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# (54) WORK MACHINE CONTROL METHOD, WORK MACHINE CONTROL PROGRAM, WORK MACHINE CONTROL SYSTEM, AND WORK MACHINE

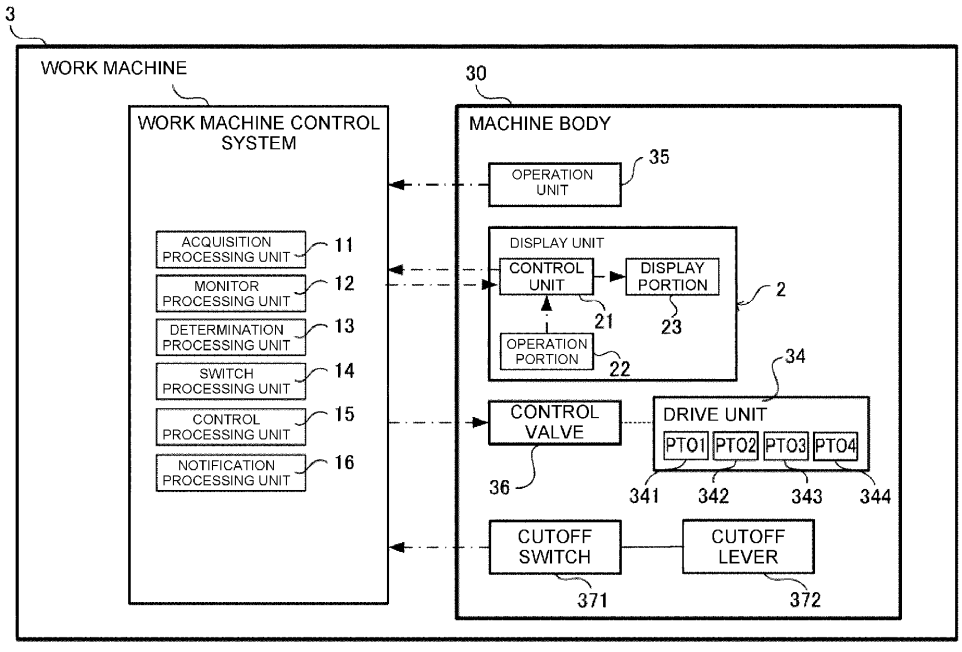
(57) [Problem]

An object is to provide a work machine control method, a work machine control program, a work machine control system, and a work machine that easily reduce a burden on an operator for an operation.

[Solution]

A method of controlling a work machine 3, includes: accepting an operation for an operation unit 35 for controlling a work machine 3; monitoring a specific event to be monitored; and determining, with the specific event occurring, whether or not a determination condition for the operation for the operation unit 35 is met.

FIG. 2

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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a work machine control method, a work machine control program, a work machine control system, and a work machine, which are used for a work machine controlled in response to an operation for an operation unit.

### BACKGROUND ART

**[0002]** As a related technology, a work machine equipped with a machine body, a work instrument installed on the machine body, and a hydraulic breaker attached to a tip portion of the work instrument is known (see, for example, Patent Document 1). The work machine according to the related technology is further equipped with a switch that can switch between an auto-hammer prohibited state that disables the hydraulic breaker and an auto-hammer permitted state that enables the hydraulic breaker to operate. So as to prevent unintentional hitting, this work machine is normally set in the auto-hammer prohibited state, and is switched to the auto-hammer permitted state by operating the switch. Specifically, the work machine shifts to an auto-hammer standby state when the switch is operated in the auto-hammer prohibited state, and shifts to the auto-hammer permitted state when the switch is operated again within a certain period in the auto-hammer standby state.

### PRIOR ART DOCUMENT

### PATENT DOCUMENT

**[0003]** Patent Document 1: Japanese Unexamined Patent Application Publication No. 2010-209641

### SUMMARY OF INVENTION

### TECHNICAL PROBLEM

**[0004]** In the above related technology, operating the switch switches the hydraulic breaker from the auto-hammer prohibited state to the auto-hammer permitted state; therefore, an operator needs to carefully operate the hydraulic breaker so as to prevent, for example, the hydraulic breaker from suddenly becoming operable and starting to hit.

**[0005]** An object of the present invention is to provide a work machine control method, a work machine control program, a work machine control system, and a work machine that easily reduce a burden on an operator for an operation.

### SOLUTION TO PROBLEM

**[0006]** A work machine control method according to one aspect of the present invention, includes: accepting an operation for an operation unit for controlling a work machine; monitoring a specific event to be monitored; and determining, with the specific event occurring, whether or not a determination condition for the operation for the operation unit is met.

**[0007]** A work machine control program according to one aspect of the present invention is a program that causes one or more processors to execute the work machine control method.

**[0008]** A work machine control system according to one aspect of the present invention, includes: an acquisition processing unit; a monitor processing unit; and a determination processing unit. The acquisition processing unit accepts an operation for an operation unit for controlling a work machine. The monitor processing unit monitors a specific event to be monitored. The determination processing unit determines, with the specific event occurring, whether or not a determination condition for the operation for the operation unit is met.

**[0009]** A work machine according to one aspect of the present invention, includes: a work machine control system; and a machine body controlled in response to the operation for the operation unit.

### ADVANTAGEOUS EFFECTS OF INVENTION

**[0010]** According to the present invention, a work machine control method, a work machine control program, a work machine control system, and work machine that easily reduce a burden on an operator for an operation can be provided.

### BRIEF DESCRIPTION OF DRAWINGS

**[0011]**

Fig. 1 is a schematic perspective view showing an overall configuration of a work machine according to a first embodiment.

Fig. 2 is a schematic block diagram of the work machine according to the first embodiment.

Fig. 3 is a schematic external view of an operation unit of the work machine according to the first embodiment.

Fig. 4 is a schematic external view of a display unit of the work machine according to the first embodiment.

Fig. 5 is a flowchart showing an operation example of a work machine control system according to the first embodiment.

Fig. 6 is a timing chart showing an operation example of a work machine control system according to the first embodiment.

Fig. 7 shows an example of a display screen displayed on the display unit of the work machine according to the first embodiment.

Fig. 8 is a flowchart showing an operation example

of a work machine control system according to a second embodiment.

DESCRIPTION OF EMBODIMENTS

**[0012]** Embodiments of the present invention will be described below with reference to the accompanying drawings. The following embodiments are each an embodied example of the present invention and are not intended to limit the technical scope of the present invention.

(First Embodiment)

[1] Overall Configuration

**[0013]** As shown in Fig. 1, a work machine 3 according to the present embodiment has a machine body 30 provided with a travel unit 31, a swivel unit 32, and a work unit 33. The work machine 3 further has a work machine control system 1 (hereinafter, simply referred to as a "control system 1"), as shown in Fig. 2. Additionally, as shown in Figs. 1 and 2, the machine body 30 further has a display unit 2, a drive unit 34, an operation unit 35, a control valve 36, a cutoff switch 371, a cutoff lever 372, and the like.

**[0014]** The "work machine" in the present disclosure refers to a machine for various types of work, examples thereof including work vehicles such as a backhoe (including a hydraulic excavator and a mini excavator), a wheel loader and a carrier. The work machine 3 is provided with the work unit 33 so configured as to be capable of executing one or more operations. The work machine 3 is not limited to the "vehicle", but may be, for example, a work vessel, or a flying work body such as a drone or a multi-copter. Further, the work machine 3 is not limited to a construction machine (construction equipment), but may also be an agricultural machine (farm equipment) such as a rice transplanter, a tractor or a combine harvester. According to the present embodiment, unless particularly specified, a case in which the work machine 3 is a riding-type backhoe and can execute digging, land preparation, trenching, or loading operations as its work will be taken as an example.

**[0015]** Further, according to the present embodiment, for convenience of description, a vertical direction in a state where the work machine 3 is usable is defined as an upper/lower direction D1. Further, a front/rear direction D2 and a right/left direction D3 are each defined based on a direction viewed from a user (operator) riding on (a drive unit 321 of) the work machine 3 in a non-swivel state of the swivel unit 32. In other words, each of the directions used in the present embodiment is a direction defined based on the machine body 30 of the work machine 3, and a direction in which the machine body 30 moves at the time of the work machine 3 moving forward is referred to as "front", and a direction in which the machine body 30 moves at the time of the work machine 3 moving rearward is referred to as "rear". Similarly, a direction in which a front end portion of the machine body 30 moves at the time of the work machine 3 swiveling to the right is referred to as "right," and a direction in which the front end portion of the machine body 30 moves at the time of the work machine 3 swiveling to the left is referred to as "left". However, these directions are not intended to limit a use direction (a direction in use) of the work machine 3.

**[0016]** The work machine 3 includes an engine serving as a power source. As one example in the present embodiment, the engine is a diesel engine. The engine is driven by fuel (in this case, light oil) supplied from a fuel tank. In the work machine 3, a hydraulic pump is driven by the engine, for example, and hydraulic oil is supplied from the hydraulic pump to hydraulic actuators (including hydraulic motor 43, hydraulic cylinder 44 and the like) of the various portions of the machine body 30, thereby to drive the machine body 30. The above work machine 3 can be controlled, for example, by a user (operator) boarding the drive unit 321 of the machine body 30 to operate the operation unit 35 such as operation levers 351, 352 (see Fig. 3).

**[0017]** In the present embodiment, it is assumed that the work machine 3 is a passenger-use backhoe as described above; therefore, the work unit 33 is driven according to the operation by the user (operator) riding on the drive unit 321, thereby to execute work such as excavation work. The drive unit 321, on which the user rides, is provided on the swivel unit 32.

**[0018]** Here, the display unit 2 and the operation unit 35 are installed on the drive unit 321 of the machine body 30; the user can operate the operation unit 35 while viewing the work machine 3's various information displayed on the display unit 2. As an example, a display screen of the display unit 2 displays information on an operation state of the work machine 3, such as cooling water temperature and hydraulic oil temperature, so that the user can check, on the display unit 2, the information that is necessary for operating the operation unit 35 and that is on the operation state of the work machine 3.

**[0019]** The travel unit 31 has a traveling function, and is so configured as to be capable of traveling (including swiveling) on the ground. The travel unit 31 includes a pair of right and left crawlers 311 and a blade 312, for example. The travel unit 31 further includes a travel-directed hydraulic motor 43 (hydraulic actuator) for driving the crawlers 311.

**[0020]** The swivel unit 32 is provided above the travel unit 31 and is so configured as to swivel, relative to the travel unit 31, about a rotation shaft along a vertical direction. The swivel unit 32 has a swivel-directed hydraulic motor (a hydraulic actuator), and the like. On the swivel unit 32, other than the drive unit 321, an engine, the hydraulic pump, and the like is installed. At the front end portion of the swivel unit 32, there is provided a boom bracket 322 on which the work unit 33 is mounted.

**[0021]** The work unit 33 is so configured as to execute

one or more operations. The work unit 33 is supported by the boom bracket 322 of the swivel unit 32, and executes operations. The work unit 33 has an attachment 331. The attachment 331 is an optional tool (work tool) selected from several types of tools according to the nature of the work. The attachment 331, as an example, is detachably attached to the machine body 30, and is replaced according to the nature of the work. The attachments 331 for work machine 3 include various tools such as breakers, augers, crushers, forks, buckets, fork claws, steel cutters, asphalt cutters, mowers, rippers, mulchers, tilt rotators, and tampers.

**[0022]** The work unit 33 further has a boom 332, an arm 333, and a hydraulic actuator (including hydraulic cylinder 44, hydraulic motor, and the like), and the like. The attachment 331 is attached to the tip end of the arm 333. Here, the work unit 33 moves under power from the engine as the power source. Specifically, the hydraulic pump is driven by the engine, and hydraulic oil is supplied from the hydraulic pump to the hydraulic actuator in the work unit 33 thereby to move the work unit 33.

**[0023]** The boom 332 is rotatably supported at the boom bracket 322 of the swivel unit 32. Specifically, the boom 332 is supported at the boom bracket 322 in a manner to rotate about a rotation axis along the horizontal direction. The boom 332 is so shaped as to extend upward from a base end portion supported at the boom bracket 322. The arm 333 is coupled to a tip end of the boom 332. The arm 333 is supported to the boom 332 in a manner to rotate about a rotation axis along the horizontal direction.

**[0024]** The work machine 3 is also equipped with the drive unit 34, and the power from the drive unit 34 drives the attachment 331 of the work unit 33 thereby to execute various types of work. That is, in the work machine 3, the attachment 331 such as a breaker or an auger, for example, is attached to the machine body 30 according to the nature of the work, and supplying the power from the drive unit 34 to the attachment 331 thereby to drive the attachment 331 performs the work. Therefore, at the time of performing the work with the work machine 3, the user (operator) operating the operation unit 35, for example, so as to cause the attachment 331 to make a desired movement controls the drive unit 34's output (power), etc. supplied to the attachment 331.

**[0025]** The drive unit 34 is used to supply power to the attachment 331. As one example in the present embodiment, the drive unit 34 includes a unit (mechanism) such as a PTO (power take-off) to take out power from the engine as power for driving the attachment 331 including a hydraulic device. Specifically, to the attachment 331, the drive unit 34 sends out the hydraulic oil from a hydraulic pump driven by the engine thereby to supply the hydraulic oil to the attachment 331. The drive unit 34 adjusts the flowrate of hydraulic fluid supplied to the attachment 331, thereby to adjust the magnitude of the power supplied to attachment 331.

**[0026]** Here, the drive unit 34 has a plurality (four in the present embodiment as an example) of output ports 341 to 344 (see Fig. 2). Each of the output ports 341 to 344 is so configured as to output power. Each of the output ports 341 to 344 can individually adjust the power, i.e., flowrate of the hydraulic oil, and the drive unit 34 outputs the power from each of the output ports 341 to 344. In the present embodiment, each of the output ports 341 to 344 is a PTO port, so the output port 341 may be denoted as "PTO1", the output port 342 as "PTO2", the output port 343 as "PTO3", and the output port 344 as "PTO4".

**[0027]** Each of the travel unit 31 and the swivel unit 32, in a manner similar to that of the work unit 33, moves under power from the engine as the power source. That is, the hydraulic oil is supplied from the hydraulic pump to the hydraulic actuators (hydraulic motors) of the swivel unit 32 and travel unit 31, thereby to move the swivel unit 32 and the travel unit 31.

**[0028]** The operation unit 35 is placed at the drive unit 321 of the machine body 30, and is a user interface for accepting the operation input by the user (operator). The operation unit 35 outputs an electric signal (operation signal) that accords to the operation by the user, for example, thereby to accept various operations by the user. As one example in the present embodiment, the operation unit 35 includes a pair of the operation levers 351, 352 (see Fig. 3). The operation unit 35 is described in detail in the column "[2] Operation Unit".

**[0029]** The control system 1 is mainly configured by a computer system having one or more processors such as a CPU (Central Processing Unit), and one or more memories such as a ROM (Read Only Memory) and a RAM (Random Access Memory), executing various processes (information process). According to the present embodiment, the control system 1 is an integrated controller that controls the overall work machine 3, and includes, for example, an electronic control unit (ECU). However, the control system 1 may be provided separate from the integrated controller, and may mainly include one processor or a plurality of processors. The control system 1 will be described in detail in the column "[3] Configuration of Control System".

**[0030]** The display unit 2 is placed at the drive unit 321 of the machine body 30, and is a user interface for accepting the operation input by the user (the operator) and outputting various types of information to the user. The display unit 2 outputs an electric signal that accords to the operation by the user, for example, thereby to accept various operations executed by the user. With this, the user (the operator) can view a display screen Dp1 (refer to Fig. 4) displayed on the display unit 2, and can operate the display unit 2 as necessary.

**[0031]** As shown in Fig. 2, the display unit 2 includes a control unit 21, an operation portion 22, and a display portion 23. The display unit 2 is so configured as to be communicable with the control system 1, and can execute sending and receiving of data to and from the control system 1. As one example in the present embodiment,

the display unit 2 is a dedicated device used for the work machine 3.

**[0032]** The control unit 21 controls the display unit 2 according to data from the control system 1. Specifically, the control unit 21 outputs an electric signal that accords to the user's operation accepted by the operation portion 22, and displays, in the display portion 23, the display screen Dp1 generated by the control system 1.

**[0033]** The operation portion 22 is a user interface for accepting the user (operator)'s operation input to the display screen Dp1 displayed in the display portion 23. The operation portion 22 outputs the electric signal that accords to a user U1's operation (refer to Fig. 4), for example, thereby to accept various operations by the user U1. As one example in the present embodiment, the operation portion 22 includes a plurality (herein six) of mechanical push button switches 221 to 226, as shown in Fig. 4. Along a periphery of a display area of the display portion 23, the plurality of push button switches 221 to 226 is placed in the vicinity of the display area (a lower portion in the example in Fig. 4). The push button switches 221 to 226 are associated with items (to be described below) displayed on the display screen Dp1; operating any of the push button switches 221 to 226 operates (selects) any of the items on the display screen Dp1.

**[0034]** Further, the operation portion 22 may include a touch screen and an operation dial. Also in this case, operating for the operation portion 22 operates (selects) any of the items on the display screen Dp1.

**[0035]** The display portion 23 is a user interface for presenting information to the user U1 (the operator), such as a liquid crystal display or organic EL display that displays various types of information. The display portion 23 presents various types of information to the user by means of display. As one example in the present embodiment, the display portion 23 is a full-color liquid crystal display with a backlight, and has a "horizontally-long" display area that is long in a horizontal direction as shown in Fig. 4.

**[0036]** Fig. 2 schematically shows a hydraulic circuit and electric circuit (electric connection) of the work machine 3 according to the present embodiment. In Fig. 2, the dotted line indicates a low-pressure (for pilot oil) oil path, and the single-dotted arrow indicates an electric signal path.

**[0037]** As shown in Fig. 2, the machine body 30 of the work machine 3 has the display unit 2, the drive unit 34 and the operation unit 35, as well as the control valve 36, the cutoff switch 371, the cutoff lever 372, and the like.

**[0038]** Here, the drive unit 34 is equipped with a pilot-type direction-switch valve (control valve) that can switch the direction and flow of the hydraulic oil from the hydraulic pump. Supplying the pilot oil, which serves as an input command, from a pilot pump to the direction-switch valve drives the drive unit 34. A solenoid type control valve 36 (electromagnetic valve) is inserted in a supply path of the pilot oil to the direction-switch valve. The control valve 36 moves in response to a control signal (current) from the control system 1. The control valve 36 is here assumed to be a (solenoid type) proportional control valve, but can be, for example, an open/close valve that can switch between opening and cutting of the flow path.

**[0039]** The control valve 36 opens the flow path of the pilot oil in an energized state, i.e., in a state of a current as the control signal being supplied, and cuts off the flow path of the pilot oil in a de-energized state, i.e., in a state of the current as the control signal being cut off. Therefore, cutting of the supply current (control signal) to the control valve 36 makes the drive unit 34 inoperable, forcibly stopping the output of the drive unit 34 regardless of the operation unit 35's operation.

**[0040]** The cutoff switch 371 is linked to the cutoff lever 372. The cutoff lever 372 is placed in the drive unit 321 of the machine body 30, and accepts an operation input by the user (operator). As one example in the present embodiment, the cutoff lever 372 can be operated along the upper/lower direction D1. When the cutoff lever 372 is in the "up position" which is the upper end position of a movable range, the cutoff switch 371 is "off"; when the cutoff lever 372 is in the "down position" which is the lower end position of the movable range, the cutoff switch 371 is "on". Then, the cutoff switch 371 is connected to the control system 1; with the cutoff switch 371 in the off state, the control system 1 cuts off the current as the control signal, thereby forcibly cutting off the hydraulic circuit at the control valve 36. When a cutoff valve is provided that is directly energized/de-energized by the on/off of the cutoff switch 371, the hydraulic circuit may be cut off in conjunction with the cutoff switch 371 without the intervention of the control system 1. That is, cutting off the hydraulic circuit by the cut-off valve when the cutoff switch 371 is off forcibly cuts off the hydraulic circuit without the intervention of the control system 1. Therefore, when the cutoff lever 372 is in the "down position", the operation unit 35's operation drives the drive unit 34, whereas when the cutoff lever 372 is in the "up position," the output of the drive unit 34 is forcibly stopped regardless of the operation unit 35's operation. Therefore, to drive the drive unit 34, the user (operator) needs to operate the cutoff lever 372 to the "down" position.

**[0041]** Further, each of the swivel unit 32 and the travel unit 31 is also moved with the hydraulic oil supplied from the hydraulic pump to the hydraulic actuator (hydraulic motor); therefore, the cutoff lever 372 being in the "up position" disables the swivel unit 32 and travel unit 31. That is, when the cutoff lever 372 is in the "up position," the work unit 33, the swivel unit 32, and the travel unit 31 are all forcibly disabled.

**[0042]** In short, the cutoff switch 371, when being off, is in a "locked state" in which the movement of the work machine 3 is restricted (including prohibition), and when being on, is in an "unlocked state" in which the movement of the work machine 3 is not restricted. Then, the cutoff lever 372 being in the "up position" and the cutoff switch 371 being in the locked state (off) forcibly restrict the movement of the work machine 3 including the drive unit

34, regardless of the operation unit 35's operation. The cutoff lever 372 is a lever that is operated for locking the movement of the work machine 3 in the above manner, and is synonymous with a gate (type) lock lever.

**[0043]** In addition to the above configuration, the machine body 30 is further provided with a communication terminal, a fuel tank, a battery, and the like. Further, the machine body 30 is provided with various sensors (including cameras) for detecting a to-be-detected object in a monitor area around the work machine 3, such as a camera for capturing an image around the machine body 30.

[2] Operation Unit

**[0044]** Next, the configuration of the operation unit 35 is described in detail with reference to Fig. 3. The operation unit 35 includes a pair of operation levers 351, 352 as described above. As shown in the "front view" in Fig. 3, the operation lever 351 is placed on the right hand side as seen from the user (operator) boarding the drive unit 321, and the operation lever 352 is placed on the left hand side as viewed from the user boarding the drive unit 321. Therefore, the user, for example, holds the operation lever 351 with the right hand and the operation lever 352 with the left hand, and operates the pair of operation levers 351, 352, thereby causing the work machine 3 to execute various movements such as moving forward and backward.

**[0045]** Here, so to make the plurality of output ports 341 to 344 of the drive unit 34 individually operable, the operation unit 35 has a plurality (here four) of operants Sw1 to Sw4 that correspond to the plurality of output ports 341 to 344 on one-to-one basis. The operant Sw1 is placed on the front side (front face) of the operation lever 351, and the operant Sw2 is placed on the front side (front face) of the operation lever 352 (see Fig. 3). The operant Sw4 is placed on the rear side (rear face) of the operation lever 351, and the operant Sw3 is placed on the rear side (rear face) of the operation lever 352 (see Fig. 3). That is, in the present embodiment, the right-hand side operation lever 351 has the operants Sw1 and Sw4 divided into its front and rear faces, and the left-hand side operation lever 352 has the operants Sw2 and Sw3 divided into its front and rear faces. The plurality of operants Sw1 to Sw4 constitute "adjusting operants" that adjust the magnitude (flowrate of hydraulic oil) of the power output from the drive unit 34.

**[0046]** As one example in the present embodiment, each of the operants Sw1 to Sw4 includes a lever switch that can be operated to tilt in a right direction A1 and a left direction A2. In particular, each of the operants Sw1 to Sw4 is a momentary type switch that has the movable range's center in the right/left direction D3 as a neutral position Pn1 (see Fig. 3), tilts in the right direction A1 or left direction A2 with an operating force being operated, and return to the neutral position Pn1 with the operating force lost. Being operated to the right direction A1 or the left direction A2, respectively, the above operants Sw1 to Sw4 determine, according to the operation volume (tilt volume) thereof, the magnitude of the power (flowrate of the hydraulic oil) output from the corresponding output ports 341 to 344. Basically, the larger the operation volume of the operants Sw1 to Sw4, the larger the power output from the respectively corresponding output ports 341 to 344, i.e., the larger the flowrate of hydraulic fluid.

**[0047]** As an example here, it is assumed that the operant Sw1 corresponds to the output port 341, the operant Sw2 corresponds to the output port 342, the operant Sw3 corresponds to the output port 343, and the operant Sw4 corresponds to the output port 344. In this case, with the user operating the operant Sw1, the power output from the output port 341 in the drive unit 34 is adjusted according to the operation volume of the operant Sw1. Meanwhile, with the user operating the operant Sw4, the power output from the output port 344 in the drive unit 34 is adjusted according to the operation volume of the operant Sw4. The correspondence between the output ports 341 to 344 and of the operants Sw1 to Sw4 are defined by "allocation information", which is stored in a memory of the control system 1, for example.

**[0048]** Although a detailed description is omitted, setting for the operation unit 35's operation, such as the allocation information (correspondence between the output ports 341 to 344 and the operants Sw1 to Sw4), is done on the display unit 2, for example. That is, in the setting screen, etc. displayed on the display portion 23 of the display unit 2, the operation by the user can set the correspondence between the output ports 341 to 344 and the operants Sw1 to Sw4.

**[0049]** In the present embodiment, an operant Sw5 is placed on the rear side (rear face) of the operation lever 351, and an operant Sw6 is placed on the rear side (rear face) of the operation lever 352. The operants Sw5 and Sw6 are for enabling (on) a maintaining function (hold function) for maintaining the output of the drive unit 34. That is, the operants Sw5 and Sw6 include "maintaining operants" for maintaining the output of the drive unit 34. As one example in the present embodiment, each of the operants Sw5 and Sw6 is a momentary type push button switch. Therefore, the user, when pressing the operants Sw5 and Sw6, enables the maintaining function, thus maintaining the output of the drive unit 34.

**[0050]** In particular, in the present embodiment, the operant Sw5 provided at the operation lever 351 enables the maintaining function for the output port 341 that corresponds to the operant Sw1 provided at the same operation lever 351. Meanwhile, the operant Sw6 provided at the operation lever 352 enables the maintaining function for the output port 342 that corresponds to the operant Sw2 provided at the same operation lever 352. So, for example, the user, when pressing the operant Sw5, maintains (holds) the output for the output port 341 out of the plurality of output ports 341 to 344.

**[0051]** However, not limited to the above configuration, it is sufficient that the operant Sw5 should correspond to

at least one of the output ports 341 and 344 that correspond to the operants Sw1 and Sw4 provided at the same operation lever 351, whereas the operant Sw6 should correspond to at least one of the output ports 342 and 343 that correspond to the operants Sw2 and Sw3 provided at the same operation lever 352. So, the operant Sw5, for example, may enable the maintaining function for both of the output ports 341 and 344, and may enable the maintaining function for the output port 344. Meanwhile, the operant Sw6 may enable the maintaining function for both of the output ports 342 and 343, and may enable the maintaining function for the output port 343.

**[0052]** In short, in the work machine 3 according to the present embodiment, the drive unit 34 moves according to the operation for the operation unit 35 having the operants Sw1 Sw6. Here, the operants Sw1 to Sw6 include the adjusting operants (operants Sw1 to Sw4) for adjusting the output of the drive unit 34, and the maintaining operants (operants Sw5, Sw6) for maintaining the output of the drive unit 34. Further, a plurality of adjusting operands (operants Sw1 and Sw4) is provided for the one operation lever 351, whereas a plurality of adjusting operands (operants Sw2 and Sw3) is provided for the one operation lever 352.

**[0053]** Here, when the adjusting operants (operants Sw1 to Sw4) and the maintenance operants (operants Sw5, Sw6) are simultaneously operated, the work machine 3 maintains the output of the drive unit 34 at a value that corresponds to the operation volume of the adjusting operants (operants Sw1 to Sw4). For example, the user pressing the operant Sw5 while operating the operant Sw1 simultaneously operates the adjusting operant (Sw1) and the maintaining operant (Sw5). In this case, the magnitude of the power output from the output port 341 is maintained at a value that corresponds to the operant Sw1's operation volume seen at the time when the operant Sw5 is operated.

**[0054]** Meanwhile, when the maintaining operants (operants Sw5, Sw6) out of the adjusting operants (operants Sw1 to Sw4) and the maintaining operants (operants Sw5, Sw6) are operated, the work machine 3 maintains the output of the drive unit 34 at a specified value. For example, when the user presses only the operant Sw5, the magnitude of the power output from the output port 341 that corresponds to the operant Sw1 is maintained at the specified value preset for output port 341.

**[0055]** Therefore, depending on how the user operates, it is possible to easily distinguish between maintaining the output of the drive unit 34 at an arbitrary value and maintaining the output of the drive unit 34 at a specified value. Hereafter, the maintaining function's movement state seen when maintaining the output of drive unit 34 at the arbitrary value is referred to as "arbitrary hold," and the maintaining function's movement state seen when maintaining the output of drive unit 34 at the specified value is referred to as "specified value hold".

**[0056]** Further, in the present embodiment, as shown in Fig. 3, each of the operation levers 351, 352 has a grip portion provided with a display light 350 to present the movement state of the maintaining function. The display light 350 includes a light-emitting element, such as an LED, for example, and presents the movement state of the maintaining function by its light-emitting state (lighting state).

**[0057]** Each of the operants Sw1 to Sw4 is not limited to the lever switch, but may be, for example, a toggle switch, a rocker switch, a rotary switch, a slide switch, or an encoder. Each of the operants Sw5 and Sw6 as well is also not limited to the push-button switch, but may be a lever switch or a touch sensor, for example. The operation levers 351, 352 may be reversed on right and left, or may be placed side by side in the forward/backward direction D2 or the upper/lower direction D1. The operation lever may be only one of the operation levers 351, 352. Further, placing of the operants Sw5, Sw6 is not limited to on the rear sides of the operation levers 351, 352, but may be on the sides or front sides of the operation levers 351, 352. At the operation levers 351, 352 described above, the operation unit 35 may have a plurality of operants other than the above operants Sw1 to Sw6. The display light 350 can also be omitted as proper.

[3] Configuration of Control System

**[0058]** Next, a configuration of the control system 1 according to the present embodiment will be described with reference to Fig. 2. The control system 1 controls various portions of the machine body 30 (including travel unit 31, swivel unit 32, work unit 33, and drive unit 34, etc.) according to the operation for the operation unit 35. In the present embodiment, the operation unit 35 is installed on the machine body 30 of the work machine 3, as described above. The control system 1 is a component of the work machine 3, and constitutes the work machine 3 together with the machine body 30 and the like. In other words, the work machine 3 according to the present embodiment has at least the control system 1 and the machine body 30 which is controlled according to the operation for the operation unit 35.

**[0059]** As shown in Fig. 2, the control system 1 is equipped with an acquisition processing unit 11, a monitor processing unit 12, a determination processing unit 13, a switch processing unit 14, a control processing unit 15, and a notification processing unit 16. As one example in the present embodiment, the control system 1 is mainly composed of a computer system having one or more processors; therefore executing a work machine control program by the one or more processors realize a plurality of function units (acquisition processing unit 11 and the like). The plurality of function units included in the control system 1 may be distributed to a plurality of cases or may be included in a single case.

**[0060]** The control system 1 is so configured as to be communicable with a device provided in each unit of the machine body 30. That is, to the control system 1, at least the display unit 2, the operation unit 35, the control valve

36, the cutoff switch 371 and the like are connected. This allows the control system 1 to control the display unit 2, the control valve 36, etc., and to acquire electric signals (operation signals, etc.) from the display unit 2, the operation unit 35, and the cutoff switch 371. Being "communicable" referred to in the present disclosure means that information (data) can be sent and received either directly by a proper communication method of a wired communication or wireless communication (communication using a radio wave or light as a medium), or indirectly via a communication network (a network), a relay or the like. Therefore, the control system 1 may send and receive various types of information (data) directly to and from each device, or indirectly via the relay or the like. The control system 1 can communicate with the device provided in each unit of the machine body 30 using a communication method such as CAN (Controller Area Network) or the like, as an example.

**[0061]** The acquisition processing unit 11 executes an acquiring process that accepts the operation for the operation unit 35 for controlling the work machine 3. That is, the operation unit 35 having a plurality of operants Sw1 to Sw6 outputs an operation signal that accords to the operation by the user, thereby causing the acquisition processing unit 11 to acquire the above operation signal. This makes it possible, for the operant Sw1 out of the operants Sw1 to Sw6, for example, that the acquisition processing unit 11 should acquire the operation signal representing the operation volume for the neutral position Pn1.

**[0062]** The monitor processing unit 12 executes a monitoring process to monitor a specific event to be monitored. The "specific event" in the present disclosure is a predetermined specific event, and the monitor processing unit 12 monitors whether or not the specific event has occurred. That is, when the specific event occurs, the monitor processing unit 12 detects the occurrence of the specific event.

**[0063]** In the present embodiment, the specific event includes an event that involves a change in the work machine 3's movement state that corresponds to the operation unit 35's operation. That is, the specific event includes an event that causes some change in the movement state of the work machine 3, despite the operation for the operation unit 35 being constant (fixed). With this configuration, the occurrence of an event where the movement state of the work machine 3 is suddenly changed while the user (operator) is maintaining the operation state of the operation unit 35 can be detected, as the occurrence of the specific event, by the monitor processing unit 12. This makes it possible to detect an event, which leads to sudden driving of the work machine 3 or sudden stopping of the work machine 3, for example, as the occurrence of the specific event.

**[0064]** Specifically, in the present embodiment, the specific event includes the switching of the cutoff switch 371 in the work machine 3, from the locked state (off) to the unlocked state (on). That is, switching from the cutoff switch 371 in the locked state (off) with the cutoff lever 372 in the "up position" to the cutoff switch 371 in the unlocked state (on) with the cutoff lever 372 operated in the "down position" is included in the specific event. With this; while the user has operated the operation unit 35, for example, the monitor processing unit 12 can detect, as the occurrence of the specific event, the sudden driving of the work machine 3 in accordance with the cutoff switch 371 being switched from the locked state to the unlocked state.

**[0065]** The specific event also includes a change in the setting for the operation unit 35's operation. That is, changing of the setting for the operation unit 35's operation, for example, changing of the "allocation information" that defines the correspondence between the output ports 341 to 344 and the operants Sw1 to Sw4 is included in the specific event. With this; while the user is operating the operant Sw1, as an example, the monitor processing unit 12 can detect, as the occurrence of the specific event, the sudden driving of output port 342 in accordance with the allocation information for the operant Sw1 being changed from the output port 341 to the output port 342.

**[0066]** When the specific event occurs, the determination processing unit 13 executes a determination process to determine whether or not a determination condition for the operation for the operation unit 35 is met. The "determination condition" in the present disclosure is a condition predetermined in relation to the operation for the operation unit 35, such as, for example, that each of the operants Sw1 to Sw4 is positioned in the neutral position Pn1, that the operants Sw5, Sw6 are not operated, or a specific operator is pressed for a long time (operated continuously for a predetermined period or longer).

**[0067]** Based on the result of the determination as to whether or not the determination condition is met, the switch processing unit 14 switches, between enabled and disabled, the work machine 3's control that corresponds to the operation unit 35's operation. When the work machine 3's control which corresponds to the operation unit 35's operation is "disabled", the drive unit 34 becomes inoperable, for example, forcibly stopping the output of the drive unit 34, regardless of the operation unit 35's operation. As one example in the present embodiment, the switch processing unit 14, with the determination condition being met, enables the work machine 3's control that corresponds to the operation unit 35's operation, and with the determination condition not met, disables the work machine 3's control that corresponds to the operation unit 35's operation.

**[0068]** The control processing unit 15 executes the control process to control the machine body 30 in response to the operation unit 35's operation. In the control process, the control processing unit 15 controls the travel unit 31, swivel unit 32, and work unit 33, etc. of the machine body 30. Specifically, the control processing unit 15 outputs a control signal to the control valve 36 in response to the operation of at least the operation unit 35, thereby to control the drive unit 34.

**[0069]** The notification processing unit 16 executes a notifying process that provides a notification which is based on the result of the determination as to whether or not the determination condition is met. "The notification" as used in the present disclosure means a notification to the user (operator) by various measures, including, for example, display (including lighting of display light), sound (including voice), sending to another terminal, or writing in a non-transient recording medium. As one example in the present embodiment, the notification processing unit 16, with the determination condition not met, that is, with the work machine 3's control that corresponds to the operation unit 35's operation "disabled", causes the display portion 23 of the display unit 2 to display a message to that effect, thereby providing a notification that is based on the determination result (see Fig. 7).

[4] Work Machine Control Method

**[0070]** Hereinafter, an example of a method of controlling the work machine 3 (hereinafter, simply referred to as a "control method") executed mainly by the control system 1 will be described with reference to Fig. 5 to Fig. 7. Fig. 5 is a flowchart showing an example of a process according to the control method. Fig. 6 shows an example of state changes of cutoff signal, PTO operation, and PTO control, with the horizontal axis as a time axis. The "cutoff signal" here is an electric signal input from the cutoff switch 371 to the control system 1, showing off (locked state) or on (unlocked state) of the cutoff switch 371. The "PTO operation" here is an electric signal (operation signal) input from the operation unit 35 to the control system 1, showing, in particular, operation states of the operants Sw1 to Sw4 for operating the output ports 341 to 344 of the drive unit 34. The "PTO control" is the state of control by an electric signal (control signal) output from the control system 1 to the control valve 36, showing, in particular, whether the control of the output ports 341 to 344 of the drive unit 34 is enabled or disabled.

**[0071]** The control method according to the present embodiment is executed by the control system 1 mainly constituted by the computer system, and in other words, is embodied by a work machine control program (hereinafter, simply referred to as "control program"). That is, the control program according to the present embodiment is a computer program that causes one or more processors to execute various processes that accord to the control method. The above control program may be cooperatively executed by, for example, the control system 1 and the display unit 2.

**[0072]** Here, when a specific start operation set in advance so as to cause the control program to be executed, the control system 1 executes the following various types of processes that accord to the control method. Examples of the start operation include an operation of starting the engine of the work machine 3. Meanwhile, when a specific termination operation set in advance is executed, the control system 1 terminates the various types of processes that accord to the control method. Examples of the termination operation include an operation of stopping the engine of the work machine 3.

**[0073]** As one example, the following describes the control method seen when defining an initial state as a state where the cutoff lever 372 is in the "up position" and the cutoff switch 371 is in the locked state (off). Further, with the cutoff switch 371's switching from the locked state (off) to the unlocked state (on) used as an example of the "specific event," the description will be made with each of the operants Sw1 to Sw4 being in the neutral position Pn1 as an example of the "determination condition.

**[0074]** As shown in Fig. 5, the control system 1 first acquires a cutoff signal from the cutoff switch 371 (S1). Here, in the initial state, the cutoff lever 372 is in the "up position" as described above, thus bringing the cutoff signal in the locked state. Then, from the cutoff signal, the monitor processing unit 12 of the control system 1 determines whether or not the cutoff switch 371 is in the unlocked state. (S2). While the cutoff lever 372 is kept in the "up position," the cutoff signal is locked; therefore, the monitor processing unit 12 determines that the unlocked state is not made (S2: No), and returns the process to step S1. Meanwhile, the user lowering the cutoff lever 372 thereby to move the cutoff lever 372 to the "down position" brings the cutoff signal in the unlocked state; therefore, the monitor processing unit 12 determines that the unlocked state is made (S2: Yes), and moves the process to step S3. At this time, with the cutoff switch 371 switched from the locked state (off) to the unlocked state (on), the monitor processing unit 12 determines that the "specific event" has occurred.

**[0075]** In step S3, the acquisition processing unit 11 of the control system 1 acquires an operation signal from the operation unit 35. At this time, the acquisition processing unit 11 acquires, as the PTO operation, the operation state of the operants Sw1 to Sw4 for operating the output ports 341 to 344 of the drive unit 34. In step S4, the determination processing unit 13 of the control system 1 determines whether or not the operants Sw1 to Sw4's operation state (PTO operation) identified from the operation signal is in the neutral position Pn1 (not limited to a pinpoint, but may be a predetermined range including play). The operants Sw1 to Sw4 are momentary type switches that return to the neutral position Pn1 when the operating force is lost. Therefore, the determination processing unit 13 determines that, when being operated by the user, at least one of the operants Sw1 to Sw4 is not in the neutral position Pn1 (S4: No), then moves the process to step S5. Meanwhile, the determination processing unit 13 determines that, when not being operated by the user, any of the operants Sw1 to Sw4 is in the neutral position Pn1 (S4: Yes), then moves the process to step S6. At this time, with all of the operants Sw1 to Sw4 in the neutral position Pn1, the determination processing unit 13 determines that the "determination

condition" is met.

**[0076]** In step S5, the switch processing unit 14 of the control system 1 disables the work machine 3's control that corresponds to the operation unit 35's operation. As one example in the present embodiment, the switch processing unit 14 disables the control of the output ports 341 to 344 of the drive unit 34 (PTO control), which control accords to the operation (PTO operation) of the operants Sw1 to Sw4, thereby disabling the work machine 3's control. This forcibly stops the output for all of the output ports 341 to 344 of the drive unit 34, regardless of the actual operation volume of the operants Sw1 to Sw4.

**[0077]** In step S6, the switch processing unit 14 of the control system 1 enables the work machine 3's control that corresponds to the operation unit 35's operation. As one example in the present embodiment, the switch processing unit 14 enables the control of the output ports 341 to 344 of the drive unit 34 (PTO control), which control accords to the operation (PTO operation) of the operants Sw1 to Sw4, thereby enabling the work machine 3's control. This makes it possible to control the output of each of the output ports 341 to 344 of the drive unit 34, according to the actual operation volume of the operants Sw1 to Sw4.

**[0078]** Then, in step S7, the acquisition processing unit 11 of the control system 1 acquires an operation signal from the operation unit 35. At this time, the acquisition processing unit 11 acquires, as the PTO operation, the operation state of the operants Sw1 to Sw4 for operating the output ports 341 to 344 of the drive unit 34. In step S8, the control processing unit 15 of the control system 1 determines whether or not the operants Sw1 to Sw4's operation state (PTO operation) identified from the operation signal is in the neutral position Pn1. The control processing unit 15 determines that, when being operated by the user, at least one of the operants Sw1 to Sw4 is not in the neutral position Pn1 (S8: No), then moves the process to step S9. Meanwhile, the control processing unit 15 determines that, when not being operated by the user, any of the operants Sw1 to Sw4 is in the neutral position Pn1 (S8: Yes), then returns the process to step S7.

**[0079]** In step S9, according to the operants Sw1 to Sw4's operation state (PTO operation) identified from the operation signal, the control processing unit 15 of the control system 1 outputs the control signal to the control valve 36, thereby to execute the PTO control for controlling the output ports 341 to 344 of the drive unit 34. With step S9, the series of processes related to the control method is completed.

**[0080]** Whenever the cutoff lever 372 is operated to the "up position" thereby to bring the cutoff switch 371 in the locked state (off), the control system 1 executes the above processes in steps S1 to S9. The flowchart shown in Fig. 5 is merely an example, and any process may be added or omitted as proper, or the sequence of processes may be swapped as proper.

**[0081]** According to the series of processes described above, the control signal will be switched between enabled and disabled, as shown in Fig. 6. That is, in a period up to a time point t1, the cutoff lever 372 is in the "up position" and the cutoff signal is locked (off). Therefore, during the period up to time point t1, the PTO control is "disabled"; therefore, the drive unit 34 is not controlled even when the operants Sw1 to Sw4 are operated from the neutral position Pn1 thereby to bring the PTO operation in the "operation" state. That is, regardless of the actual operation volume of the operants Sw1 to Sw4, outputting is forcibly stopped for all of the output ports 341 to 344 of the drive unit 34. As one example in the present embodiment, when the cutoff signal is in the locked state (off), the control signal is turned off so that no extra power consumption is caused by the control signal, but the present invention is not limited to the above configuration. That is, when the cutoff signal is in the locked state (off); in the first place, it is not so made that the hydraulic circuit is cut off thereby to drive the drive unit 34. Therefore, even when the control signal is not turned off, the drive unit 34 is forcibly stopped.

**[0082]** Meanwhile, when the user operates the cutoff lever 372 to the "down position" at the time point t1, the cutoff signal is unlocked (on). That is, at the time point t1, the "specific event" occurs in which the cutoff switch 371 switches from the locked state (off) to the unlocked state (on). However, at the time point t1, the PTO operation is in the "operation" state, not in the neutral position Pn1, thus failing to meet the "determination condition". Therefore, during the period from the time point t1 to a time point t2, the PTO control is "disabled"; therefore, the drive unit 34 is not controlled even when the operants Sw1 to Sw4 are operated from the neutral position Pn1 thereby to bring the PTO operation in the "operation" state. That is, regardless of the actual operation volume of the operants Sw1 to Sw4, outputting is forcibly stopped for all of the output ports 341 to 344 of the drive unit 34.

**[0083]** At the time point t2, the user stops operating all of the operants Sw1 to Sw4 operants, thereby to bring all of the operants Sw1 to Sw4 in the neutral position Pn1, thus bringing the PTO operation in the "non-operation" state. That is, at the time point t2, all of the operants Sw1 to Sw4 being in the neutral position Pn1 meet the "determination condition". Due to this, at the time point t2, the PTO control is switched to "enable". Therefore, at a time point t3 after the time point t2, operating the operants Sw1 to Sw4 from the neutral position Pn1 thereby to bring the PTO operation in the "operation" state controls the drive unit 34. That is, in the period after the time point t2, the outputs of the output ports 341 to 344 of the drive unit 34 are controlled according to the actual operation volume of the operants Sw1 to Sw4.

**[0084]** In the present embodiment, when the PTO control is "disabled", not only is the drive unit 34's drive that corresponds to the operation of the adjusting operants (operants Sw1 to Sw4), but also the drive unit 34's drive that corresponds to the operation of the maintaining operants (operants Sw5, Sw6) is not driven. That is, even

when the operation to drive the drive unit 34 is executed by the " specified value hold" function, output of the drive unit 34 is forcibly stopped with the PTO control being "disabled".

**[0085]** As described above, the control method according to the present embodiment has the following operations: accepting the operation for the operation unit 35 for controlling the work machine 3, monitoring the specific event to be monitored, and determining, the specific event occurring, whether or not the determination condition for the operation for the operation unit 35 is met. In short, in the example of Fig. 6, it is so determined that, when the cutoff switch 371 switches from the locked state to the unlocked state at the time point t1 (step S2 in Fig. 5: Yes), the "specific event" has occurred. In this case, it is so determined, for example, that after the time point t1, the "determination condition" is met with all of the operants Sw1 to Sw4 in the neutral position Pn1, (step S4 in Fig. 5: Yes).

**[0086]** With this configuration, when the cutoff switch 371 is switched from the locked state to the unlocked state, for example, it is determined whether or not the determination condition for the operation for the operation unit 35 is met. Therefore, by notifying the user (operator) of the determination results, for example, the operator can prepare for a sudden movement of the work machine 3, thereby easily reducing a burden on the operator for the operation.

**[0087]** The control method according to the present embodiment further has switching, between enabled and disabled, the work machine 3's control that corresponds to the operation unit 35's operation, based on the result of the determination as to whether or not the determination condition is met. This means that, when the cutoff switch 371 is switched from the locked state to the unlocked state, for example, the work machine 3's control is automatically switched between enabled and disabled according to whether or not the determination condition for the operation for the operation unit 35 is met. Therefore, it is possible to avoid the sudden movement of the work machine 3 without the user (operator) having to make a careful operation.

**[0088]** Here, in the present embodiment, the work machine 3's control that corresponds to the operation unit 35's operation is enabled with the determination condition determined to be met after the occurrence of the specific event. That is, meeting the determination condition after the occurrence of the specific event automatically enables the work machine 3's control. Therefore, it is possible to avoid the sudden movement of the work machine 3 without the user (operator) having to make a careful operation.

**[0089]** In the present embodiment, the operation for the operation unit 35 includes an operation to control the output of the PTO ports (output ports 341 to 344) of the work machine 3. With this, it is possible to prevent the output of the PTO ports (output ports 341 to 344) of the work machine 3 from suddenly occurring, when the cutoff switch 371 is switched from the locked state to the unlocked state, for example.

**[0090]** By the way, with the control method according to the present embodiment, as exemplified in Fig. 7, a notification based on the result of the determination as to whether or not the determination condition is met is done on the display screen Dp1 displayed on the display portion 23 of the display unit 2. The "screen", such as the display screen Dp1 in the present disclosure, means an image (picture) displayed on the display unit 2, and includes figures, graphics, photographs, text, and moving images. Here, when the display screen Dp1 includes a moving image or the like, the display screen Dp1 does not include a constant image but includes an image that changes from moment to moment. In the drawing showing the display screen Dp1 displayed on the display portion 23 of the display unit 2 as in Fig. 7, the dotted lines representing areas, the leading lines, and the reference codes are each only for illustration, and are not actually displayed on the display unit 2.

**[0091]** As one example in the present embodiment, the notification processing unit 16 of the control system 1, when the determination condition is not met, that is, when the work machine 3's control that corresponds to the operation unit 35's operation is "disabled", displays a message M1 on the display screen Dp1, as shown in Fig. 7. In the present embodiment, the switch processing unit 14, when having disabled the work machine 3's control that corresponds to the operation unit 35's operation (step S5 in Fig. 5), provides a notification by the notification processing unit 16 displaying the message M1. The message M1 is so displayed as to pop up in a manner to superimpose on another display on the display screen Dp1, for example, and includes a text, such as "PTO control: disabled", showing that the work machine 3's control (herein, PTO control) is "disabled". In addition, the message M1 includes a text, such as "For enabling, please once put the switch back in neutral ", showing a procedure for enabling the work machine 3's control (herein, PTO control).

**[0092]** In the present embodiment, the above message M1 is displayed only while the work machine 3's control is "disabled". Therefore, the switch processing unit 14 of the control system 1, when enabling the work machine 3's control that corresponds to the operation unit 35's operation (Fig. 5, step S6), deletes the message M1. The display mode of the notification based on the result of the determination as to whether or not the determination condition is met is not limited to the message M1. For example, it may be so made that, as well as an icon Im1 showing on/off of the cutoff switch 371, an icon displayed on the display screen Dp1 may provide the notification that is based on the result of the determination as to whether or not the determination condition is met.

**[0093]** Thus, the control method according to the present embodiment further has the following: providing a notification that is based on the result of the determination as to whether or not the determination condition

is met. This allows the user (operator) to know whether the work machine 3's control is currently "enabled" or "disabled", and to operate the operation unit 35 on that basis. The notification of the determination result is not limited to the above configuration that is executed only when the determination condition is not met, i.e., when the work machine 3's control that corresponds to the operation unit 35's operation is "disabled", as described above. That is, the notification of the determination result may be a notification that can distinguish whether or not the determination condition is met; for example, the notification of the determination result may be provided when the determination condition is met, that is, when the work machine 3's control that corresponds to the operation unit 35's operation is "enabled". Further, the fact that the work machine 3's control is "disabled" may be notified when the determination condition is not met, that is, when the work machine 3's control that corresponds to the operation unit 35's operation is "disabled," and only when the operation unit 35 is operated.

[5] Other Functions

**[0094]** The "specific event" is not limited to the cutoff switch 371 switching from the locked (off) to the unlocked (on). Similarly, the "determination condition" is not limited to each of the operants Sw1 to Sw4 being positioned in the neutral position Pn1.In addition, the control that is switched between enabled and disabled by the switch processing unit 14 is not limited to the output control (PTO control) of the PTO ports (output ports 341 to 344) of the work machine 3.

**[0095]** That is, the "specific event" may be, for example, a change of the setting for the operation unit 35's operation, such as a change in the "allocation information" that defines the correspondence between the output ports 341 to 344 and the operants Sw1 to Sw4. In this case, the specific event will occur, for example, when the setting for the operation unit 35's operation, such as allocation information, is changed by the user's operation for the display unit 2. Here, the setting for the operation unit 35's operation is not limited to the setting of the correspondence between the output ports 341 to 344 and the operants Sw1 to Sw4, but also includes setting for the correspondence between the operation unit 35's operation and the flowrate of the hydraulic fluid, etc.

**[0096]** When the control that is switched between enabled and disabled by the switch processing unit 14 is, for example, a control of the travel unit 31, swivel unit 32 or work unit 33, other than the PTO control, changing of the correspondence between the operations of the operation levers 351, 352 and a movement of the travel unit 31, swivel unit 32 or work unit 33 may be included in the specific event. Further, a change in a movement pattern of the travel unit 31, swivel unit 32 or work unit 33 in response to the operations of the operation levers 351, 352 can also be included in the specific event. In this case, the "determination condition" is that the operation levers 351, 352, not each of the operants Sw1 to Sw4, are in the neutral position.

**[0097]** In addition, the control that is switched between enabled and disabled by the switch processing unit 14 may include a quick hitch control for attaching and detaching the attachment 331 to and from the machine body 30. In this case, for example, instead of the cutoff switch 371 switching from locked to unlocked, switching, from off to on, of the power switch for enabling a movement of the quick hitch may be included in the specified event. With this; while the user (operator) has opened the quick hitch, for example, the monitor processing unit 12 can detect, as the occurrence of the specific event, the occurrence of such an event as to suddenly drive the quick hitch in accordance with the power switch being switched from on to off.

[6] Modified Example

**[0098]** A description will hereinafter be made on a modified example of the first embodiment. The modified example, which will be described below, can be applied in a proper combination.

**[0099]** The control system 1 according to the present disclosure includes the computer system. The computer system has, as hardware, one or more processors and one or more memories. Executing the program recorded in the memory of the computer system, the processor realizes the function as the control system 1 in the present disclosure. The program may be preliminarily recorded in the memory of the computer system, may be provided through an electric communication line, or may be may be provided in a manner to be recorded in a non-transitory recording medium, such as a memory card, an optical disk, a hard disk drive, or the like, each of which is readable by the computer system. Further, a part of or all of the function units included in the control system 1 may be composed of an electronic circuit.

**[0100]** A configuration in which at least a part of the functions of the control system 1 is integrated in one case is not essential for the control system 1, and the components of the control system 1 may be provided in a plurality of cases in a distributed manner. Conversely, functions that are distributed to a plurality of devices (such as the control system 1 and the display unit 2) in the first embodiment may be integrated in one case. Further, at least a part of the functions of the control system 1 may be realized by a cloud (cloud computing) or the like.

**[0101]** Further, the power source of the work machine 3 is not limited to the diesel engine, but may be, for example, an engine other than the diesel engine, a motor (an electric motor), or a hybrid power source that includes the engine and the motor (an electric motor).

**[0102]** The drive unit 34 is not limited to the PTO (power take-off) or other device to take out the power (as power for driving the attachment 331) from the engine, but may also be a device that outputs, separately from the engine, the power for driving the attachment 331. Further, the

drive unit 34 is not limited to the device that supplies power to the attachment 331 by supplying hydraulic fluid, but may also be a device that generates power by an electric motor such as a motor. In this case, the power output from the drive unit 34 is controlled by, for example, the current flowing through the drive unit 34.

**[0103]** The attachment 331 only needs to be attached to the machine body 30, and the attachment 331's detachably being attached to the machine body 30 is not an essential configuration. In addition, a plurality of attachments 331 may be attached to the machine body 30 at the same time.

**[0104]** Further, the display unit 2 is not limited to a dedicated device, but may be a general-purpose terminal, such as a laptop computer, a tablet terminal, or a smartphone. Further, the display portion 23 is not limited to the mode of directly displaying the display screen Dp1, such as a liquid crystal display or an organic EL display, but may also be configured to display the display screen Dp1 by projection, for example, as like a projector. The display area of the display portion 23 is not limited to being horizontally long, but may also be vertically long.

**[0105]** In addition, as the mode of inputting information of the operation portion 22, any mode other than the push button switches 221 to 226, the touch screen, and operation dial may also be employed. For example, the operation portion 22 may employ any mode such as a keyboard, a pointing device such mouse, a voice input, a gesture input, or inputting an operation signal from another terminal.

**[0106]** The operation unit 35, the display unit 2, etc. are not limited to having the configuration installed on the machine body 30, but may be installed separately from the machine body 30, for example. In this case, the operation unit 35 and the display unit 2, etc., are configured to communicable with the machine body 30, realizing a remote control the machine body 30.

(Second Embodiment)

**[0107]** As shown in Fig. 8, in the timing for enabling the PTO control, the control method according to the present embodiment differs from the control system 1 according to the first embodiment. Hereinafter, the same components as those in the first embodiment will be denoted by the same reference signs, and the description thereof will properly be omitted.

**[0108]** A flowchart shown in Fig. 8 differs from the flowchart shown in Fig. 5 in omitting step S6, which enables the work machine 3's control that corresponds to the operation unit 35's operation, and in adding step S16, to between step S8 and step S9, that enables the work machine 3's control that corresponds to the operation unit 35's operation. Other features are as described in the first embodiment, and therefore are omitted here.

**[0109]** That is, in the present embodiment, merely determining that the "determination condition" is met by the fact that all of the operants Sw1 to Sw4 in step S4 are in the neutral position Pn1 (S4: Yes) fails to immediately enable the work machine 3's control (PTO control). That is, the work machine 3's control (PTO control) is enabled (S16) at the timing when it is determined that, after the determination of meeting the determination condition (S4: Yes), with the operation signal acquired afresh (S7), at least one of the operants Sw1 to Sw4, that is operated by the user, is not in the neutral position Pn1 (S8: No).

**[0110]** In this example, until the user operates at least one of the operants Sw1 to Sw4 after the determination of meeting the determination condition, the work machine 3's control (PTO control) is disabled, so the message M1 as in Fig. 7 will continue to be displayed.

**[0111]** Thus, in the present embodiment; the work machine 3's control that corresponds to the operation unit 35's operation is enabled, with the determination condition determined to be met and further with the operation unit 35 operated, after the occurring of the specific event. With this, only when the user (operator) actually operates the operation unit 35, in addition to meeting the determination condition, the work machine 3's control that corresponds to the operation unit 35's operation is enabled, thus making it easy to prevent the work machine 3 from moving due to an unintended operation by the operator.

**[0112]** The configuration according to the second embodiment can be employed in a proper combination with the various configurations (including the modified example) described in the first embodiment.

REFERENCE SIGNS LIST

**[0113]**

1: work machine control system
3: work machine
11: acquisition processing unit
12: monitor processing unit
13: determination processing unit
30: machine body
35: operation unit
371: cutoff switch
341 to 344: output port (PTO port)

**Claims**

**1.** A work machine control method, comprising:

accepting an operation for an operation unit for controlling a work machine;
monitoring a specific event to be monitored; and
determining, with the specific event occurring, whether or not a determination condition for the operation for the operation unit is met.

**2.** The work machine control method as claimed in claim 1, further comprising:
switching, between enabled and disabled, the work

machine's control that corresponds to the operation unit's operation, based on a result of the determining as to whether or not the determination condition is met.

**3.** The work machine control method as claimed in claim 2, wherein
the work machine's control that corresponds to the operation unit's operation is enabled, with the determination condition determined to be met after the occurring of the specific event.

**4.** The work machine control method as claimed in claim 2, wherein
the work machine's control that corresponds to the operation unit's operation is enabled, with the determination condition determined to be met and further with the operation unit operated, after the occurring of the specific event.

**5.** The work machine control method as claimed in any one of claims 1 to 4, wherein
the specific event includes an event that involves a change in the work machine's movement state that corresponds to the operation unit's operation.

**6.** The work machine control method as claimed in claim 5, wherein
the specific event includes switching of a cutoff switch in the work machine from a locked state to an unlocked state.

**7.** The work machine control method as claimed in claim 5 or 6, wherein
the specific event includes a change in a setting for the operation unit's operation.

**8.** The work machine control method as claimed in any one of claims 1 to 7, wherein
the operation for the operation unit includes an operation to control an output of a PTO port of the work machine.

**9.** The work machine control method as claimed in any one of claims 1 to 8, further comprising:
providing a notification that is based on a result of the determining as to whether or not the determination condition is met.

**10.** A work machine control program that causes one or more processors to execute the work machine control method as claimed in any one of claims 1 to 9.

**11.** A work machine control system, comprising:

an acquisition processing unit that accepts an operation for an operation unit for controlling a work machine;

a monitor processing unit that monitors a specific event to be monitored; and
a determination processing unit that determines, with the specific event occurring, whether or not a determination condition for the operation for the operation unit is met.

**12.** A work machine, comprising:

the work machine control system as claimed in claim 11; and
a machine body controlled in response to the operation for the operation unit.

FIG. 1

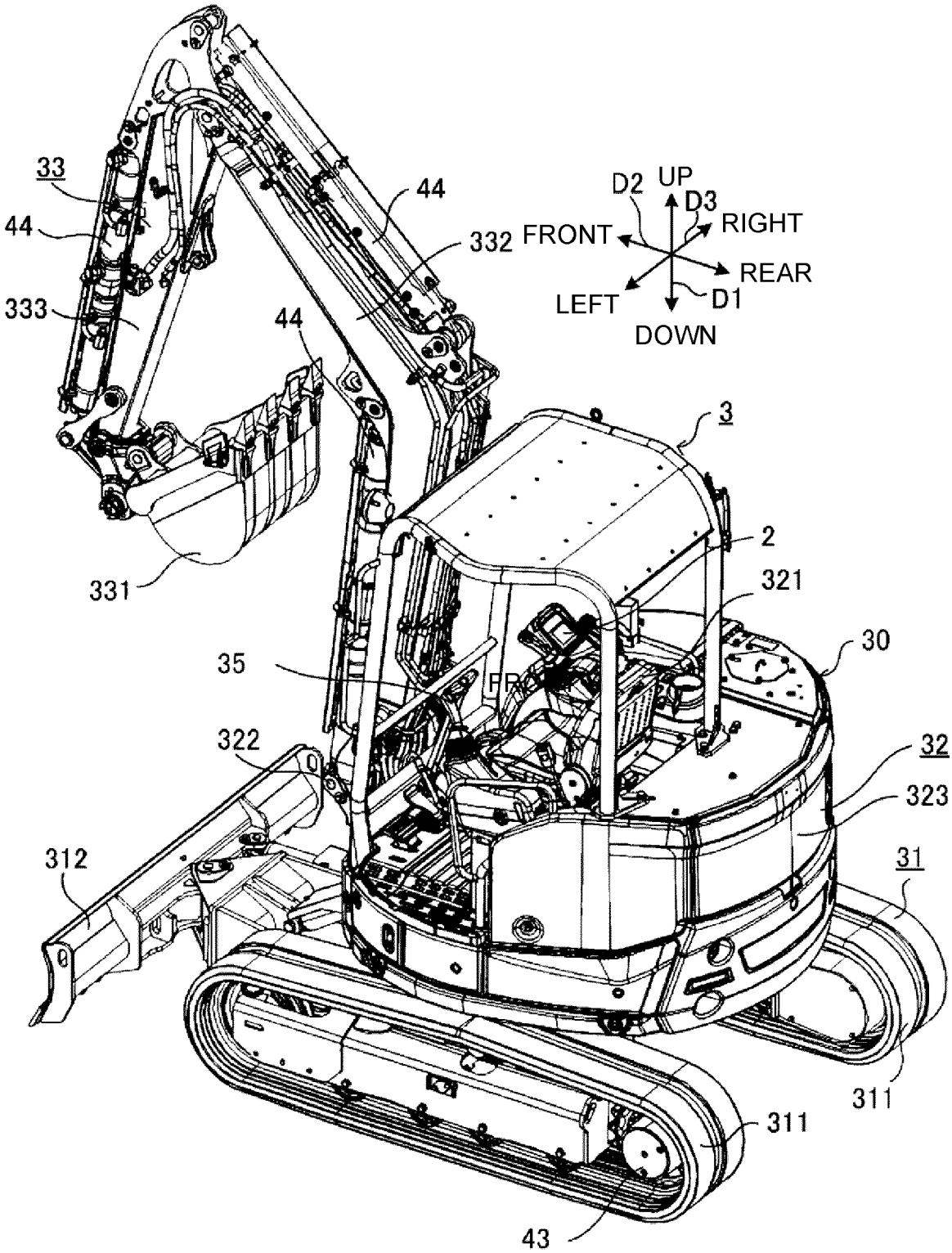

33
44
333
44
44
332
331
D2
UP
D3
RIGHT
FRONT
REAR
LEFT
D1
DOWN
3
2
321
30
35
322
32
323
312
31
311
311
43

FIG. 2

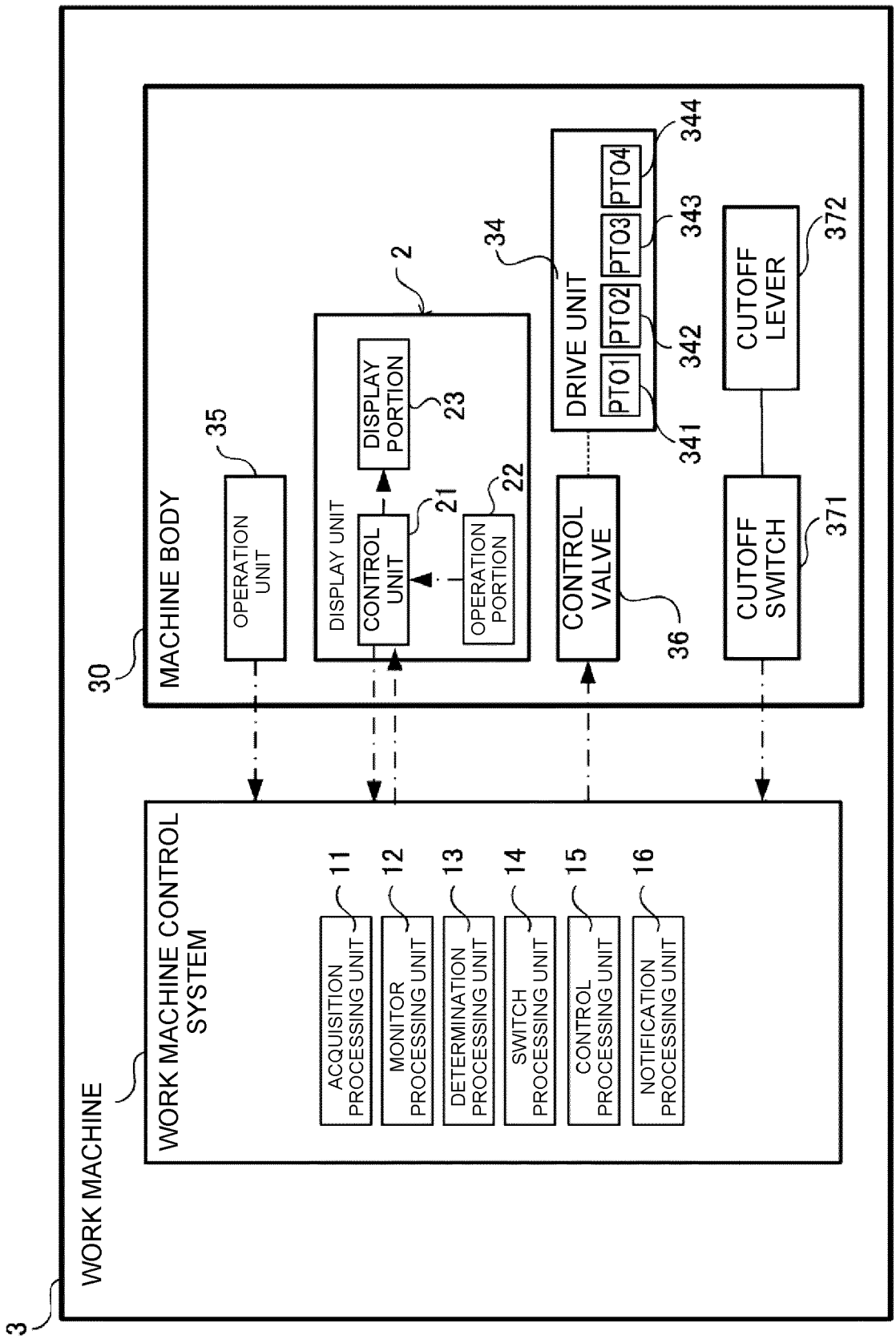

3
WORK MACHINE
WORK MACHINE CONTROL SYSTEM
11
ACQUISITION PROCESSING UNIT
12
MONITOR PROCESSING UNIT
13
DETERMINATION PROCESSING UNIT
14
SWITCH PROCESSING UNIT
15
CONTROL PROCESSING UNIT
16
NOTIFICATION PROCESSING UNIT
30
MACHINE BODY
35
OPERATION UNIT
2
DISPLAY UNIT
DISPLAY PORTION
23
CONTROL UNIT
21
OPERATION PORTION
22
34
DRIVE UNIT
PT01
PT02
PT03
PT04
341
342
343
344
CONTROL VALVE
36
CUTOFF SWITCH
371
CUTOFF LEVER
372

FIG. 3

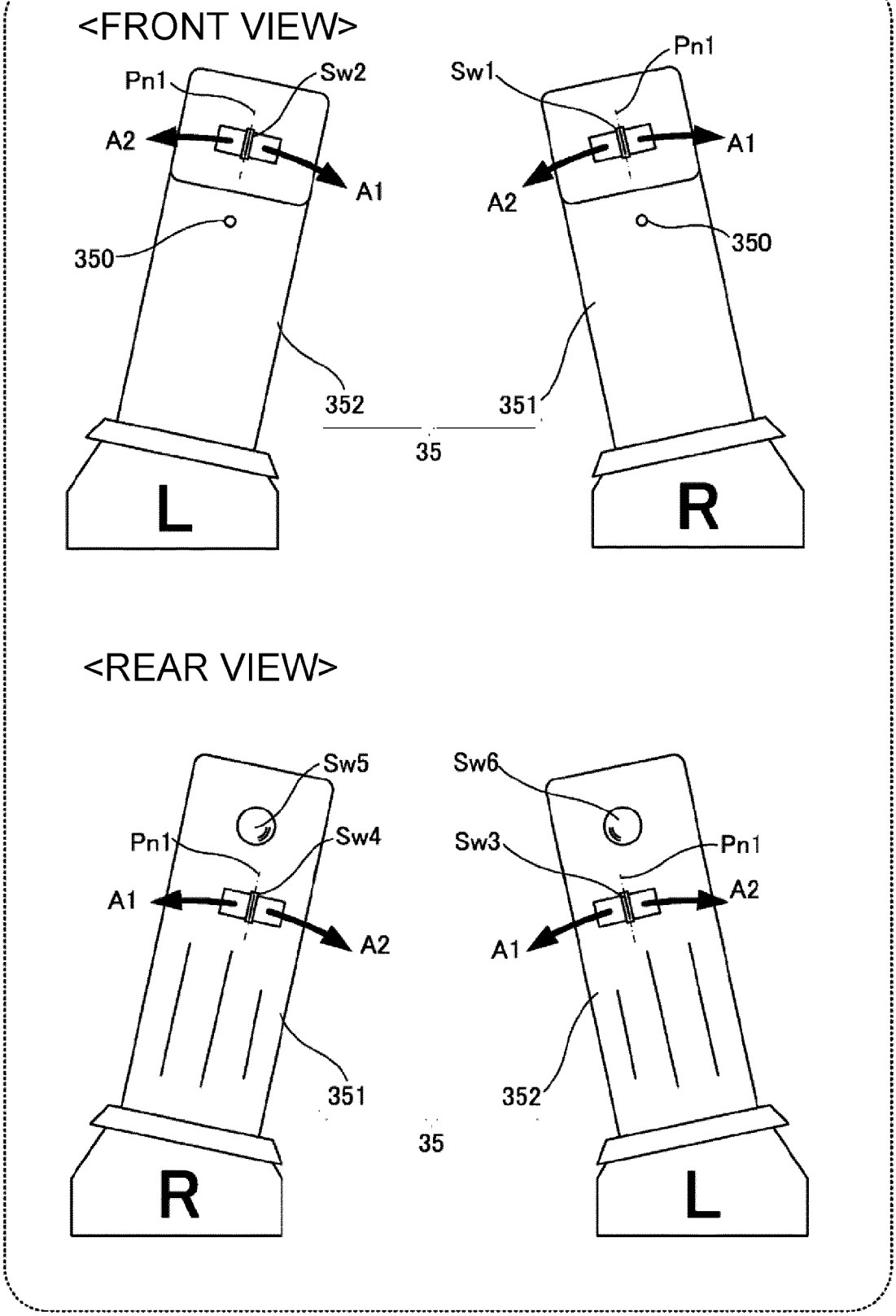

<FRONT VIEW>
Pn1
Sw2
A2
A1
350
352
L
Sw1
Pn1
A1
A2
350
351
R
35
<REAR VIEW>
Sw5
Pn1
Sw4
A1
A2
351
R
Sw6
Sw3
Pn1
A2
A1
352
L
35

FIG. 4

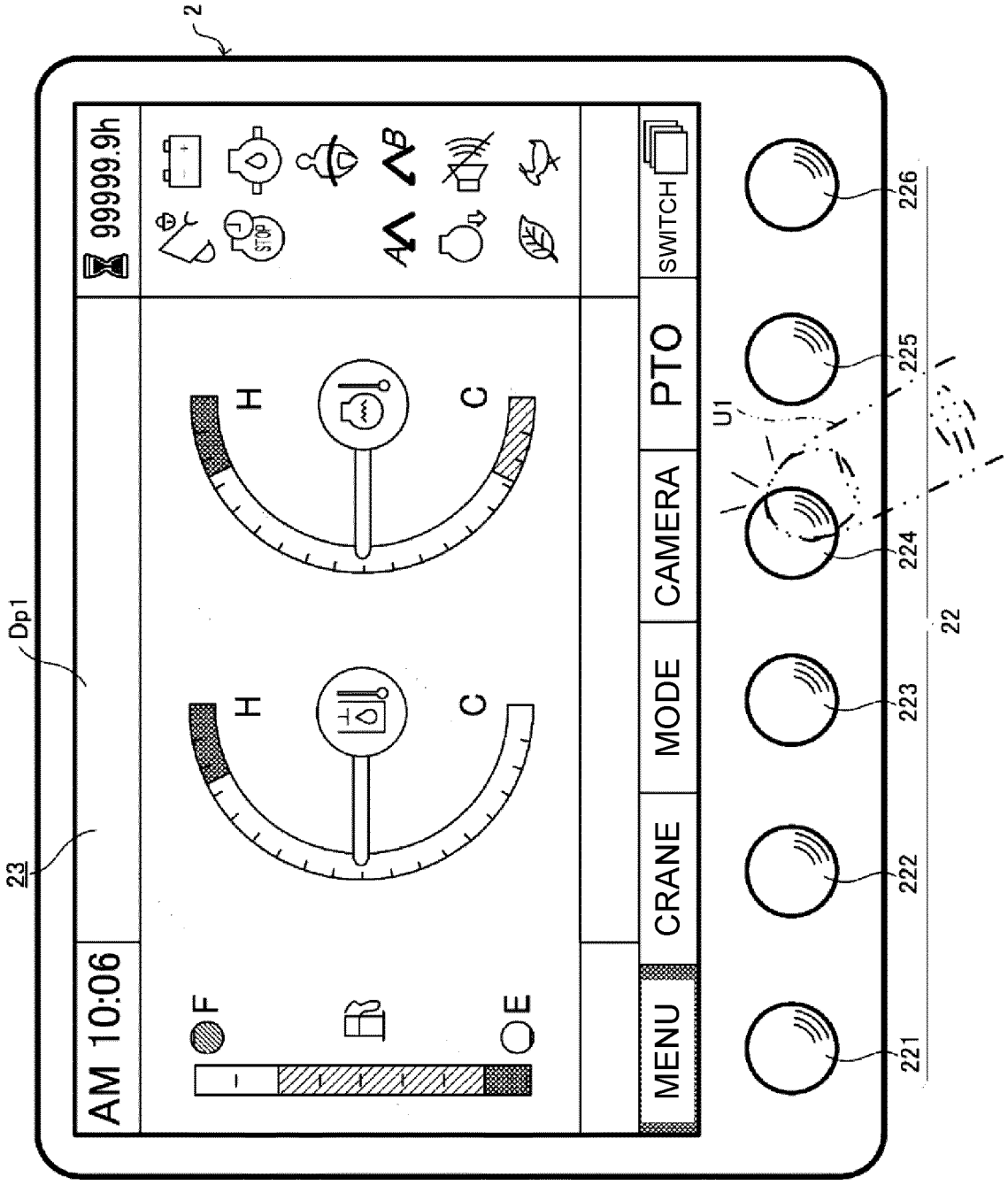

2
Dp1
23
AM 10:06
99999.9h
F
E
H
C
H
C
MENU
CRANE
MODE
CAMERA
PTO
SWITCH
U1
221
222
223
224
225
226
22

FIG. 5

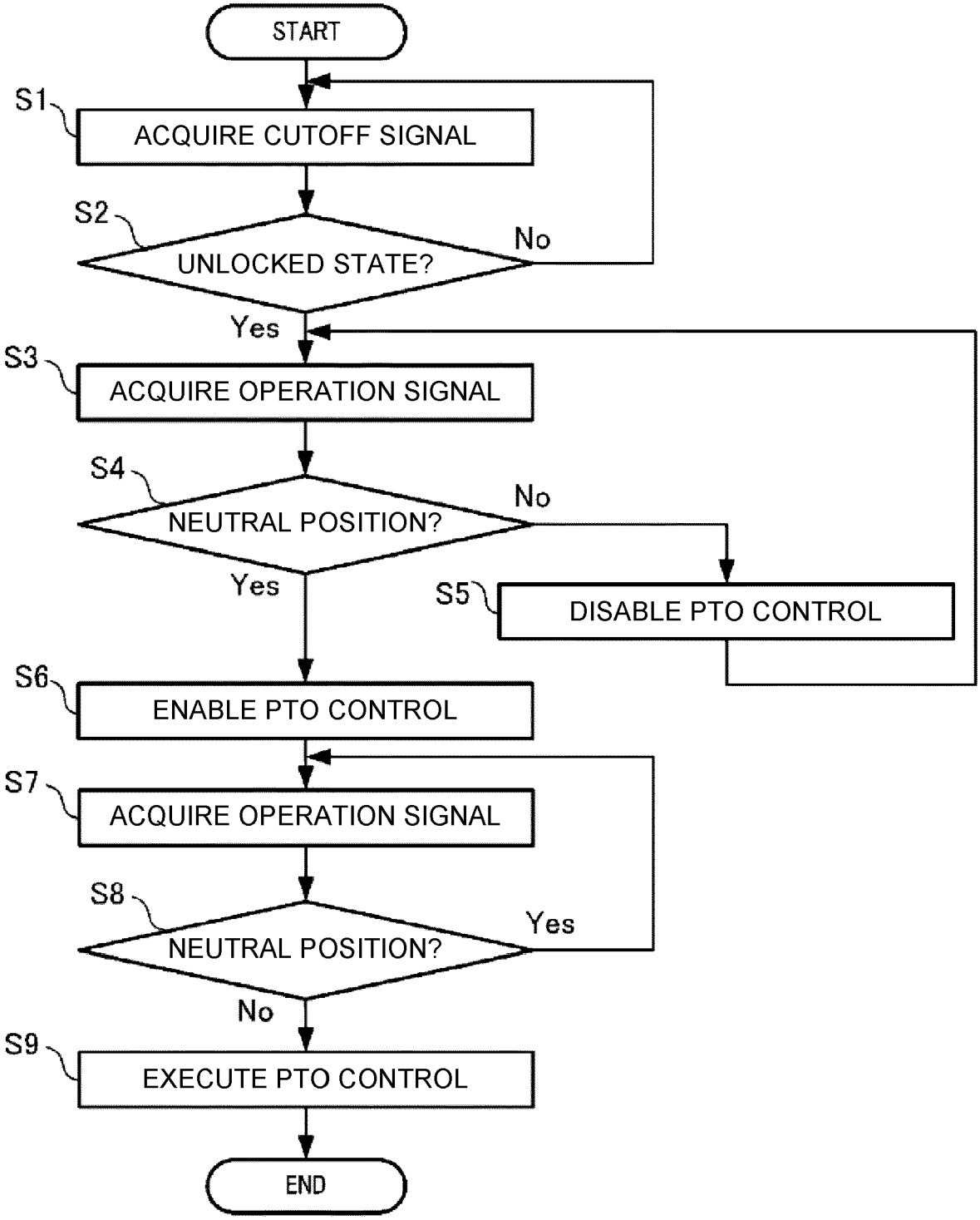

START
S1
ACQUIRE CUTOFF SIGNAL
S2
UNLOCKED STATE?
No
Yes
S3
ACQUIRE OPERATION SIGNAL
S4
NEUTRAL POSITION?
No
Yes
S5
DISABLE PTO CONTROL
S6
ENABLE PTO CONTROL
S7
ACQUIRE OPERATION SIGNAL
S8
NEUTRAL POSITION?
Yes
No
S9
EXECUTE PTO CONTROL
END

FIG. 6

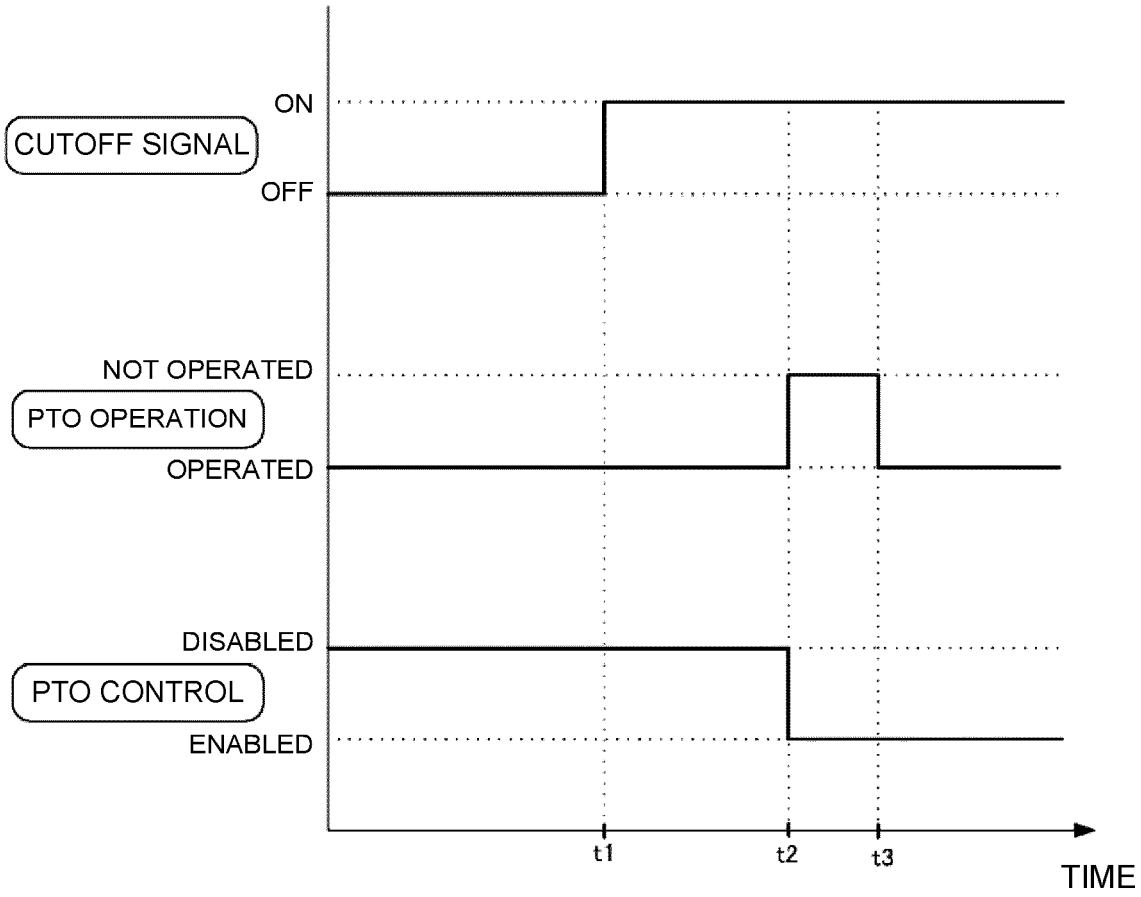

CUTOFF SIGNAL
ON
OFF
PTO OPERATION
NOT OPERATED
OPERATED
PTO CONTROL
DISABLED
ENABLED
t1
t2
t3
TIME

FIG. 7

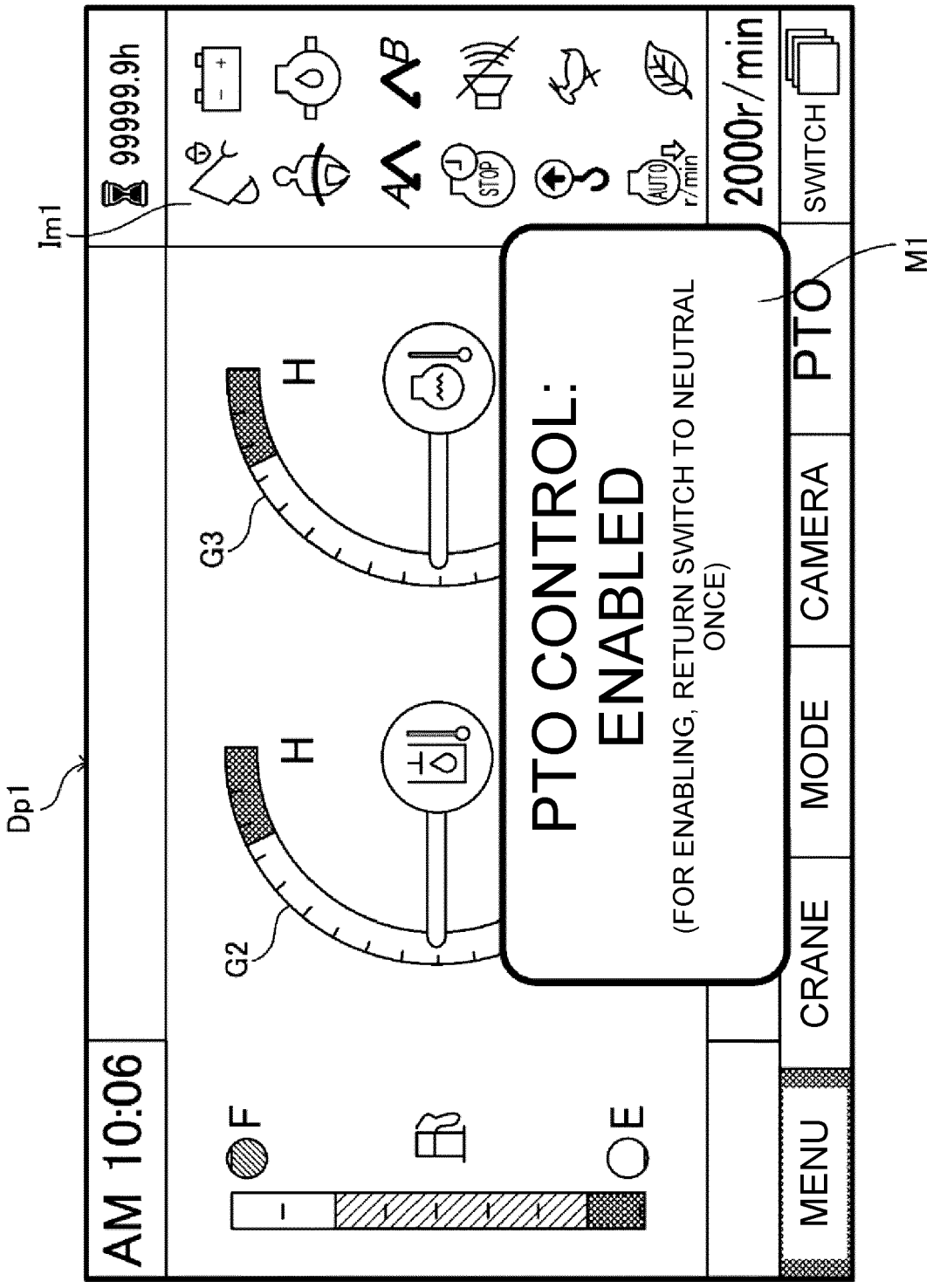
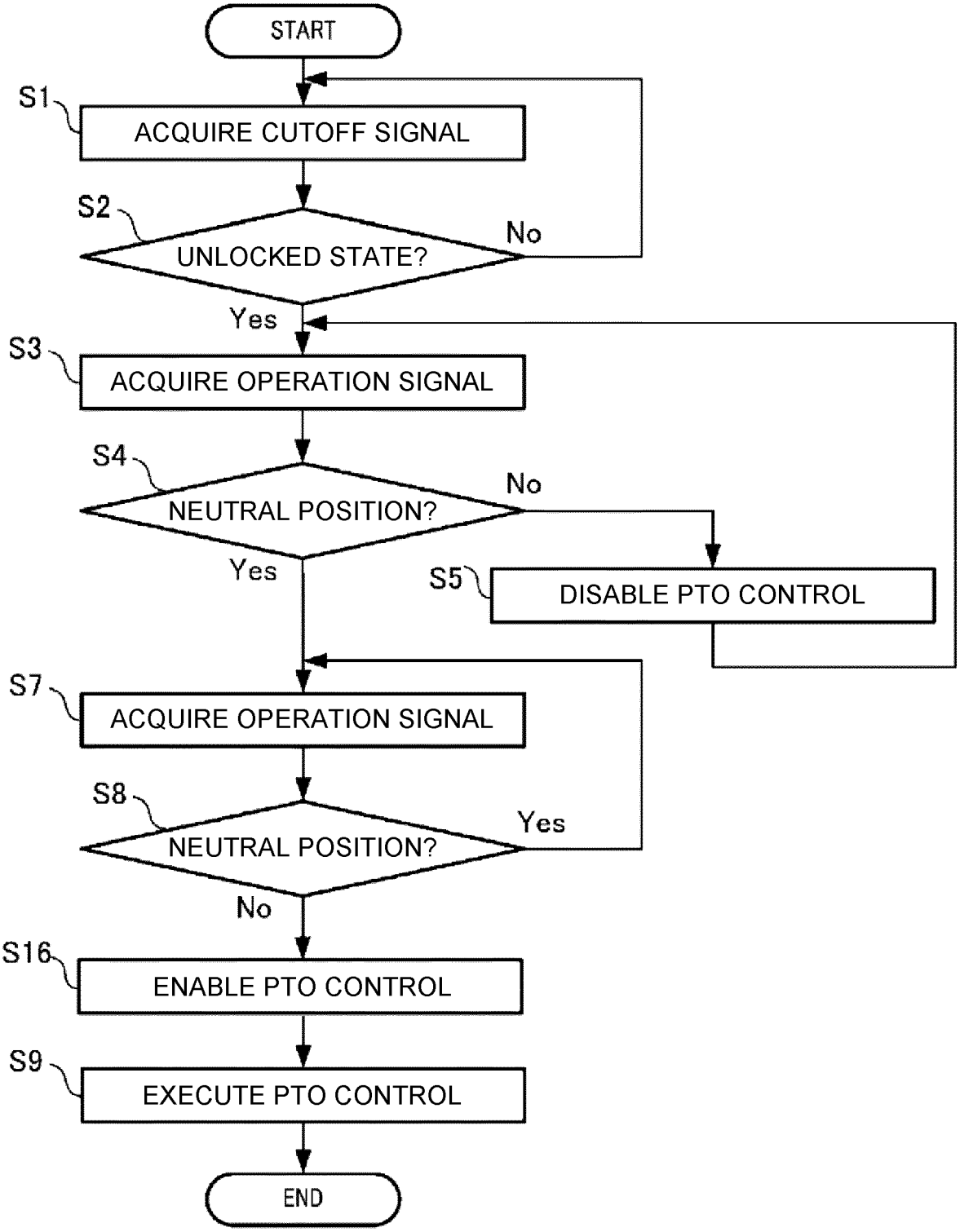

Dp1
Im1
M1
99999.9h
2000r/min
SWITCH
AM 10:06
F
E
G2
G3
H
H
PTO CONTROL:
ENABLED
(FOR ENABLING, RETURN SWITCH TO NEUTRAL ONCE)
MENU
CRANE
MODE
CAMERA
PTO

FIG. 8


START
S1
ACQUIRE CUTOFF SIGNAL
S2
UNLOCKED STATE?
No
Yes
S3
ACQUIRE OPERATION SIGNAL
S4
NEUTRAL POSITION?
No
Yes
S5
DISABLE PTO CONTROL
S7
ACQUIRE OPERATION SIGNAL
S8
NEUTRAL POSITION?
Yes
No
S16
ENABLE PTO CONTROL
S9
EXECUTE PTO CONTROL
END

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# EUROPEAN SEARCH REPORT

Application Number
EP 22 20 4838

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| | | | E02F |

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|---|---|---|
| Munich | 6 April 2023 | Clarke, Alister |

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