is driven by the prime mover and whose discharge pressure is used as a source pressure of the pilot pressure; a pilot relief valve provided on a discharge side of the pilot pump; a hydraulic pressure signal line that is connected between the discharge side of the pilot pump and a tank and in which the control valve is interposed such that the hydraulic pressure signal line is interrupted when the control valve is switched from a neutral position; a fixed restrictor provided between the discharge side of the pilot pump and the control valve in the hydraulic pressure signal line; a first pressure sensor that detects a hydraulic pressure on an upstream side of the fixed restrictor; and a second pressure sensor that detects a hydraulic pressure on a downstream side of the fixed restrictor, in which the controller is configured to detect an operation state of the operation device based on results of detection of the first pressure sensor and the second pressure sensor.

Advantages of the Invention

**[0012]** According to the present invention, it is possible to detect an operation state of the operation device even if the idle rotation speed for the prime mover is set to a low value, and to set the idle rotation speed for the prime mover to a low value.

Brief Description of the Drawings

**[0013]**

FIG. 1 is a side elevational view depicting a structure of a hydraulic excavator according to an embodiment of the present invention.

FIG. 2 is a top plan view depicting the structure of the hydraulic excavator according to the embodiment of the present invention.

FIG. 3 is a diagram depicting a configuration of a hydraulic drive system according to the embodiment of the present invention.

FIG. 4 is a flow chart depicting a processing procedure of a controller according to the embodiment of the present invention.

Modes for Carrying Out the Invention

[First Embodiment]

**[0014]** In the following, an embodiment of the present invention is described with reference to the drawings taking a hydraulic excavator as an application target of the present invention.

**[0015]** FIG. 1 is a side elevational view depicting a structure of the hydraulic excavator according to the present embodiment, and FIG. 2 is a top plan view of the structure. It is to be noted that the front side (right side in FIGS. 1 and 2), the rear side (left side in FIGS. 1 and 2), the left side (back side facing the plane of FIG. 1 and upper side in FIG. 2), and the right side (front side facing the plane of FIG. 1 and lower side in FIG. 2) of an operator where the operator sits on an operator's seat when the hydraulic excavator is in such a state as depicted in FIGS. 1 and 2 are hereinafter referred to merely as front side, rear side, left side, and right side, respectively.

**[0016]** The hydraulic excavator of the present embodiment includes a lower track structure 1 that can travel, an upper track structure 2 swingably provided on the upper side of the lower track structure 1, and a work implement 3 coupled to the front side of the upper track structure 2.

**[0017]** The lower track structure 1 includes a track frame 4 having an H shape as viewed from above. A driving wheel 5 and a driven wheel 6 are provided on the right side of the track frame 4, and a right side crawler belt (crawler) 7A extends between and around the driving wheel 5 and the driven wheel 6. The driving wheel 5 on the right side is rotated by driving of a right side travel motor 8, and consequently, the right side crawler belt 7A is rotated. A driving wheel (not depicted) and a driven wheel (not depicted) are provided also on the left side of the track frame 4, and a left side crawler belt 7B extends between and around them. The left side driving wheel is rotated by a left side travel motor (not depicted), and consequently, the left side crawler belt 7B is rotated.

**[0018]** On the front side of the track frame 4, a blade 9 for earth removal is movably provided in the upward and downward direction. The blade 9 is moved upwardly and downwardly by driving of a blade cylinder (not depicted).

**[0019]** The work implement 3 includes: a swing post 10 pivotably coupled in the leftward and rightward direction to the front side of the upper track structure 2 (particularly, of a swing frame hereinafter described); a boom 11 pivotably coupled in the upward and downward direction to the swing post 10; an arm 12 pivotably coupled in the upward and downward direction to the boom 11; and a bucket 13 pivotably coupled in the upward and downward direction to the arm 12. The swing post 10, the boom 11, the arm 12, and the bucket 13 are pivoted by driving of a swing cylinder (not depicted), a boom cylinder 14, an arm cylinder 15, and a bucket cylinder 16, respectively. It is to be noted that the bucket 13 is exchangeable for an attachment (not depicted) in which an optional hydraulic actuator is incorporated.

**[0020]** The upper track structure 2 includes a swing frame 17 that serves as a basic structure, an operation room 18 of the canopy type provided on the left side of a front portion of the swing frame 17, and a counterweight 19 provided at a rear end of the swing frame 17. The swing frame 17 of the upper track structure 2 is coupled to the upper side of the track frame 4 of the lower track structure 1 through a swing wheel 20. The upper track structure 2 swings by driving of a swing motor (not depicted).

**[0021]** At the doorway of the operation room 18, a gate lock lever (not depicted) is provided which can be operated between a raised position (getting on/off permission position) and a lowered position (getting on/off restriction position). In the inside of the operation room 18, an operator's seat 21 on which an operator is to sit, a plurality of operation lever devices (details are hereinafter described) capable of being operated by the operator, and a rotation speed indicator 22 (refer to FIG. 3 hereinafter described) are provided.

**[0022]** The hydraulic excavator includes a hydraulic drive system that drives a plurality of hydraulic actuators (particularly, the right side travel motor 8, left side travel motor, blade cylinder, swing cylinder, boom cylinder 14, arm cylinder 15, bucket cylinder 16, optional hydraulic actuator, and swing motor described hereinabove) according to the operation of the plurality of operation lever devices. The configuration of the hydraulic drive system is described with reference to FIG. 3.

**[0023]** FIG. 3 is a diagram depicting the configuration of the hydraulic drive system in the present embodiment. It is to be noted that FIG. 3 depicts a configuration relating to the right side travel motor 8 and the boom cylinder 14 as representatives.

**[0024]** The hydraulic drive system of the present embodiment includes an electric motor 23 (prime mover), a battery 24 that serves as an electric power supply to the electric motor 23, an inverter 25 that controls the rotation speed of the electric motor 23, a hydraulic pump 26 and a pilot pump 27 that are driven by the electric motor 23, a right side travel control valve 28 that controls the flow of hydraulic fluid from the hydraulic pump 26 to the right side travel motor 8, a boom control valve 29 that controls the flow of hydraulic fluid from the hydraulic pump 26 to the boom cylinder 14, an operation lever device 30 that switches the right side travel control valve 28, an operation lever device 31 that switches the boom control valve 29, and a controller 32.

**[0025]** The operation lever device 30 includes, though not depicted, a travel operation lever capable of being operated by an operator, a first pressure reducing valve that operates in response to a front side operation of the traveling operation lever, and a second pressure reducing valve that operates in response to a rear side operation of the traveling operation lever. The first pressure reducing valve generates a pilot pressure corresponding to a front side operation amount of the travel operation lever by using the discharge pressure of the pilot pump 27 as source pressure, and outputs the generated pilot pressure to a pressure reception portion on one side of the right side travel control valve 28. Consequently, the right side travel control valve 28 is switched from a neutral position to a switched position on one side thereof such that the travel motor 8 is rotated in one direction. The second pressure reducing valve generates a pilot pressure corresponding to a rear side operation amount of the travel operation lever by using discharge pressure of the pilot pump 27 as source pressure and outputs the generated pilot pressure to a pressure reception portion on the other side of the right side travel control valve 28. Consequently, the right side travel control valve 28 is switched from a neutral position to a switched position on the other side thereof such that the right side travel motor 8 is rotated in the opposite direction.

**[0026]** The operation lever device 31 includes, though not depicted, a work operation lever capable of being operated by an operator, a third pressure reducing valve that operates in response to a front side operation of the work operation lever, and a fourth pressure reducing valve that operates in response to a rear side operation of the working operation lever. The third pressure reducing valve generates a pilot pressure corresponding to a front side operation amount of the work operation lever by using the discharge pressure of the pilot pump 27 as source pressure, and outputs the generated pilot pressure to a pressure reception portion on one side of the boom control valve 29. Consequently, the boom control valve 29 is switched from a neutral position to a switched position on one side thereof such that the boom cylinder 14 is contracted. The fourth pressure reducing valve generates a pilot pressure corresponding to a rear side operation amount of the working operation lever by using discharge pressure of the pilot pump 27 as source pressure and outputs the generated pilot pressure to a pressure reception portion on the other side of the boom control valve 29. Consequently, the boom control valve 29 is switched from the neutral position to a switched position on the other side thereof such that the boom control valve 29 is stretched.

**[0027]** The operation lever device 30 or 31 configures an operation device that generates a pilot pressure corresponding to the operation amount of an operation lever and switches the control valve with the generated pilot valve. It is to be noted that, though not depicted, the foregoing similarly applies also to the configuration relating to the left side travel motor, blade cylinder, swing cylinder, arm cylinder 15, bucket cylinder 16, optional hydraulic actuator, and swing motor.

**[0028]** A pilot relief valve 33 and a lock valve 34 are provided on the discharge side of the pilot pump 27. The pilot relief valve 33 exhibits an open state when the discharge pressure of the pilot pump 27 is equal to or higher than relief pressure, and returns part of hydraulic pressure discharged from the pilot pump 27 to the tank. Consequently, the discharge pressure of the pilot pump 27 is kept at the relief pressure.

**[0029]** The lock valve 34 is switched in response to an operation of the gate lock lever described hereinabove. In particular, a lock switch is provided which has a closed state when the gate lock lever is in its lowered position and has an open state when the gate lock lever is in its raised position. Then, if the lock switch is placed into the closed state, then the solenoid part of the lock valve 34 is energized through the lock switch to switch the lock valve 34 from its neutral position to a switched position. Consequently, the discharge line of the pilot pump 27 is placed into communication to introduce the discharge pressure of the pilot pump 27 into the operation lever devices 30 and 31 and so forth. On the other hand, if the lock switch is placed into the open state, then the solenoid part of the lock valve 34 is not energized, and the lock valve 34 is placed into its neutral position by biasing force of a spring. Consequently, the discharge line of the pilot pump 27 is interrupted. As a result, even if the operation lever device 30 or 31 or the like is operated, no pilot pressure is generated and any of the plurality of hydraulic actuators does not operate.

**[0030]** A hydraulic signal line 35 is connected to the discharge side of the pilot pump 27. The hydraulic signal line 35 is connected between the discharge side of the pilot pump 27 and a tank 36 and has a plurality of control valves (including, more particularly, not only the right side travel control valve 28 and the boom control valve 29 described hereinabove, but also a left side travel control valve, a blade control valve, a swing post control valve, an arm control valve, a bucket control valve, an optional control valve, and a swing control valve) interposed therein. The hydraulic signal line 35 becomes a communication state when all control valves are in their neutral position and becomes an interrupted state when any of the control valves is switched from its neutral position.

**[0031]** A fixed restrictor 37 is provided between the discharge side of the pilot pump 27 and the plurality of control valves in the hydraulic signal line 35. Further, a pressure sensor 38 (first pressure sensor) for detecting the hydraulic pressure on the upstream side of the fixed restrictor 37 and another pressure sensor 39 (second pressure sensor) for detecting the hydraulic pressure on the downstream side of the fixed restrictor 37 (in other words, between the fixed restrictor 37 and the control valves) are provided.

**[0032]** The rotation speed indicator 22 is capable of indicating a standard rotation speed for the electric motor 23 within a predetermined range (particularly, for example, 2000 to 1500 rpm) depending upon the rotational operation position of a dial and outputs a signal corresponding to this, for example. The controller 32 sets the standard rotation speed for the electric motor 23 in response to the signal from the rotation speed indicator 22 and controls the inverter 25 such that the rotation speed of the electric motor 23 becomes the standard rotation speed.

**[0033]** Further, the controller 32 controls, when a state in which none of the operation devices is operated continues for a predetermined period of time, the inverter 25 such that the rotation speed of the electric motor 23 becomes an idle rotation speed (particularly, a low rotation speed set in advance so as to be lower than the standard rotation speed described above) (auto idle control). Here, as the most significant feature of the present embodiment, the controller 32 detects an operation state of the plurality of operation devices on the basis of results of detection of the pressure sensors 38 and 39. Describing more particularly, the controller 32 detects an operation state of the plurality of operation devices on the basis of the differential pressure between the hydraulic pressure detected by the pressure sensor 38 and the hydraulic pressure detected by the pressure sensor 39 (hereinafter referred to as differential pressure across the fixed restrictor 37).

**[0034]** When none of the operation devices is operated (i.e., when all of the control valves are in the neutral position), since the hydraulic signal line 35 is placed in a communication state, the differential pressure across the fixed restrictor 37 is great. On the other hand, if any one of the operation devices is operated (i.e., when any one of the control valves is switched from its neutral position), since the hydraulic signal line 35 is placed into an interrupted state, the differential pressure across the fixed restrictor 37 decreases to a level near to zero. The controller 32 decides that none of the operation devices is operated when the differential pressure across the fixed restrictor 37 is equal to or higher than a threshold value set in advance. Then, when the state in which none of the operation devices is operated continues for a predetermined period of time, the controller 32 decreases the rotation speed of the electric motor 23 to the idle rotation speed. Further, the controller 32 decides that one of the operation devices is operated when the differential pressure across the fixed restrictor 37 is lower than the threshold value. Then, the electric motor 23 keeps or returns the rotation speed of the electric motor 23 at or to the standard rotation speed.

**[0035]** Now, a processing procedure of the controller of the present embodiment is described. FIG. 4 is a flow chart depicting the processing procedure of the controller in the present embodiment. It is to be noted that the process depicted in FIG. 4 is executed periodically.

**[0036]** In step S1, the controller 32 calculates the differential pressure across the fixed restrictor 37 on the basis of results of detection of the pressure sensors 38 and 39. Then, the processing advances to step S2, at which the controller 32 decides whether or not the differential pressure across the fixed restrictor 37 is equal to or higher than a threshold value. When the differential pressure across the fixed restrictor 37 is equal to or higher than the threshold value (i.e., when none of the operation devices is operated), the processing advances to step S3.

**[0037]** In step S3, the controller 32 decides whether or not the rotation speed of the electric motor 23 is controlled to the idle rotation speed (in other words, whether or not the electric motor 23 is in the idle state). When the rotation speed of the electric motor 23 is not controlled to the idle rotation speed (in other words, when the electric motor 23 is not in the idle state), the processing advances to step S4.

**[0038]** In step S4, the controller 32 counts up a no-operation duration. Then, the processing advances to step S5, in which the controller 32 decides whether or not the no-operation duration reaches a predetermined time period.

**[0039]** When the no-operation duration does not reach the predetermined time period in step S5, the processing advances to step S6. In step S6, the controller 32 controls the electric motor 23 to be driven at its standard rotation speed. On the other hand, when the no-operation duration reaches the predetermined time period, the processing advances to step S7. In step S7, the controller 32 controls the electric motor 23 to be driven at the idle rotation speed. It is to be noted that, when the rotation speed of the electric motor 23 is controlled to the idle rotation speed (in other words, when the electric motor 23 is in the idle state) in step S3, the processing advances to step S7 bypassing the steps S4 and S5 described above.

**[0040]** When the differential pressure across the fixed restrictor 37 is lower than the threshold value (i.e., when any one of the control valves is operated) in step S2, the processing advances to step S6 described hereinabove through step S8. In step S8, the controller 32 clears the count of the no-operation duration.

**[0041]** In this manner, in the present embodiment, the controller 32 calculates the differential pressure across the fixed restrictor 37 on the basis of results of detection of the pressure sensors 38 and 39 and detects an operation state of the plurality of operation devices on the basis of the differential pressure. The differentia pressure of the fixed restrictor 37 used in the present embodiment can suppress the influence of the rotation speed of the electric motor 23 and so forth in comparison with the hydraulic pressure on the downstream side of the fixed restrictor 37 used in the prior art. Describing more particularly, even in a case where the rotation speed of the electric motor 23 is low and consequently the hydraulic pressure on the upstream side of the fixed restrictor 37 is low or in a case where the pressure loss in a portion of the hydraulic signal line 35 from the fixed restrictor 37 to the tank 36 is high and consequently the hydraulic pressure on the downstream side of the fixed restrictor 37 is high, the differential pressure across the fixed restrictor 37 when any one of the operation devices is operated goes down to near zero, and the differential pressure across the fixed restrictor 37
when none of the operation devices is operated becomes great. Therefore, the threshold value for deciding an operation state of the plurality of operation devices can be set easily. Further, even if the idle rotation speed for the electric motor 23 is set low, an operation state of the operation devices can be detected. Accordingly, the idle rotation speed for the electric motor 23 can be set low.

**[0042]** It is to be noted that, although, in the foregoing description of the embodiment, a case is described as an example where the controller 32 calculates the differential pressure across the fixed restrictor 37 (particularly, differential pressure between the hydraulic pressure detected by the pressure sensor 38 and the hydraulic pressure detected by the pressure sensor 39), and compares this differential pressure and a threshold value with each other to decide an operation state of a plurality of operation devices, this is not restrictive. Alternatively, the controller may add a predetermined differential pressure to a hydraulic pressure detected by the pressure sensor 39 to set a threshold value and compare the hydraulic pressures detected by the pressure sensor 38 and the threshold value with each other to decide an operation state of the plurality of operation devices. Also in such a modification as just described, advantages similar to those described above can be achieved.

**[0043]** Further, although, in the foregoing description of the embodiment, a case is described as an example where the operation lever device includes a pressure reducing valve that generates a pilot pressure corresponding to an operation amount of an operation lever by using the discharge pressure of the pilot pump 27 as source pressure and outputs the generated pilot pressure to the pressure reception portion of the control valve (in other words, the operation device that switches the control valve is configured only from the operation lever device), this is not restrictive. The operation lever device may include, for example, a potentiometer that detects an operation amount of the operation lever and outputs a corresponding electric operation signal. Then, the controller generates instruction current in response to the electric operation signal from the operation lever device and outputs the instruction current to a solenoid proportional valve. The solenoid proportional valve generates a pilot pressure corresponding to the instruction current from the controller by using the discharge pressure of the pilot pump 27 as source pressure and outputs the generated pilot pressure to the pressure reception portion of the control valve. In other words, the operation device that switches the control valve may be configured from the operation level device, controller, and solenoid proportional valve. Also in such a modification as just described, advantages similar to those described above can be achieved.

**[0044]** Further, although, in the foregoing description of the embodiment, a case is described as an example where the hydraulic excavator includes the electric motor 23 as the prime mover, this is not restrictive, and alternatively, an engine may be provided as the prime mover.

**[0045]** It is to be noted that, although the foregoing description is given of an application target of the present invention taking a hydraulic excavator as an example, this is not restrictive, and the application target may otherwise be a different construction machine such as a wheel loader.

Description of Reference Characters

**[0046]**

8: Right side travel motor
14: Boom cylinder
15: Arm cylinder
16: Bucket cylinder
23: Electric motor (prime mover)
26: Hydraulic pump
27: Pilot pump
28: Right side travel control valve
29: Boom control valve
30: Operation lever device
31: Operation lever device
32: Controller
33: Pilot relief valve
35: Hydraulic signal line
36: Tank
37: Fixed restrictor
38: Pressure sensor (first pressure sensor)
39: Pressure sensor (second pressure sensor)

## Claims

**1.** A construction machine that includes a prime mover, a hydraulic pump driven by the prime mover, a hydraulic actuator, a control valve that controls flow of hydraulic fluid from the hydraulic pump to the hydraulic actuator, an operation device that generates a pilot pressure corresponding to an operation amount of an operation lever and switches the control valve with the generated pilot pressure, and a controller that controls, when a no-operation state of the operation device continues, a rotation speed of the prime mover to an idle rotation speed set in advance, the construction machine comprising:

a pilot pump that is driven by the prime mover and whose discharge pressure is used as a source pressure of the pilot pressure;
a pilot relief valve provided on a discharge side of the pilot pump;
a hydraulic pressure signal line that is connected between the discharge side of the pilot pump and a tank and in which the control valve is interposed such that the hydraulic pressure signal line is interrupted when the control valve is switched from a neutral position;
a fixed restrictor provided between the discharge side of the pilot pump and the control valve in the hydraulic pressure signal line;
a first pressure sensor that detects a hydraulic pressure on an upstream side of the fixed restrictor; and
a second pressure sensor that detects a hydraulic pressure on a downstream side of the fixed restrictor, wherein
the controller is configured to detect an operation state of the operation device based on results of detection of the first pressure sensor and the second pressure sensor.

**2.** The construction machine according to claim 1, wherein
the controller is configured to detect an operation state of the operation device based on a differential pressure between the hydraulic pressure detected by the first pressure sensor and the hydraulic pressure detected by the second pressure sensor.

**3.** The construction machine according to claim 1, wherein
the prime mover is an electric motor.

FIG. 1

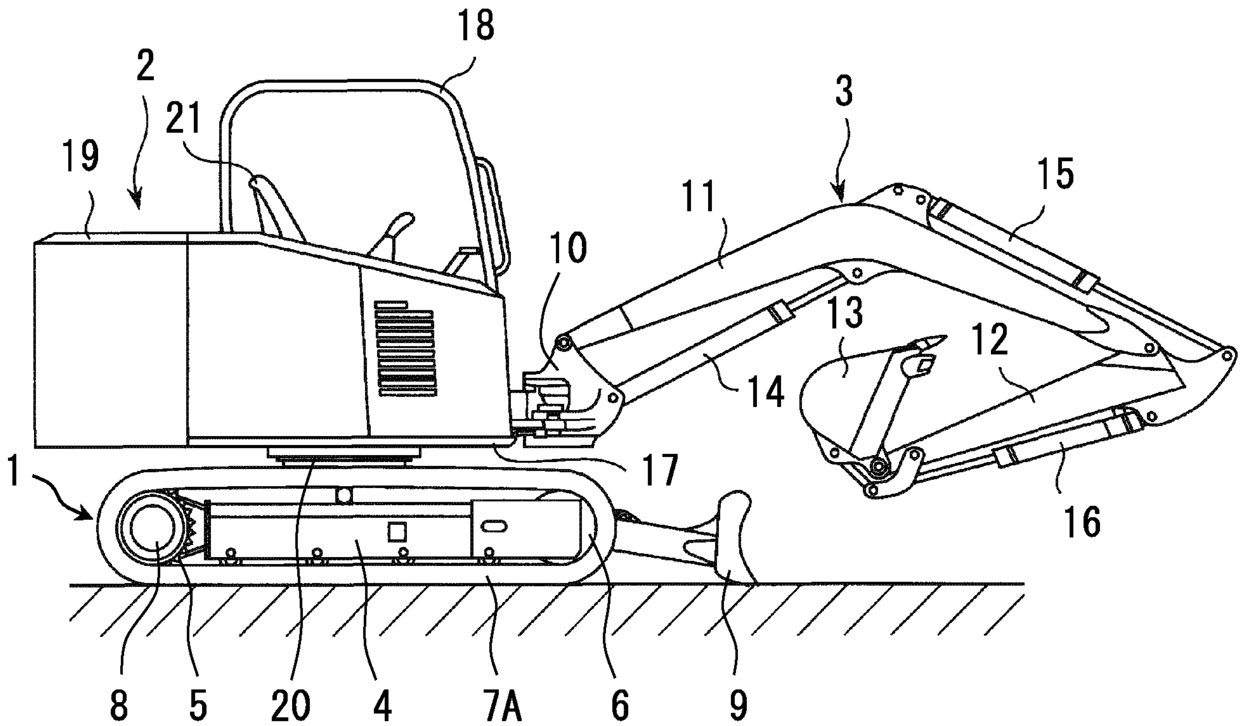


FIG. 2

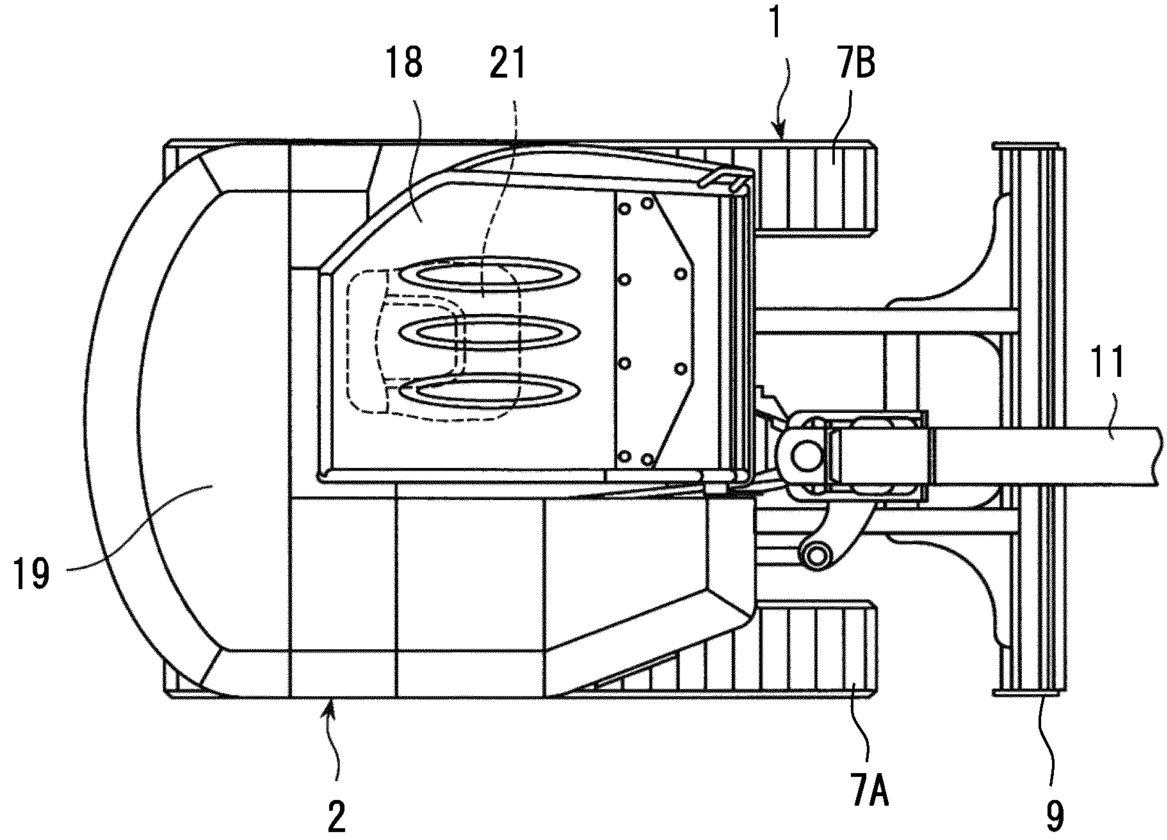
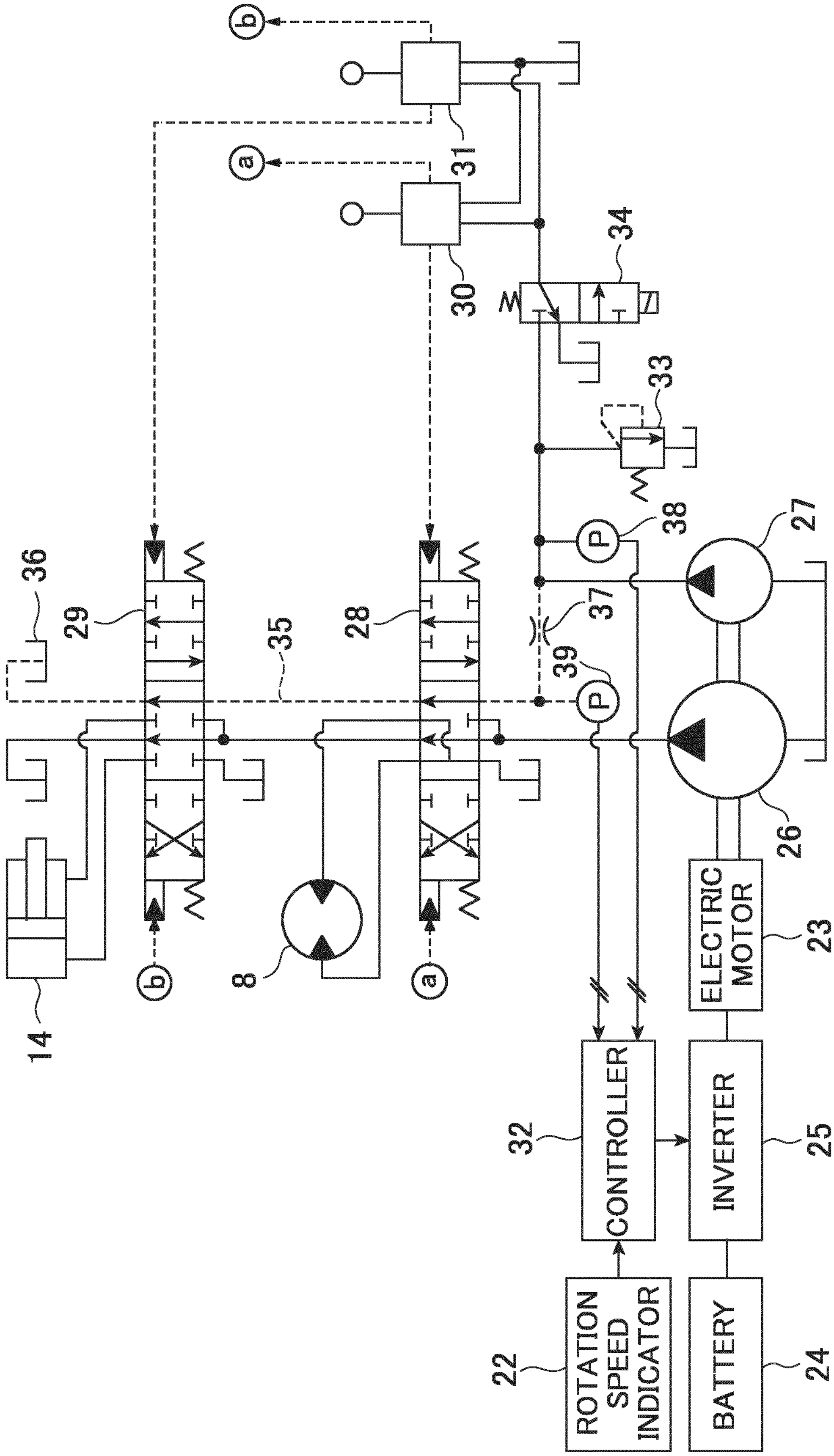


FIG. 3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CONTROLLER
INVERTER
ELECTRIC MOTOR
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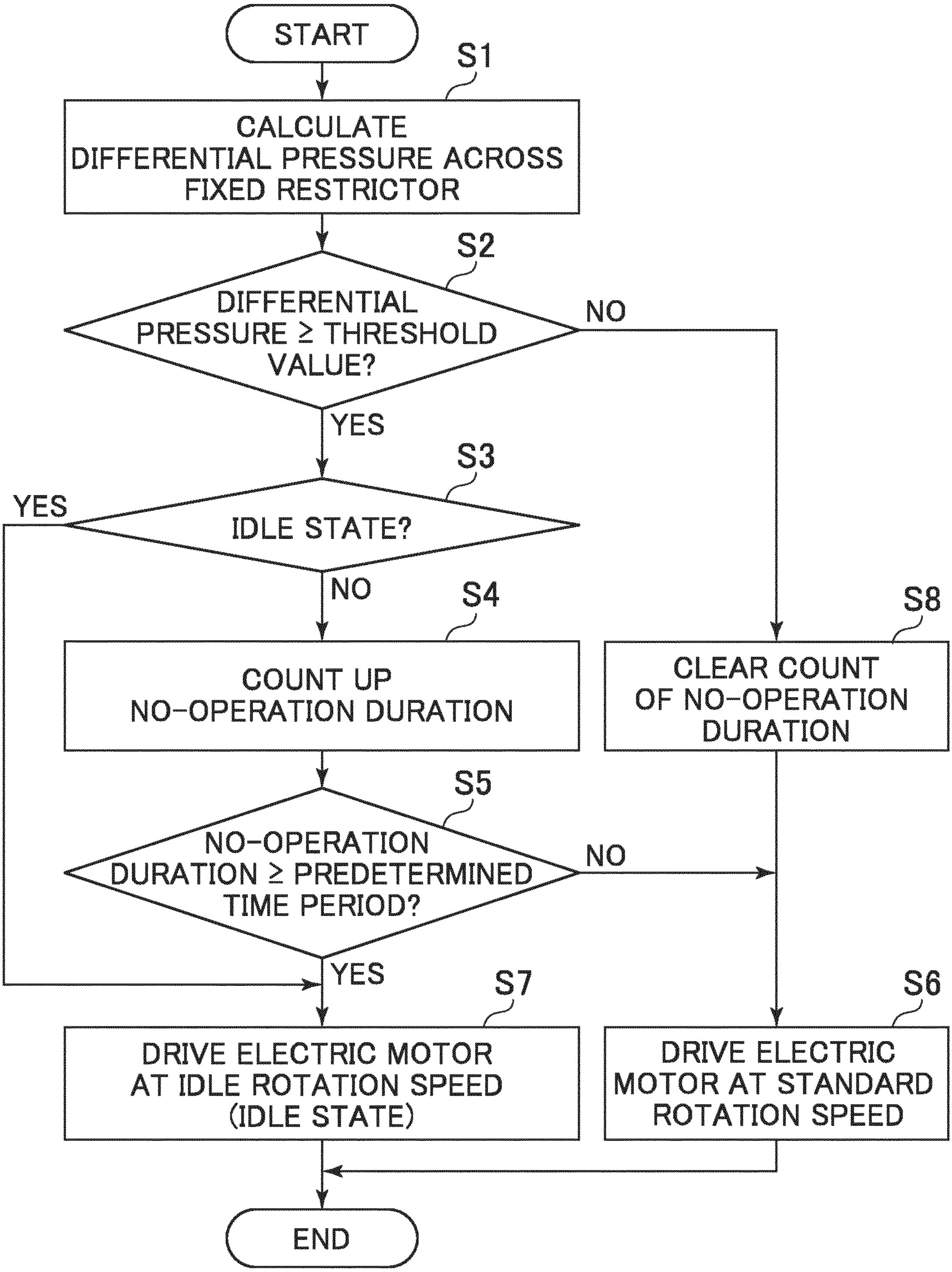
FIG. 4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FIXED RESTRICTOR
S2
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VALUE?
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YES
IDLE STATE?
NO
S4
COUNT UP
NO-OPERATION DURATION
S8
CLEAR COUNT
OF NO-OPERATION
DURATION
S5
NO-OPERATION
DURATION ≥ PREDETERMINED
TIME PERIOD?
NO
YES
S7
DRIVE ELECTRIC MOTOR
AT IDLE ROTATION SPEED
(IDLE STATE)
S6
DRIVE ELECTRIC
MOTOR AT STANDARD
ROTATION SPEED
END

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/023172

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. E02F9/20(2006.01)i, E02F9/22(2006.01)i
FI: E02F9/22 Z, E02F9/20 C

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. E02F9/20, E02F9/22

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

| | |
|---|---|
| Published examined utility model applications of Japan | 1922-1996 |
| Published unexamined utility model applications of Japan | 1971-2020 |
| Registered utility model specifications of Japan | 1996-2020 |
| Published registered utility model applications of Japan | 1994-2020 |

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | JP 2019-044688 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 22 March 2019 | 1-3 |
| A | JP 2017-206868 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 24 November 2017 | 1-3 |
| A | JP 2016-108762 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 20 June 2016 | 1-3 |
| A | JP 2010-065577 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 25 March 2010 | 1-3 |

☐ Further documents are listed in the continuation of Box C.  ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 12.08.2020 | 25.08.2020 |

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

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

**INTERNATIONAL SEARCH REPORT**
Information on patent family members

International application No.
PCT/JP2020/023172

| Patent Documents referred to in the Report | Publication Date | Patent Family | Publication Date |
|---|---|---|---|
| JP 2019-044688 A | 22.03.2019 | US 2020/0063400 A1<br>WO 2019/044468 A1<br>CN 110382846 A<br>KR 10-2019-0113874 A | |
| JP 2017-206868 A | 24.11.2017 | WO 2017/199546 A1<br>EP 3460129 A1<br>KR 10-2018-0104698 A<br>CN 108699809 A | |
| JP 2016-108762 A | 20.06.2016 | (Family: none) | |
| JP 2010-065577 A | 25.03.2010 | (Family: none) | |

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

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- JP 2012225050 A **[0006]**