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(54) **CRANE VEHICLE**

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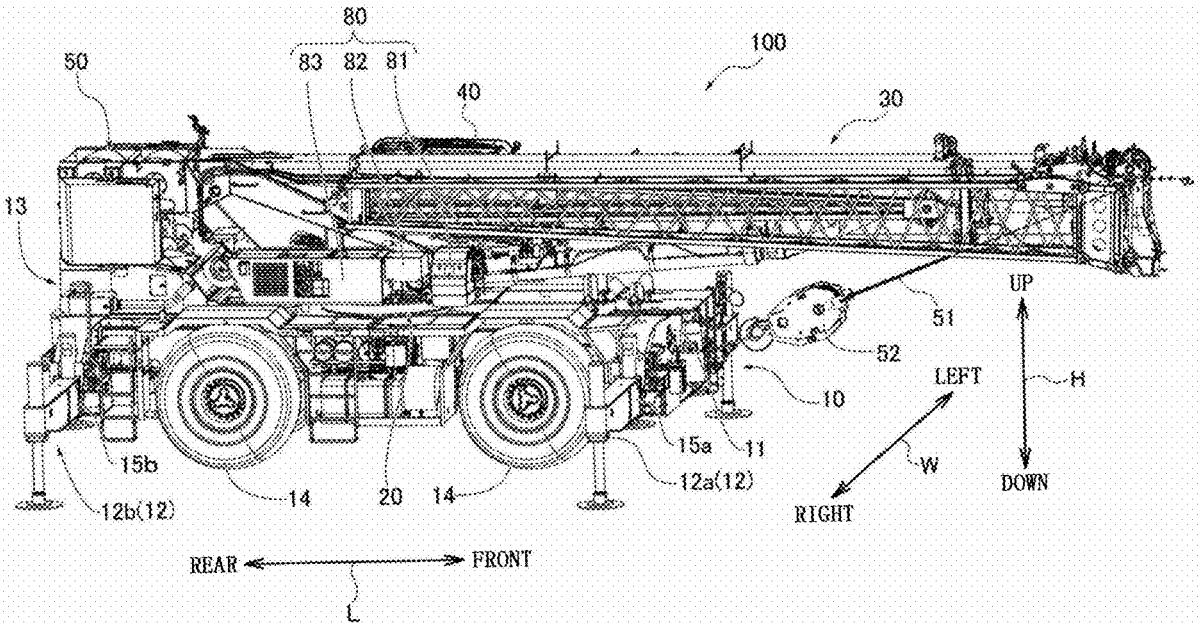
(57) **ABSTRACT**

A crane has a traveling device, a turn table, a cockpit, a main power unit, an auxiliary power unit, and a processor that selectively switches between a manual power mode and an auxiliary power mode, and the processor disables a switching between the manual power mode and the auxiliary power mode when an operation input to the operating system that operates the boom is detected, and the processor enables a switching between the main power mode and the auxiliary power mode when an operation input to the operating system is not detected.



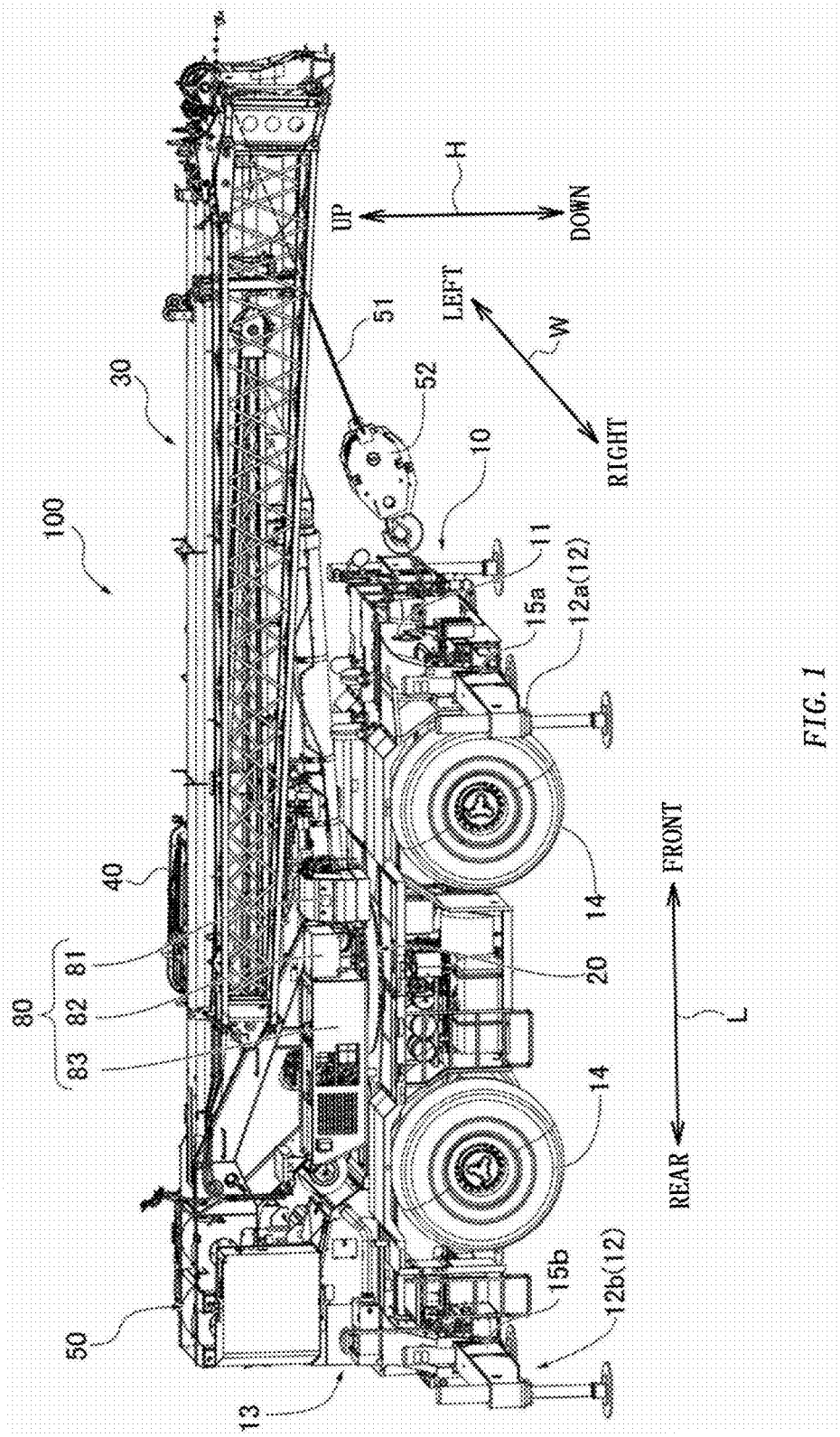

100
30
40
80
81
82
83
50
13
51
52
10
11
15a
12a(12)
14
20
15b
12b(12)
H
UP
DOWN
W
LEFT
RIGHT
L
FRONT
REAR

FIG. 1

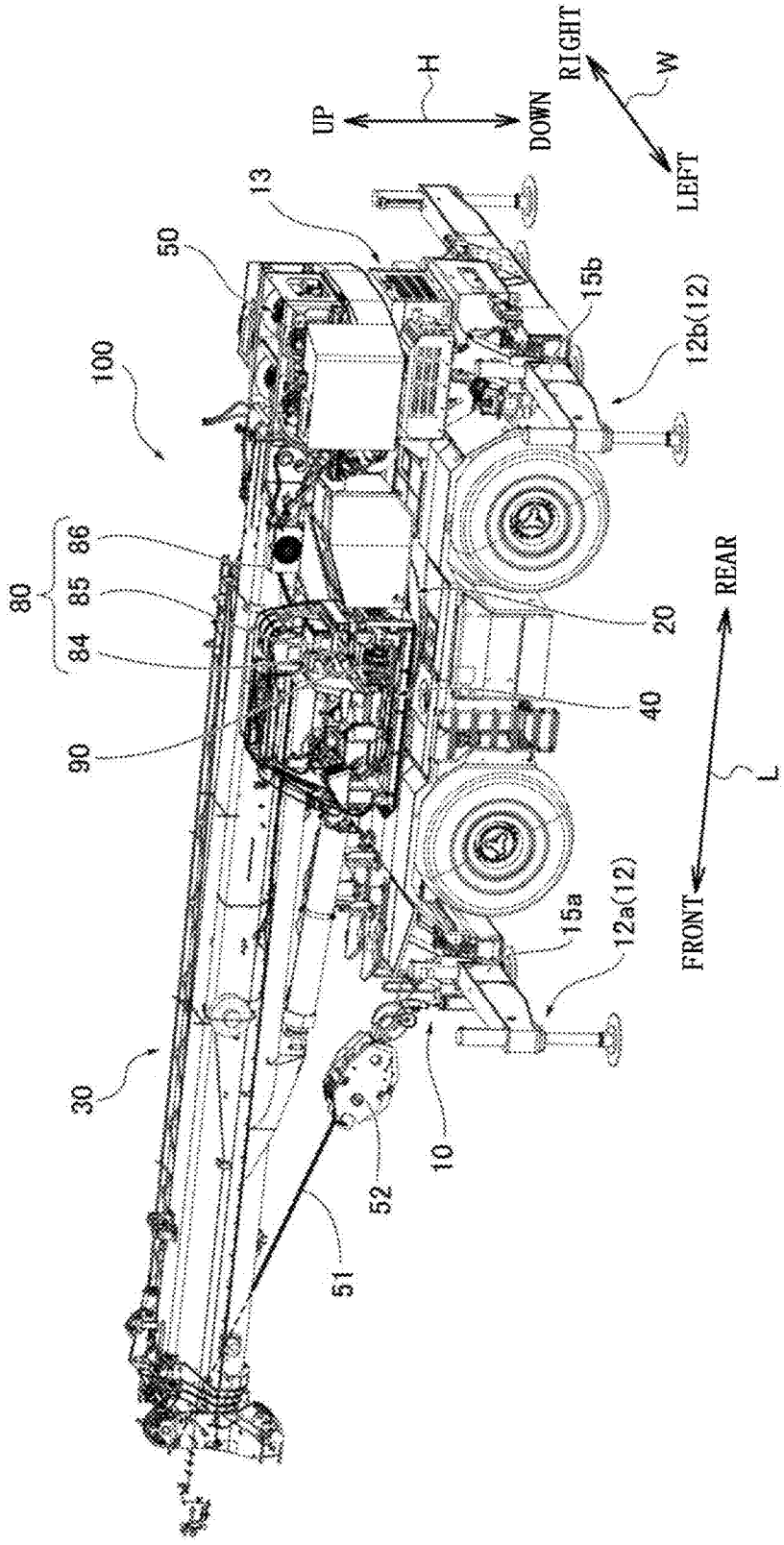

UP
H
DOWN
RIGHT
W
LEFT
13
50
100
15b
12b(12)
80
86
85
84
90
20
40
REAR
L
FRONT
15a
12a(12)
30
10
52
51

FIG. 2

FIG. 3

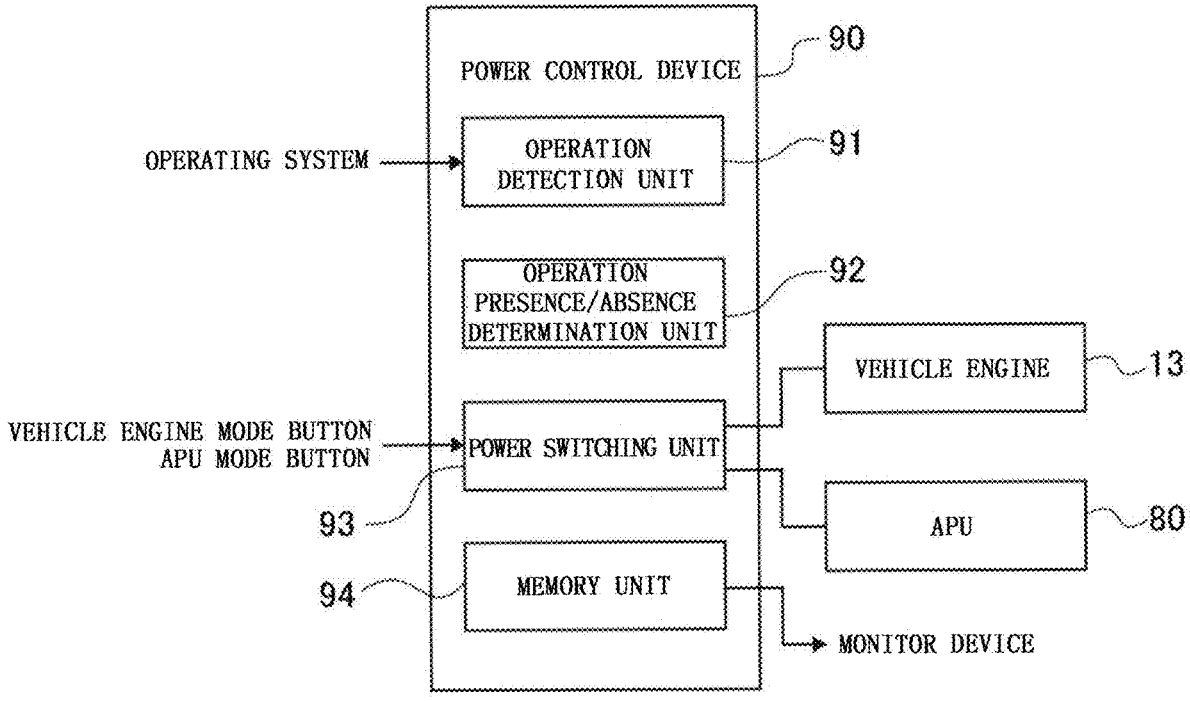

POWER CONTROL DEVICE
90
OPERATING SYSTEM
OPERATION DETECTION UNIT
91
OPERATION PRESENCE/ABSENCE DETERMINATION UNIT
92
VEHICLE ENGINE
13
VEHICLE ENGINE MODE BUTTON
APU MODE BUTTON
POWER SWITCHING UNIT
93
APU
80
94
MEMORY UNIT
MONITOR DEVICE

FIG. 4

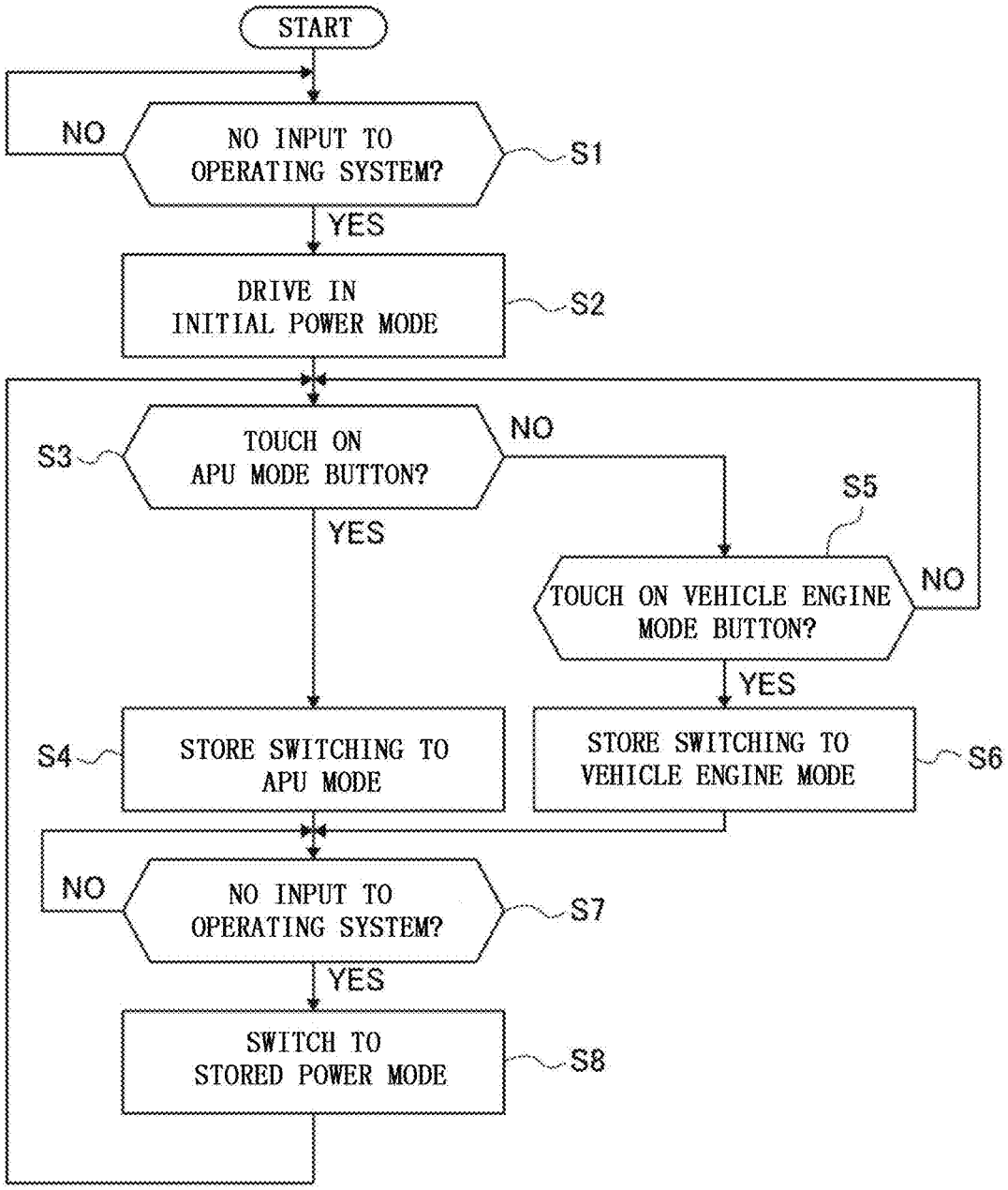

START
NO
NO INPUT TO OPERATING SYSTEM?
S1
YES
DRIVE IN INITIAL POWER MODE
S2
S3
TOUCH ON APU MODE BUTTON?
NO
YES
S5
TOUCH ON VEHICLE ENGINE MODE BUTTON?
NO
YES
S4
STORE SWITCHING TO APU MODE
STORE SWITCHING TO VEHICLE ENGINE MODE
S6
NO
NO INPUT TO OPERATING SYSTEM?
S7
YES
SWITCH TO STORED POWER MODE
S8

FIG. 5

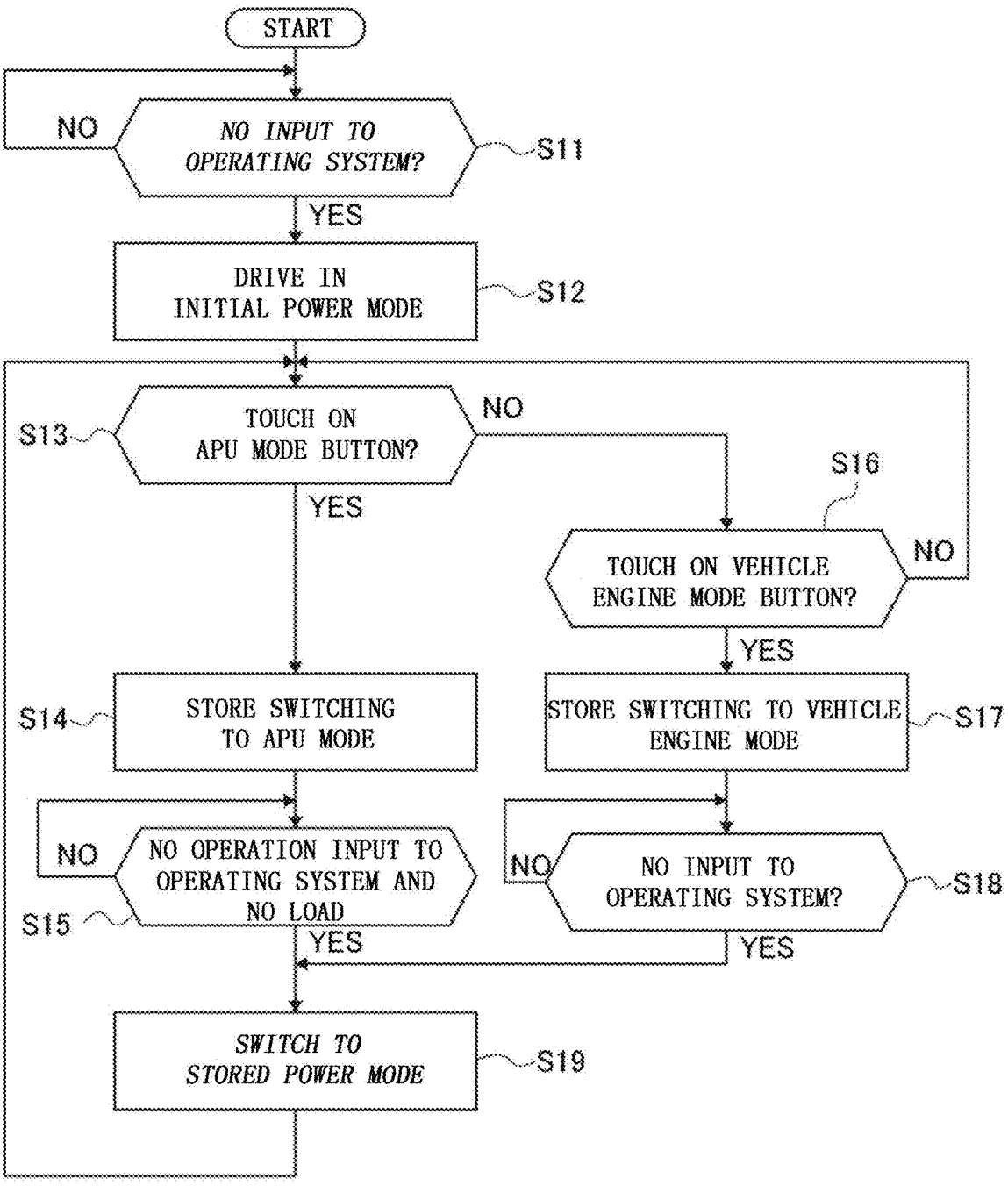

START
NO
NO INPUT TO OPERATING SYSTEM?
S11
YES
DRIVE IN INITIAL POWER MODE
S12
S13
TOUCH ON APU MODE BUTTON?
NO
YES
S16
TOUCH ON VEHICLE ENGINE MODE BUTTON?
NO
YES
S14
STORE SWITCHING TO APU MODE
STORE SWITCHING TO VEHICLE ENGINE MODE
S17
NO
NO OPERATION INPUT TO OPERATING SYSTEM AND NO LOAD
S15
NO
NO INPUT TO OPERATING SYSTEM?
S18
YES
YES
SWITCH TO STORED POWER MODE
S19

FIG. 6

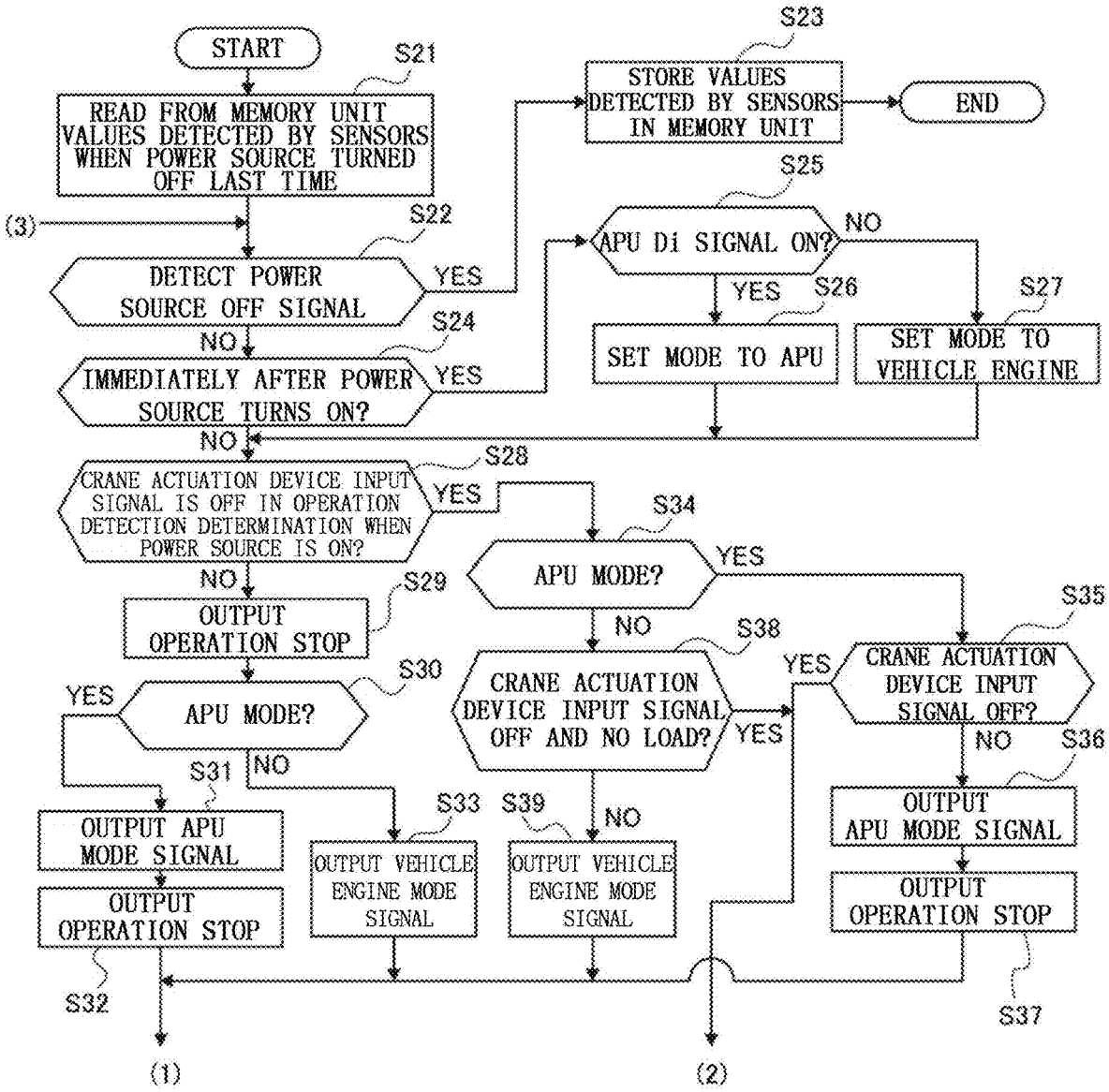
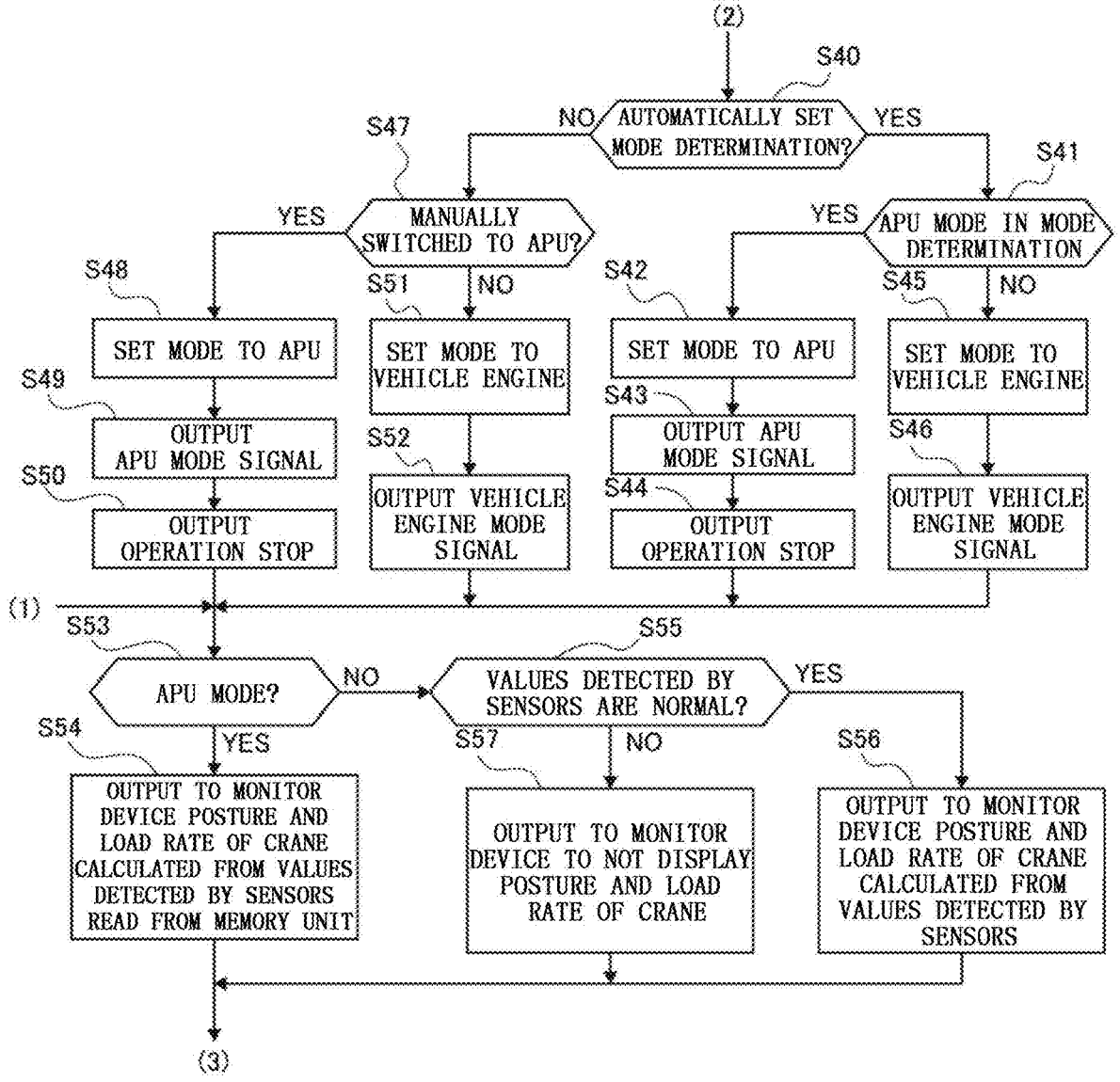

START
S21
READ FROM MEMORY UNIT VALUES DETECTED BY SENSORS WHEN POWER SOURCE TURNED OFF LAST TIME
(3)
S22
DETECT POWER SOURCE OFF SIGNAL
YES
S23
STORE VALUES DETECTED BY SENSORS IN MEMORY UNIT
END
NO
S24
IMMEDIATELY AFTER POWER SOURCE TURNS ON?
YES
S25
APU Di SIGNAL ON?
NO
YES
S26
SET MODE TO APU
S27
SET MODE TO VEHICLE ENGINE
NO
S28
CRANE ACTUATION DEVICE INPUT SIGNAL IS OFF IN OPERATION DETECTION DETERMINATION WHEN POWER SOURCE IS ON?
YES
S34
APU MODE?
YES
NO
S29
OUTPUT OPERATION STOP
S30
YES
APU MODE?
NO
S31
OUTPUT APU MODE SIGNAL
OUTPUT OPERATION STOP
S32
S33
OUTPUT VEHICLE ENGINE MODE SIGNAL
S38
CRANE ACTUATION DEVICE INPUT SIGNAL OFF AND NO LOAD?
YES
S39
NO
OUTPUT VEHICLE ENGINE MODE SIGNAL
S35
YES
CRANE ACTUATION DEVICE INPUT SIGNAL OFF?
NO
S36
OUTPUT APU MODE SIGNAL
OUTPUT OPERATION STOP
S37
(1)
(2)

FIG. 7


(2)
S40
AUTOMATICALLY SET MODE DETERMINATION?
NO
YES
S47
MANUALLY SWITCHED TO APU?
YES
NO
S41
APU MODE IN MODE DETERMINATION
YES
NO
S48
SET MODE TO APU
S51
SET MODE TO VEHICLE ENGINE
S42
SET MODE TO APU
S45
SET MODE TO VEHICLE ENGINE
S49
OUTPUT APU MODE SIGNAL
S52
OUTPUT VEHICLE ENGINE MODE SIGNAL
S43
OUTPUT APU MODE SIGNAL
S46
OUTPUT VEHICLE ENGINE MODE SIGNAL
S50
OUTPUT OPERATION STOP
S44
OUTPUT OPERATION STOP
(1)
S53
APU MODE?
NO
S55
VALUES DETECTED BY SENSORS ARE NORMAL?
YES
S54
YES
S57
NO
S56
OUTPUT TO MONITOR DEVICE POSTURE AND LOAD RATE OF CRANE CALCULATED FROM VALUES DETECTED BY SENSORS READ FROM MEMORY UNIT
OUTPUT TO MONITOR DEVICE TO NOT DISPLAY POSTURE AND LOAD RATE OF CRANE
OUTPUT TO MONITOR DEVICE POSTURE AND LOAD RATE OF CRANE CALCULATED FROM VALUES DETECTED BY SENSORS
(3)

CRANE VEHICLE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is entitled to or claims the benefit of Japanese Patent Application No. 2023-035015, filed on Mar. 7, 2023, the disclosure of which including the specification, drawings and abstract is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to a crane vehicle.

BACKGROUND ART

[0003] A self-propelled crane vehicle, such as a rough terrain crane, has a traveling device, a turn table, and a boom (including a jib) which serves as a crane portion. The traveling device is a vehicle body having equipment for traveling, and has an engine that is the power source for traveling and crane work with a boom, traveling wheels or the like that transmit the power of the engine to the road surface, and outriggers or the like for improving stability during work on the carrier frame which serves as the backbone. The turn table is disposed above the traveling device and is turnable in the horizontal plane with respect to the traveling device. The turn table is driven by an engine installed in the traveling device.

[0004] The boom is installed on the turn table and turns with the turn table with respect to the traveling device. The crane vehicle raises and lowers the load or moves the load to another position by extending and retracting the boom, raising and lowering the boom with respect to the turn table and turning the turn table, and winding up and unwinding the suspended load wire with the winch. The crane vehicle is operated by the operator in the cockpit (cabin) on the turn table, who operates the crane during traveling and operates the crane work with the boom.

[0005] By the way, it is required that a crane vehicle should reduce emissions of greenhouse gases such as carbon dioxide (CO_2) by shutting down the engine when the crane vehicle is not traveling or crane work is not being performed. On the other hand, it is required for the crane vehicle that the air conditioning device (air conditioner) in the cockpit and other accessory power sources (e.g., electric power supplied to the Universal Serial Bus (USB; registered trademark) terminal, etc.) operate for the convenience of the operator, even when the engine is stopped.

[0006] Therefore, it is proposed that the crane vehicle has an auxiliary power unit (APU) separate from the engine installed in the traveling device for traveling and the crane work (hereinafter referred to as "vehicle engine"). The APU mainly provides electric power used in the cockpit during periods when the vehicle engine is stopped. For example, the APU provides electric power for air conditioning in the cockpit and accessory components used in the cockpit, such as monitors and USB (registered trademark) terminals.

[0007] By the way, in a case where power is supplied by the vehicle engine, when the power supply is switched to the APU in a state where the operation for crane work is being performed, i.e., there is some input to the actuator for crane work, the power supplied to the boom and the winch is cut off, which may cause the boom and winch to stop moving abruptly. On the contrary, in a case where the power is supplied by the APU, when the power supply is switched to the vehicle engine in a state where there is some input to the actuator for crane work, the stopped boom or the stopped winch may suddenly start moving.

[0008] Therefore, it is required to prevent changes in the movement of the crane, such as the boom and the winch, when the power to be supplied is switched between the vehicle engine and the APU.

[0009] Here, in an elevating work vehicle that switches between the main power source and the auxiliary power source for use, a control device that regulates manual switching of the power supply by the operator between the main power source and the auxiliary power source by informing the operator of a drop in the power supply voltage has been proposed (see, for example, Patent Literature 1).

CITATION LIST

Patent Literature

[0010] Patent Literature 1: Japanese Patent Application Laid-Open No. 1982-190200

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0011] However, the technology in the Patent Literature 1 only informs the operator of a drop in power supply voltage and does not limit switching between the main power source and the auxiliary power source. The technology in the Patent Literature 1 allows the boom to be moved either by the supply of the main power source or by the supply of the auxiliary power source, and there is no difference in functionality for the boom between the main power source and the auxiliary power source.

[0012] The purpose of the present invention is to provide a crane vehicle that can prevent changes in the movement of the crane, such as the boom and the winch, when the power to be supplied is switched between the vehicle engine and the APU.

Solution to Problem

[0013] One aspect of the crane vehicle according to the present invention includes: a traveling device; a turn table that is disposed above the traveling device and turnable with respect to the traveling device; a boom and a cockpit that are provided on the turn table; a main power unit that is provided in the traveling device and supplies power to the traveling device, the boom and the cockpit; an auxiliary power unit that is provided on the turn table and does not supply power to the traveling device and the boom, but supplies power to the cockpit; and a processor that selectively switches between a main power mode supplied with power from the main power unit and an auxiliary power mode supplied with power from the auxiliary power unit, wherein the processor disables a switching between the main power mode and the auxiliary power mode when an operation input to an operating system that operates the boom is detected, and the processor enables a switching between the main power mode and the auxiliary power mode when an operation input to the operating system is not detected.

Effects of the Invention

[0014] The crane vehicle according to the present invention prevents changes in the movement of the crane, such as the boom and the winch, when the power to be supplied is switched between the vehicle engine and the APU.

BRIEF DESCRIPTION OF DRAWINGS

[0015] FIG. **1** is a diagonal view of a rough terrain crane viewed from the front right;

[0016] FIG. **2** is a diagonal view of the rough terrain crane viewed from the left rear;

[0017] FIG. **3** is a block diagram illustrating the configuration of the power control device provided by the rough terrain crane;

[0018] FIG. **4** is a flowchart illustrating one example of the movement of the power control device in Example 1;

[0019] FIG. **5** is a flowchart illustrating one example of the movement of the power control device in a variation of Example 1;

[0020] FIG. **6** is a flowchart (Part 1) illustrating one example of the movement of the power control device in Example 2; and

[0021] FIG. **7** is a flowchart (Part 2) illustrating one example of the movement of the power control device in Example 2.

DESCRIPTION OF EMBODIMENTS

[0022] Embodiments of the crane vehicle according to the present invention are described below with reference to the drawings. FIG. **1** is a diagonal view of the rough terrain crane **100** viewed from the front right, and FIG. **2** is a diagonal view of the rough terrain crane **100** viewed from the rear left. The rough terrain crane **100** illustrated in the drawings is one embodiment of the crane vehicle according to the present invention.

Overall Configuration of Crane

[0023] A rough terrain crane **100** (hereinafter simply referred to as "crane **100**"), as illustrated in FIG. **1**, has a traveling device **10**, a turn table **20**, a boom **30**, a cockpit (cabin) **40**, and a winch **50**. The crane **100** has a vehicle engine **13** (main power unit) installed in the traveling device **10**, an auxiliary power unit (APU) **80** that is separate from the vehicle engine **13** and serves as another power unit, and a power control device **90**.

[0024] The traveling device **10** is a vehicle body having equipment for traveling on a road or other ground. The traveling device **10** has a carrier frame **11** that serves as the backbone of the vehicle body, a vehicle engine **13**, wheels **14**, outriggers **12**, and the like.

[0025] The vehicle engine **13** is provided at the rear of the carrier frame **11** in the front-back direction L. The vehicle engine **13** is, for example, an internal combustion engine (diesel engine) that generates power using light oil as fuel and provides power to the traveling device **10** for traveling. The vehicle engine **13** supplies power for crane work to the boom **30**, the winch **50**, the turn table **20**, and the outriggers **12**, respectively, via the PTO. When the output to the vent solenoid is turned off, the operation for crane work is stopped by stopping the venting or by outputting to the prounital valve of each crane actuator to relieve it individually.

[0026] The power generated by the vehicle engine **13** is converted into electric power by a generator attached to the vehicle engine **13**, and the electric power is supplied to the electrical systems in the traveling device **10**, the cabin **40**, etc. to operate each of them. The generator of the vehicle engine **13** outputs electric power with a voltage of 48 V, for example.

[0027] The electrical systems in the cabin **40** that are supplied with electric power generated by the generator of the vehicle engine **13** include, for example, an air conditioning device (air conditioner) in the cabin **40**, a monitor device (MFD: multi-function display) that displays the operating status (e.g., boom **30** posture) and load state such as load rate, etc. of the crane work, accessory components such as a USB (registered trademark) terminal to which various devices are connected, a power control device **90**, and various types of sensors that detect the presence or absence of operation inputs to the operating systems installed in the cabin **40** for the crane work.

[0028] The wheels **14** are provided on the left and right of the carrier frame **11** in the vehicle width direction W and on the front and rear of the carrier frame **11** in the front-back direction L, between the front and rear outriggers **12***a*, **12***b*, respectively, which are described below. The wheels **14** transmit the power of the vehicle engine **13** to the ground and rotate, thereby causing the traveling device **10** to travel.

[0029] The outriggers **12** have front outriggers **12***a* near the front wheels **14** and rear outriggers **12***b* near the rear wheels **14**. The outriggers **12** move between the outstretched and retracted states by the power generated by the vehicle engine **13**. Each of the outriggers **12***a* and **12***b* has an outreach amount sensor **15***a* and **15***b* to detect the amount of outreach of each outrigger. The outreach amount sensors **15***a* and **15***b* operate in the vehicle engine mode described below since the outreach amount sensors **15***a* and **15***b* are operated by the electric power supplied from vehicle engine **13**, and do not operate in the APU mode since the outreach amount sensors **15***a* and **15***b* are not supplied with electric power by the APU **80**.

[0030] In the outstretched state, each of the outriggers **12***a* and **12***b* outstretches outward from the carrier frame **11** in the vehicle width direction W and touches the ground to prevent traveling by the wheels **14** and to stabilize the posture of the vehicle body of the crane **100** during crane work in which a suspended load is raised, lowered, or moved by the boom **30**. In the retracted state, each of the outriggers **12***a* and **12***b* retracts inward in the vehicle width direction W and is away from the ground upward to allow traveling by the wheels **14**.

[0031] The turn table **20** is disposed above the carrier frame **11**, approximately in the center of the front-back direction L. The turn table **20** is provided in such a manner that its center of rotation is aligned with the center of the vehicle width direction W of the traveling device **10**, and is provided to be turnable in the horizontal plane around the center of rotation with respect to the traveling device **10**. The turn table **20** turns by being driven by the vehicle engine **13**.

[0032] The boom **30**, the winch **50**, and the cabin **40** are provided on the turn table **20**, and turn in conjunction with the turn table **20** with respect to the traveling device **10**. The boom **30** extends and retracts by extending and retracting the internal extension and retraction cylinders, and raises and lowers by extending and retracting the internal raising and lowering cylinders. The extension and retraction of the

extension and retraction cylinders and the extension and retraction of the raising and lowering cylinders are performed by the power supplied from the vehicle engine **13** via the PTO.

[0033] The winch **50** lowers the hook unit **52** suspended by the wire **51** by unwinding the wound wire **51** and raises the hook unit **52** by winding up the wire **51**. The winding up and unwinding of the wire **51** by the winch **50** is performed by the power supplied from the vehicle engine **13** via the PTO.

[0034] The crane **100** then raises and lowers the load or changes the position of the load by extending and retracting the boom **30**, raising and lowering the boom, winding up or unwinding the wire **51**, and turning the turn table **20** in a state that the load is hung on the hook unit **52**.

[0035] The cabin **40** is provided on the left side in the vehicle width direction W with respect to the boom **30** in the crane **100** of the present embodiment, and may also be provided on the right side with respect to the boom **30**.

APU

[0036] The APU **80** is provided in the turn table **20** or in the cabin **40**, etc., which turns with the turn table **20**. The APU **80** provides power during the period when the vehicle engine **13** is stopped and mainly provides electric power used in the cabin **40**. Since the APU **80** is not connected to the traveling device **10**, the crane **100** cannot be driven to travel by the power of the APU **80**, and since the APU **80** does not have a PTO, the APU **80** does not provide power or electric power for crane work, such as operating the boom **30**, the winch **50** and the turn table **20**.

[0037] The electrical systems in the cabin **40** that are supplied with electric power by the APU **80** include, for example, the air conditioning device in the cabin **40**, a monitor device that displays the operating status (e.g., boom **30** posture) and load state such as load rate, etc. of the crane work, accessory components such as a USB (registered trademark) terminal to which various devices are connected, a power control device **90**, and various types of sensors that detect the presence or absence of operation inputs to the operating systems installed in the cabin **40** for the crane work.

[0038] The APU **80**, as an example, has a main body **81**, electrical system components **82** including a battery and a DC-DC converter, a fuel tank **83**, an APU controller **84**, an evaporator **85**, and a capacitor **86**.

[0039] The main body **81** is a diesel engine as an example, and the main body **81** is not limited to a diesel engine as long as the main body **81** is a power source that generates electric power. In addition to the diesel engine, the main body **81** may be a storage battery, specifically, or a power receiving output unit that receives and outputs electric power from an external source. The diesel engine (sub-engine) as the main body **81** is more compact than the vehicle engine **13**, consumes less fuel (e.g., fuel consumption per unit output) than the vehicle engine **13**, and is more efficient in fuel consumption (more fuel efficient) than the vehicle engine **13**. Thus, the APU **80** reduces fuel consumption and carbon dioxide emissions as compared to the vehicle engine **13**.

[0040] A fuel tank **83** is a tank that stores fuel to drive the sub-engine. Therefore, in a case where the main body **81** is not an internal combustion engine, such as a diesel engine, and does not require fuel, the APU **80** does not have the fuel tank **83**. The crane **100** also has a tank storing fuel to drive the vehicle engine **13**, separate from the fuel tank **83**, in the traveling device **10**. Therefore, even in a case where the APU **80** supplies fuel from the fuel tank provided in the traveling device **10** to the sub-engine to drive the sub-engine, the APU **80** does not have the fuel tank **83**.

[0041] The battery in the electrical system components **82** starts the sub-engine, and is charged with and stores the electricity generated while the sub-engine is being driven. The DC-DC converter in the electrical system components **82** boosts the voltage of the electric power generated by the sub-engine to the voltage of the electric power generated by the generator of the vehicle engine **13**.

[0042] The voltage of the electric power generated by the generator of vehicle engine **13** is set to 24 [V] as an example, and therefore, the electrical systems in the cabin **40**, such as the air conditioning device, the monitor device, the power control device, and the USB (registered trademark) power supply, are set to operate at a voltage of 24 [V]. On the other hand, the voltage of the electric power generated by the sub-engine is set to 12 [V] as an example.

[0043] Therefore, the DC-DC converter in the electrical system components **82** boosts the voltage of the electric power generated by the generator of the sub-engine to the voltage of 24 [V] of the electric power generated by the generator of the vehicle engine **13** in order to use this voltage of 12 [V] in the electrical equipment installed in the cabin **40**. Therefore, in a case where the voltage of the electric power generated by the generator of the sub-engine is the same as the voltage of the electric power generated by the generator of vehicle engine **13**, the APU **80** does not have the DC-DC converter in the electrical system components **82**.

[0044] The APU controller **84**, the evaporator **85**, and the condenser **86** provide air conditioning in the cabin **40**, powered by the sub-engine. A separate air conditioning device in the cabin **40** is powered by the vehicle engine **13**. In other words, the crane **100** has two air conditioning devices: an air conditioning device (main air conditioner) powered by the vehicle engine **13** in the traveling device **10** and an air conditioning device (sub-air conditioner; APU controller **84**, evaporator **85** and capacitor **86**) powered by the sub-engine.

[0045] The air conditioning device for the cabin **40** is then selected as the main air conditioner in the vehicle engine mode, where the vehicle engine **13** is driven, and is selected as the sub air conditioner in the APU mode, where the APU **80** is driven. The air conditioning in the cabin **40** is then performed by the selected air conditioning device.

[0046] In the present embodiment, the APU controller **84**, the evaporator **85**, and the capacitor **86**, which are not the main components of the APU **80** are disposed on the left side with respect to the boom **30**, the same as the cabin **40**.

[0047] The APU controller **84**, the evaporator **85**, and the condenser **86** are preferably disposed close to the cabin **40** to perform air conditioning inside the cabin **40**, as described above. In particular, the evaporator **85** is disposed inside the cabin **40** since the evaporator **85** is a heat exchanger in the cabin **40**. The APU controller **84** is disposed inside the cabin **40**, the same as the evaporator **85**, since the APU controller **84** includes electronic components and is required not to be exposed to water, such as rain or snow, and to the outside air, which is at a higher temperature. The condenser **86** is disposed outside the cabin **40** to perform the heat exchange which is the opposite of the heat exchange required inside the cabin **40**.

[0048] The APU controller **84** performs control of the operation of the sub air conditioner, control of the drive of the main body **81**, control of the drive of the pump of the fuel tank **83**, control of the operation of the electrical system components (DC-DC converter, battery) **82**, control of the operation of the monitor device, and control of the electric power supply to accessory components such as the USB (registered trademark) terminal installed inside the cabin **40** (accessory power supply). The APU controller **84** is a hardware processor such as a central processing unit (CPU) that performs the various controls described above.

EXAMPLE 1

Power Control Device

[0049] FIG. **3** is a block diagram illustrating the configuration of the power control device **90** of Example 1 in which the crane **100** illustrated in FIGS. **1** and **2** is included, and FIG. **4** is a flowchart illustrating one example of the operation of the power control device **90** of Example 1.

[0050] The power control device **90** of Example 1 performs control on the crane **100** by selectively switching between supplying power by the vehicle engine **13** and supplying power by the APU **80**. The power control device **90** has an operation detection unit **91**, an operation presence/absence determination unit **92**, a power switching unit **93**, and a memory unit **94**, as illustrated in FIG. **3**. The functions of the power control device **90** are realized, for example, by a computer. The operation detection unit **91**, the operation presence/absence determination unit **92**, and the power switching unit **93** are hardware processors, such as a CPU, and the memory unit **94** is a memory such as a read only memory (ROM) and a random access memory (RAM).

[0051] The power control device **90** operates with electric power supply from the vehicle engine **13** in the vehicle engine mode or with electric power supply from the APU in the APU mode. The power control device **90** performs calculations of the load state of the crane **100**, as well as other operations described below.

[0052] The power control device **90** is provided in the cabin **40**. The monitor device is provided in the cabin **40**. The monitor device is a touch panel type, for example, and when an operator touches a button icon displayed on the monitor device, the function set for that icon is executed.

[0053] In addition to the operating status (e.g., boom **30** posture) and load state of the crane work described above, the monitor device displays an icon for the vehicle engine mode button indicating the vehicle engine mode (main power mode) and an icon for the APU mode button indicating the APU mode (auxiliary power mode). The icon for the vehicle engine mode button is the switch corresponding to the vehicle engine mode, and the icon for the APU mode button is the switch corresponding to the APU mode.

[0054] The switch corresponding to the vehicle engine mode or the APU mode is not limited to the icon for the vehicle engine mode button or the icon for the APU mode button displayed on the monitor device, and can also be a mechanical switch that physically switches on and off. The mechanical switch may be a single switch that selectively switches between the vehicle engine mode and the APU mode, instead of two separate switches, one to turn the vehicle engine mode on and off and one to turn the APU mode on and off.

[0055] The vehicle engine mode is a power mode that drives the vehicle engine **13** and supplies power or electric power generated by the vehicle engine **13** to the crane **100**, and the APU mode is a power mode that drives the APU **80** and supplies power or electric power generated by the APU **80** to the crane **100**.

[0056] The vehicle engine mode not only can supply electric power to the cabin **40**, but also can allow the traveling device **10** to drive the crane **100** to travel and perform crane work that operates the boom **30** or the winch **50**. On the other hand, the APU mode can supply electric power to the cabin **40**, but cannot drive the crane **100** to travel or perform crane work.

[0057] When the icon for the vehicle engine mode button is touched (vehicle engine mode is selected as the power mode), the power control device **90** switches the power supplied to the crane **100** to power supplied by the vehicle engine **13** according to predetermined conditions, and when the icon for the APU mode button is touched (APU mode is selected as the power mode), the power control device **90** switches the power supplied to the crane **100** to power supplied by the APU **80** according to the predetermined conditions. The predetermined conditions are, for example, that there is no input to the operating system for crane work, which is described below.

[0058] The operation detection unit **91** of the power control device **90** detects the presence or absence of an input to the operating system for crane work. The operating system for crane work includes, for example, a raising and lowering operation lever that operates the raising and lowering movement of the boom **30**, an extension and retraction operation lever that operates the extension and retraction movement of the boom **30**, a winch operation lever that operates the unwinding movement and the winding up movement of the winch **50**, and operation pedals that operate the movement speed of each movement corresponding to each of these operation levers.

[0059] Therefore, the operation detection unit **91** detects the presence or absence of an operation input to the raising and lowering operation lever or the raising and lowering operation pedal to perform the raising and lowering movement and to adjust the speed of the raising and lowering movement, detects the presence or absence of an operation input to the extension and retraction operation lever or the extension and retraction operation pedal to perform the extension and retraction movement and to adjust the speed of the extension and retraction movement, detects the presence or absence of an operation input to the winch operation lever to perform the unwinding or winding up movement of the wire **51** and to adjust the speed of that movement, and detects the presence or absence of an operation input to the turning lever to perform a turning movement of the turn table **20** and to adjust the speed of the turning movement.

[0060] The operation detection unit **91** may detect the presence or absence of an operation input to these operating systems by acquiring an output signal from a detection sensor provided in advance in the respective operating system, or the detection sensor provided in advance in the respective the operating system may be used as the operation detection unit **91**.

[0061] The operation presence/absence determination unit **92** of the power control device **90** determines whether the detection result of the operation detection unit **91** indicates that there is no input for all operating systems, or whether

there is an input for at least one of all operating systems, and outputs the result. In a case where there is no input for all operating systems, there is no operation input to all of the raising and lowering operation lever, the raising and lowering operation pedal, the extension and retraction operation lever, the extension and retraction operation pedal, the winch operation lever, the winch operation pedal, and the turning lever.

[0062] On the other hand, in a case where there is an input for any one of all operating systems, there is an operation input for at least one of the raising and lowering operation lever, the raising and lowering operation pedal, the extension and retraction operation lever, the extension and retraction operation pedal, the winch operation lever, the winch operation pedal and the turning lever.

[0063] The power switching unit **93** of the power control device **90** can switch from the vehicle engine mode to the APU mode or from the APU mode to the vehicle engine mode when the operation presence/absence determination unit **92** determines that there is no operation input to all operating systems.

[0064] The power switching unit **93** stops the vehicle engine **13** that is being driven and drives the APU **80** that is stopped in such a manner that in the vehicle engine mode supplied with power by the vehicle engine **13**, when the APU mode button on the monitor device is touched, the power switching unit **93** actually switches from the vehicle engine mode to the APU mode in a state that allows switching from the vehicle engine mode to the APU mode, as described above.

[0065] The power switching unit **93** stops the APU **80** that is being driven and drives the vehicle engine **13** that is stopped in such a manner that in the vehicle engine mode supplied with power by the APU **80**, when the vehicle engine mode button on the monitor device is touched, the power switching unit **93** actually switches from the APU mode to the vehicle engine mode in a state that allows switching from the APU mode to the vehicle engine mode, as described above.

[0066] On the other hand, the power switching unit **93** of the power control device **90** mutually prevents switching of the power mode between the vehicle engine mode and the APU mode when the operating system input is determined to be present by the operation presence/absence determination unit **92**.

[0067] Therefore, when the power switching unit **93** prevents switching of the power mode, even when the APU mode button on the monitor device is touched or the vehicle engine mode button is touched, switching of the power mode is disabled and the vehicle continues to be driven in the current power mode.

[0068] The memory unit **94** stores the outreach amount of each outrigger **12***a* and **12***b* detected by the outreach amount sensors **15***a* and **15***b* in the vehicle engine mode.

[0069] The operation of the power control device **90** described above is illustrated with reference to the flowchart illustrated in FIG. **4**.

[0070] The crane **100** starts when the vehicle engine mode or APU mode is selected and a power source is turned on. In this process of starting the crane **100**, either the vehicle engine **13** is driven and a power source is turned on by the power supply from the vehicle engine **13** in the vehicle engine mode, or the APU **80** is driven and a power source is turned on by the power supply from the APU **80** in the APU mode. The supply of power by the vehicle engine **13** or by the APU **80** supplies electric power to the power control device **90**, thereby activating the power control device **90**.

[0071] At the beginning after the start when the power source is turned on, the operation detection unit **91** detects the presence or absence of the input to the operating system described above (S**1** in FIG. **4**). In other words, the power control device **90** checks that the operating system of the crane work is not in an operating state that allows the crane work to be performed when the crane **100** is started.

[0072] As a result of the detection by the operation detection unit **91**, when the operation presence/absence determination unit **92** determines that there is no operation input to all operating systems (YES in S**1**), the power switching unit **93** controls to drive (supply power) in the initially selected power mode (vehicle engine mode or APU mode) (S**2**). When the power switching unit **93** switches to supply power in the vehicle engine mode, crane work is possible as long as the PTO is turned on and the PTO is connected to the vehicle engine **13**.

[0073] On the other hand, as a result of the detection by the operation detection unit **91**, when the operation presence/absence determination unit **92** determines that there is an operation input to one of the operating systems (NO in S**1**), the power switching unit **93** does not control to drive (supply power) in the initially selected power mode (vehicle engine mode or APU mode), but instead stands by until it is determined that there is no operation input to all operating systems (process of S**1** is repeated). At this time, the power control device **90** simultaneously turns off the output to the vent solenoid to stop venting orthe power control device **90** outputs to the prounital valves of each crane actuator to relieve them individually, so that the movements of the boom **30**, the winch **50** and the turn table **20** for crane work are stopped (operation stop output).

[0074] Subsequently, when there is no more operation input to all operating systems (YES in S**1**), the power switching unit **93** controls to drive (supply power) in the initially selected power mode (vehicle engine mode or APU mode) (S**2**).

[0075] After running in the selected power mode (vehicle engine mode or APU mode), the power switching unit **93** stands by for detection (S**3**) of a touch operation on the APU mode button on the monitor device for switching to the APU mode or for detection (S**5**) of a touch operation on the vehicle engine mode button on the monitor device for switching to the vehicle engine mode.

[0076] When neither touch operation to the APU mode button nor touch operation to the vehicle engine mode button is detected (NO in S**3** and NO in S**5**), the power switching unit **93** continues the power mode that is being driven in S**2**.

[0077] The power switching unit **93** detects touch operation on the APU mode button (YES in S**3**) and stores the switching that is to the APU mode (S**4**). At the time of the process of S**4**, the switch to the APU mode is not performed. The power switching unit **93** detects touch operation on the vehicle engine mode button (YES in S**5**) and stores the switching that is to the vehicle engine mode (S**6**). At the time of the process of S**6**, the switch to vehicle engine mode is not performed.

[0078] After storing the switch that is to the APU mode in the process of S**4** or after storing the switch that is to the

vehicle engine mode in the process of S6, the operation detection unit **91** acquires the presence or absence of an operation input to the operating system, as in the process of S1 (S7).

[0079] As a result of the detection by the operation detection unit **91**, when the operation presence/absence determination unit **92** determines that there is no operation input to all operating systems (YES in S7), the determination result is output to the power switching unit **93**. On the other hand, as a result of the detection by the operation detection unit **91**, when the operation presence/absence determination unit **92** determines that there is an operation input to one of the operating systems (NO in S7), the operation presence/absence determination unit **92** stands by until there is no operation input to all operating systems (S7).

[0080] When the power switching unit **93** receives a determination result from the operation presence/absence determination unit **92** that there is no operation input to all operating systems (YES in S7), the power switching unit **93** switches the power mode to the APU mode in accordance with the storage of switching to the APU mode stored in the process of S4 (S8) or the memory of switching to the vehicle engine mode stored in the process of S6 (S9), or switches the power mode to the vehicle engine mode in accordance with the storage of switching to the vehicle engine mode stored in the process of S6 (S8). After switching the power mode, the power switching unit **93** returns to the process of S3 and the process of S5, and stands by for a touch operation on the APU mode button or the vehicle engine mode button.

[0081] On the other hand, until the power switching unit **93** receives a determination result (YES in S7) from the operation presence/absence determination unit **92** that there is no operation input to all operating systems, the power switching unit **93** continues to drive in the original power mode without switching the power mode regardless of the storage of switching to the APU mode stored in the process of S4 or the storage of switching to the vehicle engine mode stored in the process of S6.

[0082] Thus, according to the crane **100** of Example 1, a condition for switching the power supplied to the crane **100** between the vehicle engine **13** and the APU **80** is that there is no operation input to all operating systems for crane work, such as the boom **30** or the winch **50**.

[0083] Thus, the crane **100** prevents, for example, the boom **30** or the winch **50**, which has been operating in the vehicle engine mode, from stopping suddenly when the power supply is cut off at the moment of switching to the APU mode.

[0084] In a case where the boom **30** or the winch **50**, which has been moving by crane work, suddenly stops, the load suspended by the crane work may swing greatly due to inertia.

[0085] However, the crane **100** of Example 1 does not switch from the vehicle engine mode to the APU mode when the boom **30** or the winch **50** is operating (when there is an operation input in the operating system), so the boom **30** or the winch **50** does not stop suddenly, and therefore, it is possible to prevent the occurrence of a situation in which the suspended load swings greatly.

[0086] The crane **100** also prevents the boom **30** or the winch **50** that are stopped in the APU mode from suddenly starting to move due to the switch to the vehicle engine mode and the supply of power.

[0087] In other words, in the APU mode, since power for crane work is not supplied to the boom **30** or the winch **50**, even when there is an operation input to the operating system for crane work, the boom **30** or the winch **50** will not operate. Therefore, in the APU mode, even when there is an operation input to the operating system for crane work, it is not noticed by the operator.

[0088] When the operator switches the power mode to the vehicle engine mode without noticing that there is an operation input to the operating system, the boom **30** or the winch **50**, which has been stopped in the APU mode, are supplied with power at the moment of switching to the vehicle engine mode, and the boom **30** or the winch **50** may suddenly start moving according to the operation input to the operating system.

[0089] However, the crane **100** of Example 1 does not switch from the APU mode to the vehicle engine mode when there is an operation input to the operating system that operates the boom **30** or winch **50**, so it is possible to prevent the boom **30** or the winch **50** from suddenly starting to move without the operator's intention.

[0090] In the crane **100** of Example 1, during the period when the power control device **90** switches the power mode to the vehicle engine mode, the electric power generated by the vehicle engine **13** allows the outreach amount sensors **15***a* and **15***b* to detect the outreach amount of the outriggers **12***a* and **12***b* in real time. Therefore, when the crane **100** is in the vehicle engine mode, based on the outreach amount of the outriggers **12***a* and **12***b* detected in real time by the outreach amount sensors **15***a* and **15***b*, the control device of the crane **100** (not illustrated) can calculate the operating status (e.g., boom **30** posture) and load rate, etc. of the crane **100**, and can display the load state, etc., on the monitor device.

[0091] On the other hand, in the crane **100**, during the period when the power control device **90** switches the power mode to the APU mode, the outreach amount sensors **15***a* and **15***b* are not supplied with electric power, so the outreach amount of the outriggers **12***a* and **12***b* cannot be detected in real time. However, the memory unit **94** of the power control device **90** stores the outreach amount of the outriggers **12***a* and **12***b* detected by the outreach amount sensors **15***a* and **15***b* during the period of the vehicle engine mode, immediately prior to the switch to APU mode.

[0092] Therefore, when the crane **100** is in the APU mode, based on the outreach amount of the outriggers **12***a* and **12***b* stored in the memory unit **94**, the APU controller **84** can calculate the operating status (boom **30** posture, etc.) and load rate, etc. of the crane **100**, and can display the load state, etc. on the monitor device.

[0093] The load state of the crane **100**, etc. calculated by the APU controller **84** is not based on the detection values detected in real time from the outreach amount sensors **15***a* and **15***b*, and in the APU mode, the outriggers **12** do not operate. Therefore, the outriggers **12** remain the same in the outreach amount from when the outriggers **12** are operating in the vehicle engine mode immediately prior to the switch to the APU mode.

[0094] Therefore, in the APU mode, the load state, etc. of the crane **100** calculated based on the outreach amount of outriggers **12***a* and **12***b* stored in the memory unit **94** is not inferior in accuracy to that calculated based on the outreach amount detected in real time.

[0095] To calculate the load state, etc. of the crane **100**, in addition to the outreach amount of the outriggers **12** described above, data such as the extension/retraction length and the raising and lowering angle of the boom **30**, the turning angle of the turn table **20**, and the load of the suspended load on the wire **51** of the winch **50** are also required, and these data can be obtained in real time by the APU controller **84** in the APU mode.

Variation of Example 1

[0096] FIG. **5** is a flowchart illustrating one example of the operation of the power control device **90** of a variation of Example 1 in which the crane **100** illustrated in FIGS. **1** and **2** is included. The power control device **90** of Example 1 prevents mutually switching of the power mode between the vehicle engine mode and the APU mode when an operation input is detected for at least one of the operating systems.

[0097] In contrast, the flowchart of the variation of the power control device **90** illustrated in FIG. **5** adds, as a predetermined condition for switching from the vehicle engine mode to the APU mode, that there is no load from a suspended load on the wire **51** of the winch **50**, i.e., that no load is being suspended by the hook unit **52** to the condition that no operation input is detected for all operating systems. The above additional condition in this variation of the power control device **90** is not included in the predetermined conditions for switching from the APU mode to the vehicle engine mode.

[0098] That there is no load on the wire **51** of the winch **50** can be detected, for example, by performing a calculation to convert the reaction force by the operation detection unit **91** based on the detection results from sensors that detect the boom length and the boom angle respectively, the number of hooks on the wire **51** set by the operator's inputting on the monitor device (MFD), and the detection results from sensors that detect the internal pressure of the raising and lowering cylinders.

[0099] The operation detection portion **91** handles the detection that there is no load on the wire **51** of the winch **50** in the same way as the operation detection portion **91** handles the detection that there is no operation input to other operating systems, and on the other hand, the operation detection portion **91** handles detection that there is a load on the wire **51** of the winch **50** in the same way as the operation detection portion **91** handles the detection that there is an operation input to other operating systems, so that the operation presence/absence determination portion **92** determines the presence or absence of operation.

[0100] The operation of the power control device **90** in the above described variation is illustrated in the flowchart in FIG. **5**. The processes from S**11** to S**14** in the flowchart in FIG. **5** are the same processes corresponding to the processes from S**1** to S**4** in the flowchart in FIG. **4**, and the processes from S**16** to S**19** in the flowchart in FIG. **5** are the same processes corresponding to the processes from S**5** to S**8** in the flowchart in FIG. **4**. Therefore, the description is omitted.

[0101] On the other hand, as described above, as a predetermined condition that the power switching portion **93** switches from the vehicle engine mode to the APU mode, the process of S**15** in FIG. **5** determines the detection by the operation presence/absence determination portion **92** that there is no operation input to all operating systems and the detection by the operation presence/absence determination portion **92** that there is no load on the wire **51** of the winch **50**, instead of the process of S**7** in FIG. **4**.

[0102] In the process of S**15**, in a case where the determination result is that no operation input is detected for all operating systems and there is no load on the wire **51** of the winch **50** (YES in S**15**), the power switching unit **93** performs the process of switching from the vehicle engine mode to the APU mode (S**19**), and in the process of S**15**, in a case where an operation input is detected for the operating system or the determination result (NO in S**15**) is that there is no load on the wire **51** of the winch **50**, the power switching unit **93** does not switch the power mode, and the original vehicle engine mode continues.

[0103] Thus, even in a case where the stroke holding function of the cylinder is impaired by an internal leak due to damage to the piston seal in the raising and lowering cylinders or the extension and retraction cylinders of the boom **30**, the crane **100** of variation can prevent the power mode from being switched to the APU mode by adding to the predetermined conditions that there is no load on the wire **51** of the winch **50** as a predetermined condition for switching from the vehicle engine mode to the APU mode.

[0104] In other words, in the vehicle engine mode, power can be provided to the winch **50** to raise and lower the wire **51**. Thus, even in a case where the crane **100** falls into a situation where the stroke holding function of the raising and lowering cylinders or the extension and retraction cylinders of the boom **30** is impaired and the boom **30** starts to go down or shorten, it is possible to reduce the load state of the crane **100** by quickly landing the suspended load by unrolling the wire **51**. In contrast, the crane **100** can also wind up the wire **51** to prevent the suspended load from landing or slow the speed of landing to suppress the impact applied to the suspended load.

EXAMPLE 2

[0105] FIG. **6** is a flowchart (Part 1) illustrating the operation of the power control device **90** in Example 2 in which the crane **100** illustrated in FIGS. **1** and **2** is included, and FIG. **7** is a flowchart (Part 2) illustrating the operation of the power control device **90** in Example 2.

[0106] The power control device **90** in Example 1 allows the operator to manually select either the vehicle engine mode or the APU mode, and switches to the manually selected power mode when specified conditions are met.

[0107] In contrast, the power control device **90** of Example 2 has two power modes that can be selected by the operator: vehicle engine mode and APU mode, as in Example 1, and in addition to manual switching, the power control device **90** of Example 2 also has an automatic switching mode that automatically switches to APU mode when specific conditions are met in the vehicle engine mode. The automatic switching mode is selectable on the monitor device as an icon for the automatic switching mode button, similar to the manual switching vehicle engine mode and the manual switching APU mode.

[0108] In other words, the monitor device displays three selectable switches: an icon for the vehicle engine mode button for manual switching, an icon for the APU mode button for manual switching, and an icon for the automatic switching mode button for automatic switching.

[0109] When the automatic switching mode is selected by touching the icon for the automatic switching mode button, the power control device **90** controls the switching of the

power mode from the vehicle engine mode to the APU mode when specific conditions are met. Here, the specific conditions are, for example, that the operating system for crane work continues for a certain period of time (e.g., 20 minutes or more) without any operation input. The specific conditions are not limited to that the operating system for crane work continues for a certain period of time (e.g., 20 minutes or more) without any operation input, and other conditions may be applied.

[0110] In the automatic switching mode, the power control device **90** does not unconditionally switch from the vehicle engine mode to the APU mode when the specific conditions described above are met, but, as in the case of Embodiment 1 and the variation, a precondition is that the predetermined condition of no operation input to all operating systems is met.

[0111] In the crane vehicle according to the present invention, the specific conditions in which the automatic switching mode switches the power mode from the vehicle engine mode to the APU mode are not limited to the case where the above-described no-operation condition continues for a certain period of time.

[0112] The power control device **90** in the crane **100** of Example 2 configured in this manner performs processes as illustrated in the flowcharts in FIGS. **6** and **7**.

[0113] The crane **100** of the second embodiment first turns on the power source by the vehicle engine mode or the APU mode (START). At this stage, the crane **100** is supplied with electric power only for the process of setting the power mode, either in the vehicle engine mode or in the APU mode. In the vehicle engine mode, the vehicle engine **13** provides power, and when the PTO is connected to the vehicle engine **13**, also provides power for crane work.

[0114] After the power source is turned on, the power control device **90** reads the values which is detected by the outreach amount sensors **15***a* and **15***b* of the outriggers **12**, and have been stored in the memory unit **94** when the power source was turned off the last time (S**21**).

[0115] Next, the power control device **90** detects whether the power source has been turned off (S**22**). When the power control device **90** detects that the power source has been turned off (YES in S**22**), the power control device **90** stores the values detected by the outreach amount sensors **15***a* and **15***b* in the memory unit **94** (S**23**), the power control device **90** turns off the power source and ends the process (END).

[0116] When the power control device **90** does not detect that the power source has been turned off (NO in S**22**), the power control device **90** determines whether or not the power source has immediately been turned on (S**24**). When the power control device **90** performs this determination for the first time after the power source is turned on, the power control device **90** determines that it is immediately after the power source is turned on (YES in S**24**), and when the power control device **90** performs this determination for the second time after the power source is turned on, the power control device **90** determines that it is not immediately after the power source is turned on (NO in S**24**).

[0117] When the power control device **90** determines that the power source has immediately been turned on (YES in S**24**), the power control device **90** determines whether or not the first power source is turned on in APU mode (S**25**). When the power control device **90** determines that the first power source is turned on in APU mode (YES in S**25**), the power control device **90** sets the power mode to APU mode (S**26**). At this time, the power control device **90** only stores that it is the APU mode and does not supply power in the APU mode.

[0118] On the other hand, when the power control device **90** determines that the first power source is not turned on in APU mode (NO in S**25**), the power control device **90** sets the power mode to vehicle engine mode (S**27**). At this time, the power control device **90** only stores that it is the vehicle engine mode and does not provide actual power in the vehicle engine mode.

[0119] When the power control device **90** determines in the process of S**24** that the power source has not been turned on immediately (NO in S**24**) and sets the power mode by the process of S**26** or the process of S**27**, the operation detection unit **91** of the power control device **90** then determines whether or not there is no operation input to the operating system for crane work (crane actuation device input signal OFF) (S**28**).

[0120] When the power control device **90** determines that there is an operation input to the operating system (NO in S**28**), the power control device **90** forcibly turns off the operation input to the operating system and enters a state where there is no operation input to the operating system (S**29**). Thereafter, the power control device **90** determines whether or not the power mode stored in the process of S**26** or the process of S**27** is the APU mode (S**30**).

[0121] When the power mode stored by the power control device **90** is the APU mode according to the process of S**26** (YES in S**30**), the power switching unit **93** of the power control device **90** outputs the APU mode signal to start supplying mechanical power and electric power by the APU **80** to start the APU mode (S**31**). The power control device **90** then forcibly sets the operation input to the operating system to turn off (S**32**). Thereafter, the power control device **90** proceeds to the process of S**53** illustrated in FIG. **7**.

[0122] Here, the power control device **90** forcibly sets the operation input to the operating system to turn off (S**32**), but this process of forcibly turning off the operation input to the operating system is a process to disable the actual crane work operation in the APU mode, even when there is an operation to the operating system, and is not a process for the condition to switch the power mode to the APU mode.

[0123] The process of S**37**, the process of S**44**, and the process of S**50** described below, in which the power control device **90** forcibly sets the operation input to the operating system to turn off, are also performed for the same reason as the process of S**32**, and are not processes for the condition of switching the power mode to APU mode.

[0124] When the power mode stored by the power control device **90** is the vehicle engine mode according to the process of S**27** (NO in S**30**), the power switching unit **93** of the power control device **90** outputs a vehicle engine mode signal to start supplying mechanical power and electric power by the vehicle engine **13** to start the vehicle engine mode (S**33**). Thereafter, the power control device **90** proceeds to the process of S**53** illustrated in FIG. **7**.

[0125] When the power control device **90** determines in the process of S**28** that there is no operation input to the operating system (YES in S**28**), the power control device **90** determines whether the power mode stored in the process of S**26** or the process of S**27** is the APU mode (S**34**).

[0126] When the power mode stored by the power control device **90** is the APU mode by the process of S**26** (YES in

S34), the power control device **90** determines whether or not there is an operation input to the operating system for crane work (crane actuator input signal OFF) (S35).

[0127] When the power control device **90** determines that there is an operation input to the operating system (NO in S35), the power switching unit **93** of the power control device **90** outputs an APU mode signal to start supplying mechanical power and electric power by the APU **80** to start the APU mode (S36). The power control device **90** then forcibly sets the operation input to the operating system to turn off (S37) and proceeds to the process of S53 described later in FIG. **7**.

[0128] When the power control device **90** determines that there is no operation input to the operating system (YES in S35), the power control device **90** proceeds to the process of S40 described later in FIG. **7**, which is the determination process of the automatic switching mode.

[0129] In the process of S34, when the power mode stored by the power control device **90** is the vehicle engine mode by the process of S27 (NO in S34), it is determined whether or not there is no operation input to the operating system for crane work and there is no load on the wire **51** (crane operating system input signal OFF and no load) (S38).

[0130] When the power control device **90** determines that there is no operation input to the operating system or no load (NO in S38), the power switching unit **93** of the power control device **90** outputs a vehicle engine mode signal to start supplying mechanical power and electric power by the vehicle engine **13** to start the vehicle engine mode (S39), and proceeds to the process of S53 described later in FIG. **7**.

[0131] When the power control device **90** determines that there is no operation input to the operating system and no load (YES in S38), the power control device **90** proceeds to the S40 process described later in FIG. **7**, which is the determination process of the automatic switching mode.

[0132] When the power control device **90** determines that there is no operation input to the operating system (YES in S35) in the APU mode (YES in S34), or when the power control device **90** determines that there is no operation input to the operating system and no load (YES in S38) in the vehicle engine mode (NO in S34), the power control device **90** proceeds to the process of S40 illustrated in FIG. **7**.

[0133] Here, processes after S40 (processes in which the number of S is 40 or more) indicate the operation when the power mode is switched from the power mode at the time the power source is first turned on to the other power mode. In other words, the processes after S40 are processes in a case where the operator touches one of the vehicle engine mode button, the APU mode button, or the automatic switching mode button displayed on the monitor device.

[0134] First, the power control device **90** determines whether the automatic switching mode button is selected among the three power mode buttons displayed on the monitor device (S40).

[0135] When the power control device **90** determines that the automatic switching mode button has been selected (automatic mode determination setting) (YES in S40), the power control device **90** determines whether the switching by automatic switching mode should be set to the APU mode that meets the specific conditions (S41).

[0136] When the power switching unit **93** of the power control device **90** determines that the switching should be set to the APU mode (YES in S41), the power switching unit **93** sets the power mode to the APU mode (S42). At this time, the power control device **90** only stores that it is the APU mode and does not switch to the APU mode.

[0137] Thereafter, the power switching unit **93** of the power control device **90** corresponds the power mode to the stored APU mode and outputs an APU mode signal to start supplying mechanical power and electric power by the APU **80** to start the APU mode (S43). The power control device **90** then forcibly sets the operation input to the operating system to turn off (S44). Thereafter, the power control device **90** proceeds to the process of S53.

[0138] When the power switching unit **93** of the power control device **90** determines that the power mode should not be set to APU mode because the specific conditions are not met (NO in S41), the power switching unit **93** sets the power mode to the vehicle engine mode (S45). At this time, the power control device **90** only stores that it is the vehicle engine mode and does not switch to vehicle engine mode.

[0139] Thereafter, the power switching unit **93** of the power control device **90** corresponds the power mode to the stored vehicle engine mode and outputs a vehicle engine mode signal to start supplying mechanical power and electric power by the vehicle engine **13** to start the vehicle engine mode (S46). Thereafter, the power control device **90** proceeds to the process of S53.

[0140] When the power control device **90** determines in the process of S40 that the automatic switching mode button is not selected (NO in S40), the power control device **90** further determines whether the APU mode button is selected (manually switched to APU) (S47).

[0141] When the power switching unit **93** of the power control device **90** determines in the process of S47 that the APU mode button is selected (YES in S47), the power switching unit **93** sets the power mode to the APU mode (S48). At this time, the power control device **90** only stores that it is the APU mode and does not switch to the APU mode.

[0142] Thereafter, the power switching unit **93** of the power control device **90** outputs an APU mode signal to start supplying mechanical power and electric power by the APU **80**, corresponding to the stored APU mode, to start the APU mode (S49). The power control device **90** then forcibly sets the operation input to the operating system to turn off (S50). The condition for the power switching unit **93** of the power control device **90** to switch the power mode to the APU mode, i.e., no operation input to the operating system, is met by the process of S35 or the process of S38. Thereafter, the power control device **90** proceeds to the process of S53.

[0143] When the power switching unit **93** of the power control device **90** determines in the process of S47 that the vehicle engine mode button is selected (NO in S47), the power switching unit **93** sets the power mode to the vehicle engine mode (S51). At this time, the power control device **90** only stores that it is the vehicle engine mode and does not switch to vehicle engine mode.

[0144] Thereafter, the power switching unit **93** of the power control device **90** corresponds the power mode to the stored vehicle engine mode and outputs a vehicle engine mode signal to start supplying mechanical power and electric power by the vehicle engine **13** to start the vehicle engine mode (S52). Thereafter, the power control device **90** proceeds to the process of S53.

[0145] The power control device **90** determines in the process of S53 whether or not the current power mode is the APU mode. When the power control device **90** determines

that the power mode is the APU mode (YES in S53), the power control device **90** reads from the memory unit **94** the values detected by the outreach amount sensors **15***a* and **15***b* of the outriggers **12** that are stored in the memory unit **94** immediately before the switch from the vehicle engine mode to the APU mode, calculates the operating status (e.g., boom **30** posture) and load state such as load rate of the crane **100** based on the read values, and outputs the calculated results to the monitor device (S54). Thereafter, the power control device **90** returns to the process of S22.

[0146] When the power control device **90** determines in the process of S53 that the current power mode is not the APU mode (NO in S53), since the power mode is the vehicle engine mode, the power control device **90** determines whether or not the real-time outreach amount sensors **15***a* and **15***b* of the outriggers **12** at the current time are functioning normally (S55). The power control device **90** determines that the outreach amount sensors **15***a* and **15***b* are functioning normally when the output values of the outreach amount sensors **15***a* and **15***b* are within the rated range and determines that the outreach amount sensors **15***a* and **15***b* are not functioning normally when the output values are not within the rated range.

[0147] When the power control device **90** determines in the process of S55 that the outreach amount sensors **15***a* and **15***b* are functioning normally (YES in S55), the power control device **90** calculates the operating status (e.g., boom **30** posture) and load state such as load rate of the crane **100** based on the values detected in real time by the outreach amount sensors **15***a* and **15***b* of outriggers **12**, and outputs the calculated results to the monitor device (S56). Thereafter, the power control device **90** returns to the process of S22.

[0148] When the power control device **90** determines in the process of S55 that the outreach amount sensors **15***a* and **15***b* are not functioning normally (NO in S55), the power control device **90** does not calculate the operating status (e.g., boom **30** posture.) and load state such as load rate of the crane **100**, and does not control to display on the monitor device (S57). Thereafter, the power control device **90** returns to the process of S22.

[0149] As described in detail above, according to the power control device **90** of Example 2, as in Example 1 and the variation, a condition for switching the power supplied to the crane **100** between the vehicle engine **13** and the APU **80** is that there is no operation input to all operating systems for crane work, such as the boom **30** or the winch **50**.

[0150] Therefore, the crane **100** of Example 2, for example, prevents the boom **30** or the winch **50**, which has been operating in the vehicle engine mode, from stopping suddenly when the power supply is cut off at the moment of switching to the APU mode.

[0151] The crane **100** of Example 2 also prevents the boom **30** or the winch **50** from stopping in the APU mode and suddenly starting to move due to the switch to the vehicle engine mode and the supply of power.

[0152] The crane **100** in Example 2 also allows the display of the load state etc. on the monitor device by the APU controller **84** calculating the operating status (e.g., boom **30** posture) and load state such as load rate of the crane **100** based on the outreach amounts of outriggers **12***a* and **12***b* detected by the outreach amount sensors **15***a* and **15***b* during the period of the vehicle engine mode, immediately prior to switching to the APU mode, when the power control device **90** switches the power mode to the APU mode.

[0153] The power control device **90** of Example 2 is not limited to the case of manual switching of the power mode, but can also be used in the automatic switching mode to prevent a situation in which the power supply is cut off at the moment of switching to the APU mode, causing a sudden stop.

[0154] The power control device **90** in Example 2 is a power mode in which the automatic switching mode automatically switches from the vehicle engine mode to the APU mode, and a power mode that automatically switches from the APU mode to the vehicle engine mode can also be applied, or the power modes can be automatically switched to each other.

[0155] The power control device **90** of Example 2 forcibly sets the operation input to the operating system to turn off when switching to APU mode (each process of S32, S37, S44, and S50), and the power control device **90** of Example 2 may apply a process that forcibly sets the operation input to the operating system to turn off under predetermined conditions, even in a case of switching to the vehicle engine mode.

REFERENCE SIGNS LIST

[0156] **10** Traveling device
[0157] **13** Vehicle engine (main power unit)
[0158] **20** Turn table
[0159] **30** Boom
[0160] **40** Cabin (cockpit)
[0161] **80** APU (auxiliary power unit)
[0162] **90** Power control device
[0163] **100** Rough terrain crane (crane vehicle)

1. A crane vehicle comprising:
a traveling device;
a turn table that is disposed above the traveling device and turnable with respect to the traveling device;
a boom and a cockpit that are provided on the turn table;
a main power unit that is provided in the traveling device and supplies power to the traveling device, the boom and the cockpit;
an auxiliary power unit that is provided on the turn table and does not supply power to the traveling device and the boom, but supplies power to the cockpit; and
a processor that selectively switches between a main power mode supplied with power from the main power unit and an auxiliary power mode supplied with power from the auxiliary power unit, wherein
the processor disables a switching between the main power mode and the auxiliary power mode when an operation input to an operating system that operates the boom is detected, and the processor enables a switching between the main power mode and the auxiliary power mode when an operation input to the operating system is not detected.

2. The crane vehicle according to claim **1**, wherein
the processor disables a switching from the main power mode to the auxiliary power mode when a load from a suspended load on the boom is detected or when an operation input to the operating system is detected, and
the processor enables a switching from the main power mode to the auxiliary power mode when a load from a

suspended load on the boom is not detected and when an operation input to the operating system is not detected.

3. The crane vehicle according to claim **1**, wherein

in an automatic switching mode set to switch between the main power mode and the auxiliary power mode when specific conditions are met, the processor disables a switching between the main power mode and the auxiliary power mode when an operation input to an operating system that operates the boom is detected, and the processor enables a switching between the main power mode and the auxiliary power mode when an operation input to the operating system is not detected.

4. The crane vehicle according to claim **1** further comprising:

an outreach amount sensor that detects an outreach amount of an outrigger provided on the traveling device in the main power mode; and

a memory that stores the outreach amount detected by the outreach amount sensor in the main power mode, wherein

the processor calculates a load state of the crane based on the outreach amount stored in the memory in the auxiliary power mode.

5. The crane vehicle according to claim **3** further comprising:

an outreach amount sensor that detects an outreach amount of an outrigger provided on the traveling device in the main power mode; and

a memory that stores the outreach amount detected by the outreach amount sensor in the main power mode, wherein

the processor calculates a load state of the crane based on the outreach amount stored in the memory in the auxiliary power mode.

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