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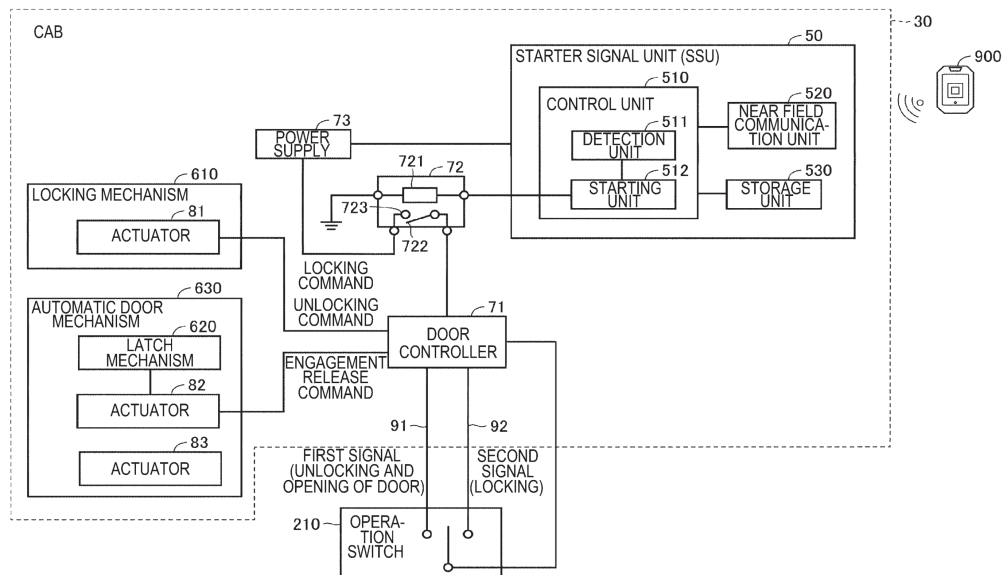
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(54) **WORK MACHINE AND METHOD FOR CONTROLLING WORK MACHINE**

(57) A work machine includes a cab having an entry door, an operation switch for the door, an automatic door mechanism configured to automatically open the door, and a controller configured to detect an operator

present in a vicinity of the work machine and output a command to open the door to the automatic door mechanism on condition that an operation of the operation switch is accepted.

FIG. 7



Description

Technical Field

[0001] The present disclosure relates to a work machine and a control method for a work machine.

Background Art

[0002] According to the related art, various work machines including a work implement are known. For example, JP2022-157162A (PTL 1) discloses a starting system of such a work machine.

[0003] The starting system of PTL 1 activates a vehicle body control unit when it is authenticated that the operator on board the work implement is a specific operator. The starting system unlocks the door when the specific operator is present in the vicinity of the work machine. The starting system does not perform the unlocking when the specific operator is not present in the vicinity of the work machine.

Citation List

Patent Literature

[0004] PTL 1: JP2022-157162A

Summary of Invention

Technical Problem

[0005] In PTL 1, when the specific operator is present in the vicinity of the work machine, the work machine automatically unlocks the locked door. However, in PTL 1, even when the door is unlocked, the door is in a closed state. Therefore, the operator needs to manually open the door.

[0006] The present disclosure provides a work machine that does not require the operator to manually open the door, and a control method for the work machine.

Solution to Problem

[0007] A work machine according to an aspect of the present disclosure includes a cab having an entry door, an operation switch for the door, an automatic door mechanism configured to automatically open the door, and a controller configured to detect an operator present in a vicinity of the work machine and output a command to open the door to the automatic door mechanism on condition that an operation of the operation switch is accepted.

Advantageous Effects of Invention

[0008] According to the present disclosure, the op-

erator does not need to manually open the door of the work machine.

Brief Description of Drawings

[0009]

[FIG. 1] FIG. 1 is a side view showing a wheel loader.

[FIG. 2] FIG. 2 is a diagram showing a left-side door.

[FIG. 3] FIG. 3 is an enlarged view of a main part around a ladder.

[FIG. 4] FIG. 4 is a diagram showing a state where a lid is opened.

[FIG. 5] FIG. 5 is a diagram illustrating a device arrangement around a door in a cab.

[FIG. 6] FIG. 6 is a diagram illustrating an actuator.

[FIG. 7] FIG. 7 is a block diagram illustrating the hardware configuration and the functional configuration of the wheel loader.

[FIG. 8] FIG. 8 is a flowchart illustrating a flow of processing executed in the wheel loader.

25 Description of Embodiments

[0010] Hereinafter, an embodiment will be described with reference to the drawings. In the description below, the same components are denoted by the same reference signs. The names and functions thereof are also the same. Therefore, a detailed description thereof will not be repeated.

[0011] In the description below, the term "automatically" may mean "spontaneously operate without anything being done" or may mean "operate in response to an operation of a switch or the like and do not require a manual operation".

[Overall Configuration]

[0012] In the embodiment, first, the configuration of a wheel loader, which is an example of the work machine according to the present disclosure, will be described. FIG. 1 is a side view showing a wheel loader 10 according to an embodiment of the present disclosure.

[0013] As shown in FIG. 1, the wheel loader 10 includes a front frame 12, a rear frame 14, a front wheel 26, a rear wheel 27, a work implement 16, a cab (operator cab) 30, and a rear structure 18.

[0014] In the description below, a direction in which the wheel loader 10 travels straight is referred to as a front-rear direction of the wheel loader 10. In the front-rear direction of the wheel loader 10, a side where the work implement 16 is disposed with respect to the front frame 12 and the rear frame 14 is defined as a front direction, and a side opposite to the front direction is defined as a rear direction. A left-right direction of the wheel loader 10 is a direction orthogonal to the front-

rear direction when viewed in a plan view. The right side and the left side in the left-right direction when the operator seated on the operator's seat of the wheel loader 10 views the front direction are a right direction and a left direction, respectively. An up-down direction of the wheel loader 10 is a direction orthogonal to a plane defined by the front-rear direction and the left-right direction. In the up-down direction, the side where the ground is present is a lower side, and the side where the sky is present is an upper side.

[0015] The front frame 12 and the rear frame 14 form a vehicle body frame having an articulated structure. The front frame 12 is provided to the front of the rear frame 14. The front frame 12 is rotatably connected to the rear frame 14 via a center pin (not illustrated). The rotation center of the front frame 12 with respect to the rear frame 14 is an axis extending in the up-down direction.

[0016] The front frame 12 and the rear frame 14 are coupled by a steering cylinder (not illustrated). A pair of left and right steering cylinders are provided. When the steering cylinders are driven to extend and retract, the front frame 12 rotates to the left and right about the center pin.

[0017] The front wheel 26 and the rear wheel 27 are traveling wheels of the wheel loader 10. The front wheel 26 is provided on the front frame 12. A pair of left and right front wheels 26 are provided. The rear wheel 27 is provided on the rear frame 14. A pair of left and right rear wheels 27 are provided.

[0018] The work implement 16 is provided on the front frame 12. The work implement 16 includes a boom 21, a bucket 24, a boom cylinder 21A, a bell crank 22, a bucket cylinder 24A, and a link 23.

[0019] The cab 30 and the rear structure 18 are provided on the rear frame 14. The cab 30 is provided to the rear of the work implement 16. An operator gets on board the cab 30 and performs a traveling operation of the wheel loader 10 and an operation of the work implement 16.

[0020] The rear structure 18 is provided to the rear of the cab 30. The rear structure 18 includes a hydraulic oil tank, an engine, a hydraulic pump, and the like. The front frame 12, the rear frame 14, and the rear structure 18 form a vehicle body 11 of the wheel loader 10.

[Configuration of Cab]

[0021] Next, the structure of the cab 30 will be described. The cab 30 has a cab body 31. The cab body 31 defines an indoor space of the cab 30. The cab body 31 is formed of, for example, a steel plate and a transparent window combined together.

[0022] The cab body 31 has a hexagonal shape when viewed from the top view. The cab body 31 has a front side surface 32, a rear side surface 33, a left side surface 34, a right side surface (not illustrated), an obliquely left front side surface 36, and an obliquely right

front side surface (not illustrated).

[0023] The front side surface 32 faces forward. The rear side surface 33 faces rearward. The length of the front side surface 32 in the left-right direction is shorter than the length of the rear side surface 33 in the left-right direction. The right side surface is provided to face rightward. The right side surface is disposed between the front side surface 32 and the rear side surface 33. The right side surface continues to a right end part of the rear side surface 33. The left side surface 34 faces leftward. The left side surface 34 is disposed between the front side surface 32 and the rear side surface 33. The left side surface 34 continues to a left end part of the rear side surface 33.

[0024] The obliquely left front side surface 36 is provided to face obliquely left forward. The obliquely left front side surface 36 is disposed between the front side surface 32 and the left side surface 34. The obliquely left front side surface 36 continues to a left end part of the front side surface 32 and a front end part of the left side surface 34. The obliquely right front side surface is provided to face obliquely right forward. The obliquely right front side surface is disposed between the front side surface 32 and the right side surface. The obliquely right front side surface continues to a right end part of the front side surface 32 and a front end part of the right side surface. The distance between the obliquely left front side surface 36 and the obliquely right front side surface in the left-right direction decreases from the rear toward the front.

[0025] The cab body 31 of the cab 30 is not limited to the above-described hexagonal top view, and may have, for example, a rectangular top view.

[0026] The cab 30 has a left-side door 61 and a right-side door (not illustrated). The left-side door 61 and the right-side door are entry doors for the operator to get on board the cab 30. Both the left-side door 61 and the right-side door are provided so as to be rotatable with respect to the cab body 31. Both the left-side door 61 and the right-side door are provided so as to be able to open and close a doorway of the cab body 31.

[0027] The door 61 is provided on the left side of the cab body 31. The door 61 is provided on the left side surface 34. The door 61 can be opened and closed not only manually but also automatically. The right-side door is provided on the right side of the cab body 31. The right-side door is provided on the right side surface. In this example, the right-side door is a manual door that can be manually opened and closed. However, similarly to the left-side door 61, the right-side door may be configured to be able to be opened and closed manually or automatically.

[Configuration of Left-Side Door]

[0028] Next, the structure of the door 61 and the structure around the door 61 will be described.

[0029] A doorway is formed in the cab body 31. The

doorway is an opening provided in the cab body 31 for the operator to get on board and leave the cab 30. The doorway has a rectangular opening shape in which the up-down direction is the longitudinal direction as a whole. The doorway is provided on the left side surface 34 and the right side surface.

[0030] The door 61 is provided at the doorway formed on the left side surface 34. The door 61 is provided to be movable between a closed position in which the doorway is in a closed state and an open position in which the doorway is in an open state. The door 61 opens and closes the doorway.

[0031] The door 61 includes a hinge part 62. The door 61 is rotatably supported by the cab body 31 via the hinge part 62. The door 61 is provided to be rotatable between the closed position and the open position about the hinge part 62. The door 61 is of an outward-opening type that opens outward of the cab 30. The door 61 is a rear-hinge type in which the hinge part 62 is disposed on the rear side of the doorway.

[0032] When the door 61 is in the closed position, the door 61 is disposed parallel to the left side surface 34. When the door 61 is in the open position, the door 61 is disposed so as to extend in an obliquely left rear direction from the rear end of the opening formed by the doorway. The open position of the door 61 is located to the rear of the doorway.

[0033] The wheel loader 10 further includes a ladder 41. The cab 30 is disposed above the ladder 41. The ladder 41 is provided between the ground and the cab 30. The ladder 41 is used when the operator moves up and down between the ground and the cab 30.

[0034] The ladder 41 is attached to left and right side surfaces of the rear frame 14. The ladder 41 has a plurality of steps 42. The steps 42 form a scaffold on which the operator can put his or her foot. The plurality of steps 42 are arranged at intervals in the up-down direction.

[0035] FIG. 2 is a diagram illustrating the left-side door 61. As shown in FIG. 2, the door 61 includes a key cylinder 601, and a door handle (door knob) 602 outside the vehicle, in addition to the hinge part 62. The operator can manually unlock the locked door 61 by inserting a key (not illustrated) into the key cylinder 601 and rotating the key in a predetermined direction. After the door 61 is unlocked, the operator can shift the door 61 from the closed position to the open position by operating the door handle 602. As will be described in detail later, when the door 61 is automatically opened and closed, the operator does not need to perform such a key operation and the operation of the door handle 602.

[Operation Switch Outside Cab]

[0036] FIG. 3 is an enlarged view of a main part around the ladder 41. As shown in FIG. 3, a lid 202 is provided between two consecutive steps 42 when the

ladder 41 is viewed from the front side. In this example, the lid 202 is provided between the fourth step 42 and the fifth step 42 from the bottom. The lid 202 is provided between the steps 42 so that the lid 202 can be opened and closed. From the viewpoint of operability, the lid 202 is preferably provided at a position (height) where the lid 202 can be opened and closed in a state where the operator is standing.

[0037] The lid 202 includes a hinge part 203. The lid 202 is attached to a side wall 201 of the vehicle body 11 so as to be able to open and close via the hinge part 203. The lid 202 is not locked and is always openable and closable. In this example, the lid 202 does not have a locking function. However, the present invention is not limited thereto, and the lid 202 may have a locking function.

[0038] The lid 202 is provided with a knob 204 for opening the lid 202. A cushion material, not illustrated, is provided on the front side of the lid 202. The cushion material reduces impact when the lid 202 collides with the ladder 41 when the lid 202 is opened. In this way, the operator can freely open and close the lid 202.

[0039] FIG. 4 is a diagram showing a state where the lid 202 is opened. As shown in FIG. 4, as the lid 202 is opened, an operation switch 210 for the door 61 is exposed to the outside. Thus, the operation switch 210 is disposed outside the cab 30. The operation switch 210 includes a lever 211. In this example, the operation switch 210 is a three-position momentary toggle switch.

[0040] The operation switch 210 is also provided at a position lower than the cab 30 so that the operator standing on the ground can easily operate the operation switch 210. The operation switch 210 is installed near the ladder 41 so that the operator can easily operate the operation switch 210 before getting on board the cab 30. The operation switch 210 in a state of being covered by the lid 202 is installed in the wheel loader 10. The operation switch 210 is operated by the operator immediately before the operator gets on the cab 30 and after the operator gets out of the cab 30.

[0041] The operation switch 210 can shift the lever 211 from an OFF position to a first ON position. The operation switch 210 shifts the lever 211 from the OFF position to a second ON position.

[0042] The operation switch 210 is in the OFF position when the lever 211 is in a neutral position. When the lever 211 is tilted upward by the operator, the operation switch 210 is in the first ON position. When the lever 211 is tilted downward by the operator, the operation switch 210 is in the second ON position. In this way, the operation switch 210 can shift the lever 211 to any one of the OFF position, the first ON position, and the second ON position. Since the operation switch 210 is a momentary switch, the lever 211 automatically returns to the neutral position (OFF position) when the operator releases his or her hand from the tilted lever 211.

[0043] As will be described in detail later, in this ex-

ample, the first ON position is the unlocking position of the key. The second ON position is the locking position of the key. However, the present invention is not limited thereto, and the wheel loader 10 (specifically, a door controller 71, described later) may be configured such that the first ON position is the locking position of the key and the second ON position is the unlocking position of the key.

[0044] In the above description, the operation switch 210 is installed so that the lever 211 is tilted up and down, but the present invention is not limited thereto. The operation switch 210 may be installed such that the lever 211 tilts to the left and right. The type of the operation switch 210 is not particularly limited. The operation switch 210 may have two ON positions and an OFF position. For example, the operation switch 210 may be a three-position alternate toggle switch.

[0045] The lever 211 is an example of an "operation unit" according to the present disclosure. The operation of tilting the lever 211 upward is an example of a "first operation" according to the present disclosure. The operation of tilting the lever 211 downward is an example of a "second operation" according to the present disclosure.

[Mechanism Related to Left-Side Door]

[0046] FIG. 5 is a diagram illustrating a device arrangement around the door 61 in the cab 30. As shown in FIG. 5, the wheel loader 10 further includes a door lock knob 611 and covers 691, 692. The wheel loader 10 further includes an automatic door mechanism 630 (see FIG. 7) that automatically opens the unlocked door 61. The automatic door mechanism 630 includes a latch mechanism 620, an actuator 82, and an actuator 83 (see FIG. 6).

[0047] In a state where the door 61 is locked, the door lock knob 611 is at a pressed position. In a state where the door 61 is unlocked, the door lock knob 611 is at a raised position. When the operator in the cab 30 presses down the door lock knob 611 (in the direction of an arrow D2) in the state where the door 61 is unlocked, the door 61 is locked. When the operator in the cab 30 pulls up the door lock knob 611 (in the direction of an arrow D1) in the state where the door 61 is locked, the door 61 is unlocked. The position of the door lock knob 611 is interlocked with the rotation operation of the key inserted into the key cylinder 601.

[0048] The latch mechanism 620 includes a catcher 621 provided on the door 61, a striker 622 provided on the cab body 31, and an operation lever 623. The latch mechanism 620 holds the door 61 at the closed position by engaging the catcher 621 with the striker 622. A part of the catcher 621 is covered by the cover 691.

[0049] Upon accepting a manual operation (operation in the direction of an arrow D3) by the operator in the cab 30 when the door 61 is in the unlocked state, the operation lever 623 releases the engagement be-

tween the catcher 621 and the striker 622. After the engagement is released, the operator in the cab 30 pushes the door 61 in a direction toward the outside of the cab 30 and thus the position of the door 61 shifts from the closed position to the open position.

[0050] The wheel loader 10 further includes a locking mechanism 610 (see FIG. 7) that locks and unlocks the door 61. The locking mechanism 610 includes the key cylinder 601, the door lock knob 611, a link mechanism (not illustrated) that operates in conjunction with the key cylinder 601 and the door lock knob 611, and an actuator 81. The link mechanism is covered by the cover 691 and the cover 692.

[0051] The actuator 81 automatically unlocks the locked door 61 and automatically locks the unlocked door 61. The actuator 81 is covered by the cover 692. The actuator 81 is, for example, a motor-driven actuator.

[0052] The actuator 82 is covered by the cover 692. The actuator 82 causes the latch mechanism 620 to operate and release the holding of the door 61 in the closed position. The actuator 82 automatically releases the engagement between the catcher 621 and the striker 622 by causing the catcher 621 to operate at the closed position. The actuator 82 is, for example, a solenoid actuator.

[0053] FIG. 6 is a diagram illustrating the actuator 83. As shown in FIG. 6, in this example, the actuator 83 is a gas spring. The actuator 83 includes a cylinder 831 and a rod 832.

[0054] The cylinder 831 includes a pressure tube (not illustrated). Gas and oil are enclosed in the pressure tube. The rod 832 has a piston (not illustrated) located in the cylinder 831. An end part 834 of the rod 832 opposite to the piston is attached to the cab body 31. An end part 833 of the cylinder 831 opposite to the rod 832 is attached to the door 61.

[0055] The actuator 83 is rotatably attached to the cab body 31 and the door 61. The actuator 83 is rotatable with respect to the cab body 31 by having the end part 834 connected to the cab body 31 with a pin or the like. The actuator 83 is rotatable with respect to the door 61 by having the end part 833 connected to the door 61 with a pin or the like.

[0056] In the state where the door 61 is closed (closed position), the piston is moved to the end part 833 side. Thus, the gas in the cylinder is compressed. In this state, a force (reaction force) is applied to the rod 832 in a direction in which the rod 832 is pushed out from the cylinder 831.

[0057] When the engagement between the catcher 621 and the striker 622 in the latch mechanism 620 is released, the rod 832 moves in a direction of protruding from the cylinder 831 due to the reaction force applied to the rod 832. Thus, the door 61 automatically opens. Specifically, the position of the door 61 automatically shifts from the closed position to the open position. Thus, the actuator 83 rotates the door 61 in the opening

direction in the state where the engagement between the catcher 621 and the striker 622 is released.

[0058] The actuator 81 is an example of a "first actuator" according to the present disclosure. The actuator 82 corresponds to a "second actuator" according to the present disclosure.

[Block Diagram]

[0059] FIG. 7 is a block diagram illustrating the hardware configuration and the functional configuration of the wheel loader 10. As shown in FIG. 7, the cab 30 further includes a starter signal unit 50, a door controller 71, a relay 72, and a power supply 73, in addition to the locking mechanism 610 including the actuator 81, and the automatic door mechanism 630 including the latch mechanism 620 and the actuators 82, 83. The relay 72 includes a coil 721, a moving contact 722, and a fixed contact 723.

[0060] The starter signal unit 50 is constantly supplied with electric power from the power supply 73. The power supply 73 is connected to the fixed contact 723. As will be described in detail later, the starter signal unit 50 detects that the operator is present in the vicinity of the wheel loader 10, based on predetermined information that is associated with the operator and received from a terminal device 900 carried by the operator. Thus, the operator can notify the wheel loader 10 of the presence of the operator himself or herself, simply by carrying the terminal device 900.

[0061] The relay 72 is provided between the power supply 73 and the door controller 71. The door controller 71 is connected to the moving contact 722 side of the relay 72.

[0062] The starter signal unit 50 includes a control unit 510, a near field communication unit 520, and a storage unit 530. The control unit 510 includes a detection unit 511 and a starting unit 512. As will be described in detail later, the detection unit 511 detects the operator present in the vicinity of the wheel loader 10. The detection unit 511 detects an operator of the wheel loader 10. When the operator approaches the wheel loader 10, the detection unit 511 detects the operator.

[0063] The near field communication unit 520 communicates with the terminal device 900 carried by the operator. In this example, the near field communication unit 520 can communicate with the terminal device 900 via Bluetooth (registered trademark). Specifically, in this example, wireless communication according to a wireless standard called "Bluetooth low energy (BLE)" is used as the communication between the near field communication unit 520 and the terminal device 900. The terminal device 900 is an RFID tag (IC tag, key fob). The terminal device 900 may be a device having a screen such as a smartphone.

[0064] The near field communication unit 520 performs a scan at each predetermined scan timing and determines whether an advertisement packet is re-

ceived. When an advertisement packet is not received, the detection unit 511 determines that the operator is not present in the vicinity of the wheel loader 10 (specifically, in the vicinity of the starter signal unit 50).

[0065] When an advertisement packet is received, the near field communication unit 520 reads a device identification (ID) and an operator ID from the advertisement packet. When the read device ID is not an ID indicating the wheel loader 10, the detection unit 511 determines that the operator is not present in the vicinity of the wheel loader 10.

[0066] When the read device ID is an ID indicating the wheel loader 10, the detection unit 511 determines whether an authority flag that is associated with the operator ID read from the advertisement packet is ON in the storage unit 530. When the authority flag is OFF, the detection unit 511 determines that the operator is not present in the vicinity of the wheel loader 10. When the authority flag is ON, the detection unit 511 determines that the operator is present in the vicinity of the wheel loader 10.

[0067] When the detection unit 511 determines that the operator is present in the vicinity of the wheel loader 10, the detection unit 511 sends a predetermined signal to the starting unit 512. Upon receiving the predetermined signal, the starting unit 512 causes a current to flow through the coil 721 of the relay 72. When the current flows through the coil 721, the moving contact 722 moves, and the moving contact 722 and the fixed contact 723 come into contact with each other.

[0068] As described above, when the operator is detected by the detection unit 511, the starting unit 512 turns the relay 72 into an ON state. When the relay 72 is in the ON state, electric power is supplied from the power supply 73 to the door controller 71. The door controller 71 is activated when electric power is supplied from the power supply 73. Moreover, electric power is supplied to the operation switch 210 via the door controller 71.

[0069] As described above, when the operator is detected, the starter signal unit 50 outputs a signal to turn the relay 72 into the ON state, thereby activating the door controller 71, and enabling the operation switch 210. As described above, since the operation switch 210 is enabled when the operator is detected, the operator does not need to perform an operation of enabling the operation switch 210.

[0070] The operation switch 210 is electrically connected to the door controller 71 via a first path 91 and a second path 92. The first path 91 and the second path 92 are wires. The operation switch 210 is OFF as illustrated in a state where no operation is accepted. Specifically, the position of the lever 211 (see FIG. 4) of the operation switch 210 is the OFF position (neutral position).

[0071] When the operation switch 210 accepts an operation of tilting the lever 211 upward, a first signal is transmitted from the operation switch 210 to the door

controller 71 via the first path 91. When the operation switch 210 accepts an operation of tilting the lever 211 downward, a second signal is transmitted from the operation switch 210 to the door controller 71 via the second path 92.

[0072] When the operation switch 210 accepts an operation of tilting the lever 211 upward in a state where the door 61 is locked, the door controller 71 unlocks the door 61 and causes the latch mechanism 620 to operate. Specifically, the door controller 71 transmits (outputs) a command (unlocking command) for causing a movable part (not illustrated) of the actuator 81 to operate in a direction of unlocking the door 61, to the actuator 81 of the locking mechanism 610. Upon accepting the unlocking command signal from the door controller 71, the actuator 81 automatically unlocks the locked door 61.

[0073] Subsequently, the door controller 71 transmits (outputs) a command (engagement release command) for causing a movable part (not illustrated) of the actuator 82 to operate in a direction of releasing the engagement by the latch mechanism 620, to the actuator 82 of the automatic door mechanism 630. In this way, the door controller 71 outputs an operation command to the actuator 82 after outputting an operation command to the actuator 81.

[0074] Specifically, the unlocking command, the engagement release command, and a locking command, described later, which are operation commands, are electric signals. The "unlocking command" corresponds to a "command to unlock the door" according to the present disclosure. The "engagement release command" corresponds to a "command to open the door" according to the present disclosure.

[0075] Under the control of the door controller 71, the locked door 61 is unlocked by the actuator 81. The engagement of the unlocked door 61 by the latch mechanism 620 is released under the control of the door controller 71. Specifically, the actuator 82 releases the engagement between the catcher 621 and the striker 622.

[0076] When the engagement between the catcher 621 and the striker 622 in the latch mechanism 620 is released, the rod 832 of the gas spring 170 moves in the direction of protruding from the cylinder 831, as described above. Thus, the door 61 automatically opens. Specifically, the position of the door 61 automatically shifts from the closed position to the open position.

[0077] As described above, when the operator is detected in the state where the door 61 is locked, the door controller 71 outputs an operation command to the locking mechanism 610 and the automatic door mechanism 630 on condition that an operation of unlocking the door with the operation switch 210 is accepted. Specifically, when the operator is detected in the state where the door 61 is locked, the door controller 71 outputs an operation command to the actuator 81 on con-

dition that an operation of unlocking the door 61 with the operation switch 210 is accepted.

[0078] Specifically, when the operator is detected in the state where the door 61 is locked, the door controller 71 unlocks the door 61 and causes the automatic door mechanism 630 to operate to automatically open the door 61, on condition that the operation switch 210 accepts an operation of tilting the lever 211 upward.

[0079] More specifically, the door controller 71 unlocks the door 61 by causing the actuator 81 to operate. The door controller 71 releases the engagement between the catcher 621 and the striker 622 by causing the actuator 82 to operate. When the engagement between the catcher 621 and the striker 622 is released, the door 61 is automatically opened by the actuator 83.

[0080] According to such a configuration, when the operator who is scheduled to perform work with the wheel loader 10 simply carries the terminal device 900, approaches the wheel loader 10, and operates the operation switch 210, the door 61 is unlocked and automatically opened. Therefore, the operator does not need to perform the unlocking operation of the door 61 using the key cylinder 601 and the operation of manually opening the door 61 using the door handle 602.

[0081] When the cab 30 is at a high position, the positions of the key cylinder 601 and the door handle 602 shown in FIG. 2 are also high. In this example, the operation switch 210 is provided at a position lower than the cab 30, as described above. Therefore, the operator does not need to perform the operation of the key cylinder 601 (key operation) and the operation of the door handle 602 at a high position.

[0082] As described above, the operation switch 210 is installed near the ladder 41. Therefore, in this example, the door 61 can be automatically unlocked and automatically opened without putting a foot on the ladder 41 to reach the position of the door 61.

[0083] The operation switch 210 in the state of being covered by the lid 202 that is not locked and is openable and closable is installed in the wheel loader 10. According to such a configuration, the operator approaching the wheel loader 10 can operate the operation switch 210 without performing the unlocking operation of the lid 202.

[0084] The operator on board the cab 30 operates a door handle 65 (see FIG. 6) attached to the inner side surface of the door 61 and thus moves the door 61 from the open position to the closed position. Subsequently, the operator operates the wheel loader 10 while in the cab 30.

[0085] Next, a process when the operator on board the cab 30 gets off the cab 30 after the end of operation will be described. When the work with the wheel loader 10 ends, the operator manually unlocks the locked door 61 while in the cab 30. Specifically, the operator pulls up the door lock knob 611 (FIG. 5). The operator moves the door lock knob 611 in the direction of the arrow D1 in FIG. 5. Thus, the door 61 is manually unlocked.

[0086] Next, the operator moves the operation lever 623 in the direction of the arrow D3 in FIG. 5. Thus, the engagement between the catcher 621 and the striker 622 in the latch mechanism 620 is released. When the engagement is released, the door 61 is automatically opened by the actuator 83.

[0087] Subsequently, the operator gets out of the cab 30 through the doorway. Subsequently, the operator closes the door 61 by operating the door 61 with a hand from outside. Thus, the catcher 621 and the striker 622 are engaged with each other. The operator opens the lid 202 and tilts the lever 211 of the operation switch 210 downward. When the lever 211 is tilted downward, the second signal is transmitted from the operation switch 210 to the door controller 71 via the second path 92, as described above.

[0088] The door controller 71 transmits, to the actuator 81, the command (locking command) for causing the movable part (not illustrated) of the actuator 81 to operate in the direction of locking the door 61. Upon accepting the locking command from the door controller 71, the actuator 81 automatically locks the unlocked door 61.

[0089] In this way, when the actuator 81 accepts the release command from the door controller 71 in the state where the door 61 is unlocked, the actuator 81 automatically locks the door 61. The door controller 71 transmits the locking command to the actuator 81 on condition that the operation switch 210 accepts the operation of tilting the lever 211 downward. Thus, the door 61 is automatically locked.

[0090] According to this, the operator does not need to perform the operation of the key cylinder 601 (key operation) at a high position when getting off the wheel loader 10. The operation of the key cylinder 601 in the state where a foot is put on the step 42 of the ladder 41 is not necessary.

[0091] The starter signal unit 50 is an example of a "first controller" according to the present disclosure. The door controller 71 is an example of a "second controller" according to the present disclosure. A device including at least the starter signal unit 50 and the door controller 71 is an example of a "controller" according to the present disclosure. With such a device, a command to open the door 61 can be output to the automatic door mechanism 630 on condition that the operator present in the vicinity of the wheel loader 10 is detected and that an operation of the operation switch 210 is accepted. Thus, with this device, the operator does not need to manually open the door 61 as described above.

[Control Structure]

[0092] FIG. 8 is a flowchart illustrating a flow of processing executed in the wheel loader 10.

[0093] In step S1, the starter signal unit 50 determines whether the operator is detected. When the op-

erator is detected (YES in step S1), the starting unit 512 of the starter signal unit 50 in step S2 turns on the relay 72 to turn on the power of the door controller 71, and the operation switch 210 is thus enabled. When the operator is not detected (NO in step S1), the near field communication unit 520 of the starter signal unit 50 continues the scan at each predetermined scan timing.

[0094] After step S2, when the lever 211 of the operation switch 210 is tilted upward (YES in step S3), the first signal designating the release of the door 61 and the opening of the door is transmitted from the operation switch 210 to the door controller 71 in step S4. In this example, the signal via the first path 91 is transmitted from the operation switch 210 to the door controller 71.

[0095] In step S5, the door controller 71 transmits the unlocking command to the actuator 81. In step S6, the door controller 71 transmits the engagement release command to the actuator 82. Thus, the door 61 shifts from the closed position to the open position.

[0096] Meanwhile, when the lever 211 of the operation switch 210 is tilted downward (YES in step S7), the second signal designating the locking of the door 61 is transmitted from the operation switch 210 to the door controller 71 in step S8. In this example, the signal via the second path 92 is transmitted from the operation switch 210 to the door controller 71. In step S9, the door controller 71 transmits the locking command to the actuator 81. Thus, the door 61 is automatically locked.

[Modification Example]

[0097] In the above description, a configuration in which the door 61 is moved from the closed position to the open position only by the actuator 83 (a gas spring in this example) has been described as an example, but the present invention is not limited thereto.

[0098] For example, the actuator 83 may include a plurality of actuators. The actuator 83 may include, for example, a gas spring and another actuator controlled by the door controller 71, such as a solenoid. In this case, the gas spring may be moved by the solenoid to a position where the door 61 can be automatically opened by the force of the gas spring alone. When the door 61 is to be opened, the door 61 is opened to a predetermined position by the operation of the solenoid. When the door 61 reaches the predetermined position, the door 61 is automatically moved to the fully open position (open position) by the gas spring. When closing the door 61, the operator manually moves the door 61 to a predetermined position. Subsequently, the door 61 is automatically moved to the closed position by the solenoid.

[0099] Alternatively, the actuator 83 may be an actuator controlled by a controller, such as a solenoid, without using a gas spring as the actuator 83. The actuator 83 may be, for example, an electric linear actuator and

the manual operation for closing the door may thus be changed to automatic.

[0100] The right-side door may also be configured to be automatically openable and closable like the left-side door 61. In this case, from the viewpoint of operability, it is preferable to further provide another operation switch 210 on the right side of the vehicle body.

[0101] The method for detecting the operator is not limited to the above method. For example, the wheel loader 10 may be configured to authenticate whether it is the operator of the wheel loader 10 with the camera after detecting the approach of the operator.

[0102] The wheel loader 10 may be configured as follows. When the starter signal unit 50 detects that the operator is present in the vicinity of the wheel loader 10, the starter signal unit 50 outputs a command (unlocking command) to unlock the door 61 to the locking mechanism 610. The door controller 71 outputs a command (engagement release command) to open the door 61 to the automatic door mechanism 630 on condition that an operation of the operation switch 210 is accepted.

<Appendices>

[Item 1]

[0103] A work machine includes:

- a cab having an entry door;
- an operation switch for the door;
- an automatic door mechanism configured to automatically open the door; and
- a controller configured to detect an operator present in a vicinity of the work machine and output a command to open the door to the automatic door mechanism on condition that an operation of the operation switch is accepted.

[Item 2]

[0104] In the work machine according to Item 1, the operation switch is provided at a position lower than the cab.

[Item 3]

[0105] The work machine according to Item 1 or 2 further includes a ladder, and the operation switch is installed in a vicinity of the ladder.

[Item 4]

[0106] The work machine according to any one of Items 1 to 3 further includes

- a locking mechanism including a first actuator con-

figured to unlock the locked door, the locking mechanism being configured to lock and unlock the door, and

when the operator is detected in a state where the door is locked, the controller is configured to output a command to unlock the door to the first actuator on condition that an operation of the operation switch is accepted.

10 [Item 5]

[0107] In the work machine according to Item 4, the automatic door mechanism includes

- 15 a latch mechanism configured to hold the door at a closed position, and
- a second actuator configured to operate the latch mechanism and release the holding of the door at the closed position, and
- 20 the second controller outputs a command to open the door to the second actuator after outputting a command to unlock the door to the first actuator.

[Item 6]

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[0108] In the work machine according to any one of Items 1 to 5, the controller is configured to detect that the operator is present in the vicinity of the work machine, based on predetermined information that is associated with the operator and received from a terminal device carried by the operator.

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[Item 7]

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[0109] In the work machine according to Item 4, the controller includes a first controller and a second controller,

the first controller is configured to detect that the operator is present in the vicinity of the work machine, and

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the second controller outputs a command to unlock the door and a command to open the door to the locking mechanism and the automatic door mechanism, respectively, on condition that an operation of the operation switch is accepted.

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[Item 8]

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[0110] The work machine according to Item 7 further includes:

- a power supply; and
- a relay provided between the power supply and the second controller, and
- when the operator is detected, the first controller outputs a signal to turn the relay into an ON state, thereby activating the second controller, and en-

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abling the operation switch.

[0111] The present disclosure is applied to various work machines including a cab. The work machine according to the present disclosure is not limited to a wheel loader and may be a bulldozer, a hydraulic excavator, a motor grader, a crane, a forestry machine, or the like.

[0112] While certain embodiments have been described, these embodiments have been presented by way of example only and are not intended to give any limitations. The scope of the present invention is defined by the terms of the claims, rather than the description above, and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

Reference Signs List

[0113]

10 wheel loader
11 vehicle body
12 front frame
14 rear frame
16 work implement
18 rear structure
21 boom
21A boom cylinder
22 bell crank
23 link
24 bucket
24A bucket cylinder
26 front wheel
27 rear wheel
30 cab
31 cab body
32, 36 front side surface
33 rear side surface
34 left side surface
41 ladder
42 step
50 starter signal unit
61 door
62, 203 hinge part
65, 602 door handle
71 door controller
72 relay
73 power supply
81, 82, 83 actuator
91 first path
92 second path
201 side wall
202 lid
204 knob
210 operation switch
211 lever
510 control unit

511 detection unit
512 starting unit
520 near field communication unit
530 storage unit
601 key cylinder
610 locking mechanism
611 door lock knob
620 latch mechanism
621 catcher
622 striker
623 operation lever
630 automatic door mechanism
691, 692 cover
721 coil
722 moving contact
723 fixed contact
831 cylinder
832 rod
833, 834 end part
900 terminal device

Claims

- 25 **1.** A work machine comprising:
- 30 a cab having an entry door;
an operation switch for the door;
an automatic door mechanism configured to automatically open the door; and
a controller configured to detect an operator present in a vicinity of the work machine and output a command to open the door to the automatic door mechanism on condition that an operation of the operation switch is accepted.
- 35 **2.** The work machine according to claim 1, wherein the operation switch is provided at a position lower than the cab.
- 40 **3.** The work machine according to claim 1 or 2, further comprising:
- 45 a ladder, wherein the operation switch is installed in a vicinity of the ladder.
- 50 **4.** The work machine according to claim 1 or 2, further comprising
- 55 a locking mechanism including a first actuator configured to unlock the locked door, the locking mechanism being configured to lock and unlock the door, wherein when the operator is detected in a state where the door is locked, the controller outputs a command to unlock the door to the first actua-

tor on condition that an operation of the operation switch is accepted.

tion that the operator is detected and the operation is accepted.

5. The work machine according to claim 4, wherein the automatic door mechanism includes: 5

a latch mechanism configured to hold the door at a closed position; and
a second actuator configured to cause the latch mechanism to operate and release the holding of the door at the closed position, and the controller is configured to output a command to open the door to the second actuator after outputting a command to unlock the door to the first actuator. 10 15

6. The work machine according to claim 1 or 2, wherein the controller is configured to detect that the operator is present in the vicinity of the work machine, based on predetermined information that is associated with the operator and received from a terminal device carried by the operator. 20

7. The work machine according to claim 4, wherein the controller includes a first controller and a second controller, 25

the first controller is configured to detect that the operator is present in the vicinity of the work machine, and 30
the second controller is configured to output a command to unlock the door and a command to open the door to the locking mechanism and the automatic door mechanism, respectively, on condition that an operation of the operation switch is accepted. 35

8. The work machine according to claim 7, further comprising: 40

a power supply; and
a relay provided between the power supply and the second controller, wherein when the operator is detected, the first controller outputs a signal to turn the relay into an ON state, thereby activating the second controller, and enabling the operation switch. 45

9. A control method for a work machine, the method comprising: 50

a step of detecting an operator present in a vicinity of the work machine;
a step of accepting an operation of an operation switch for an entry door; and 55
a step of outputting a command to open the door to an automatic door mechanism configured to automatically open the door, on condi-

FIG. 1

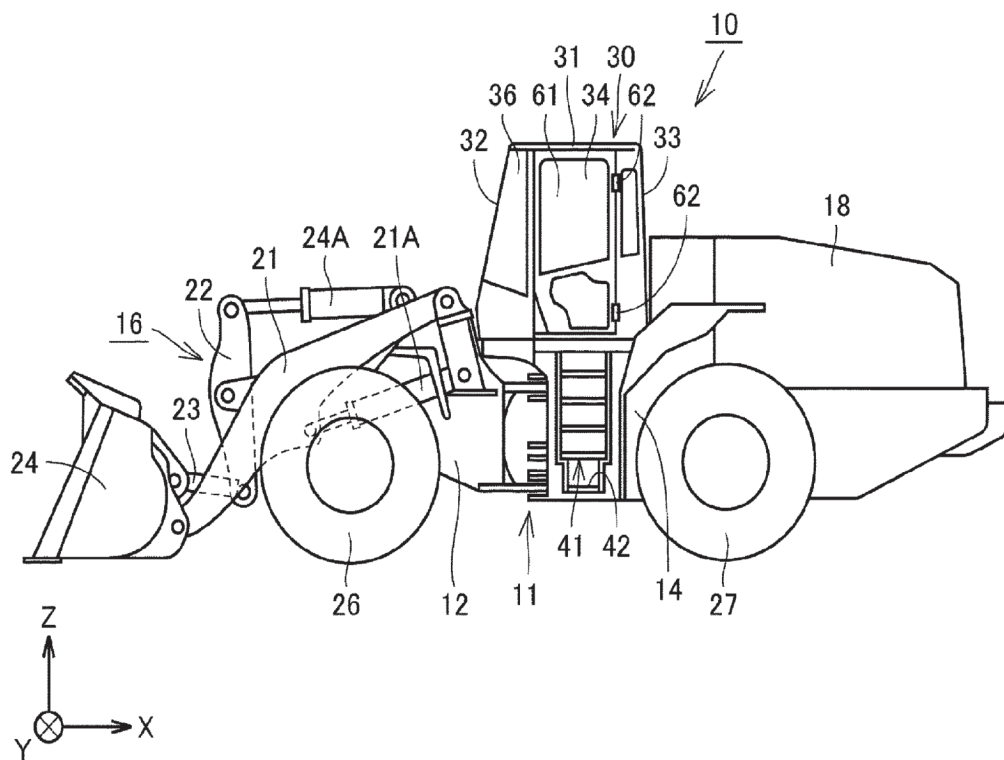


FIG. 2

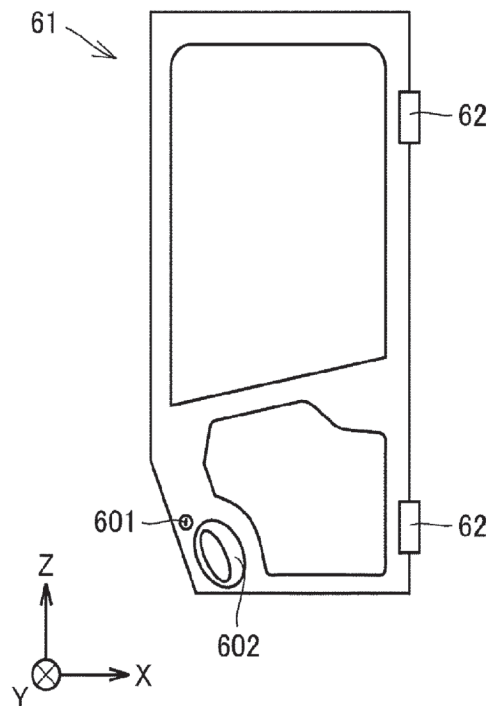


FIG. 3

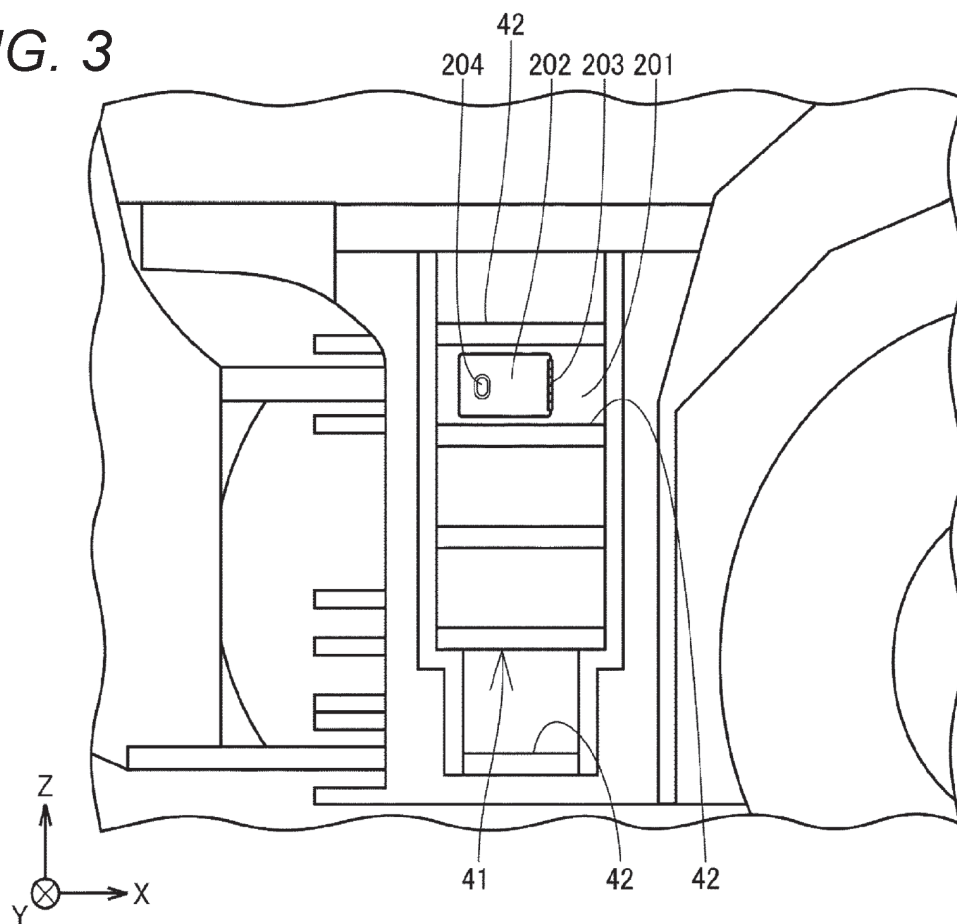


FIG. 4

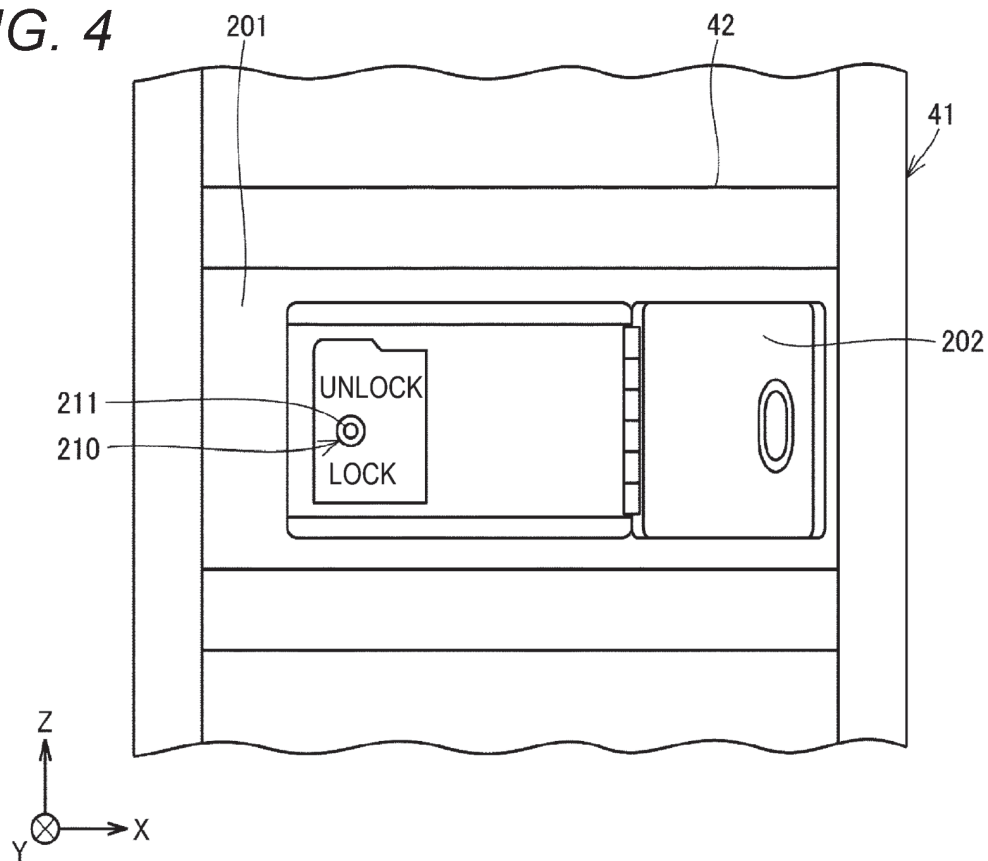


FIG. 5

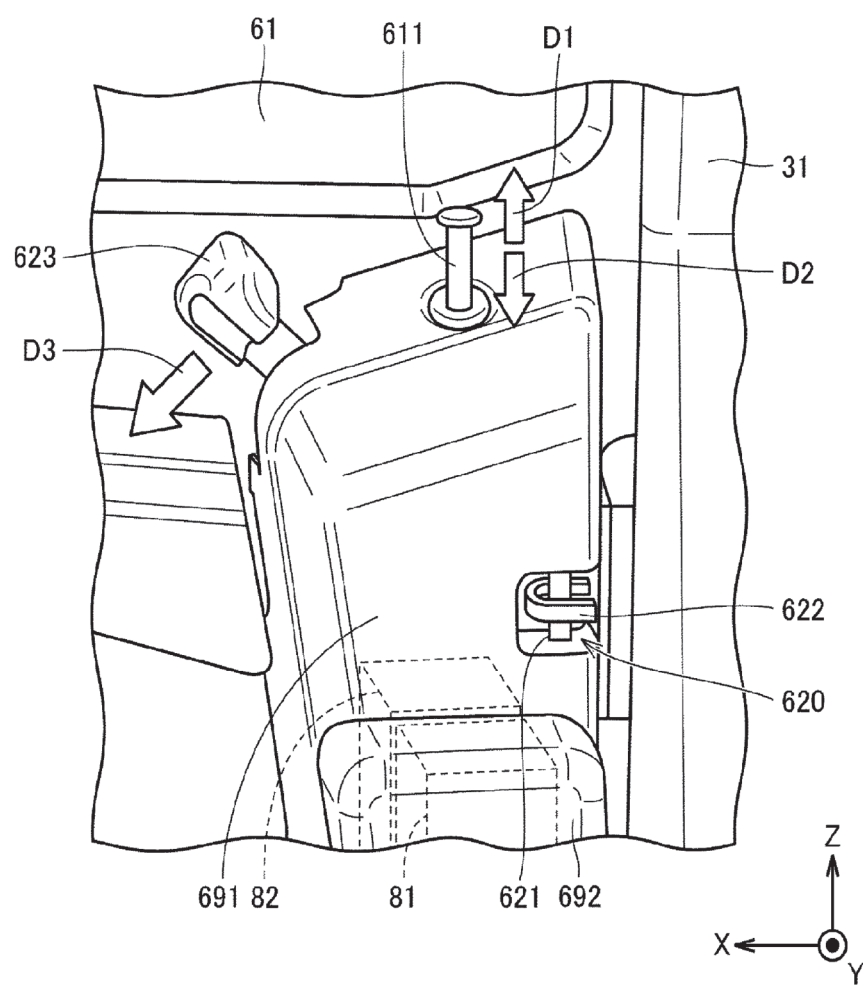


FIG. 6

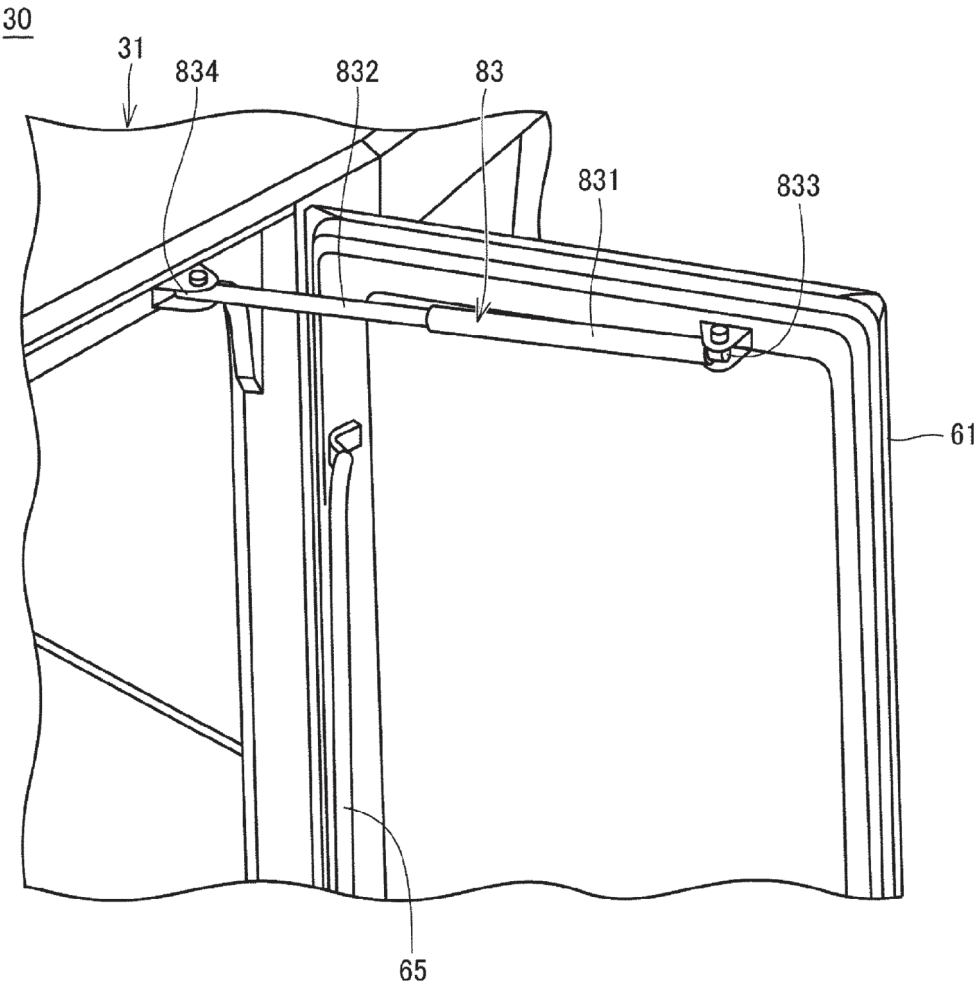


FIG. 7

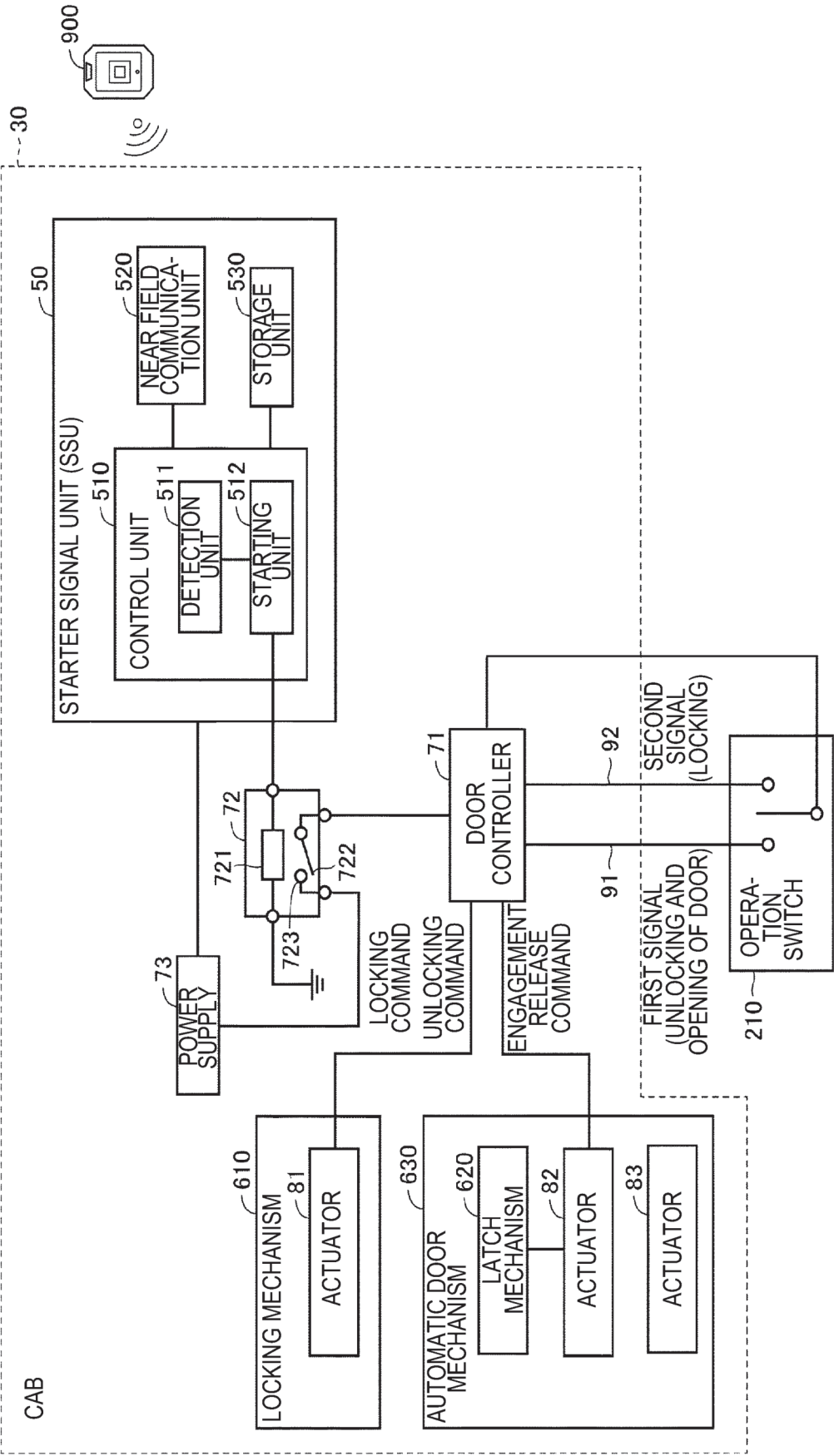
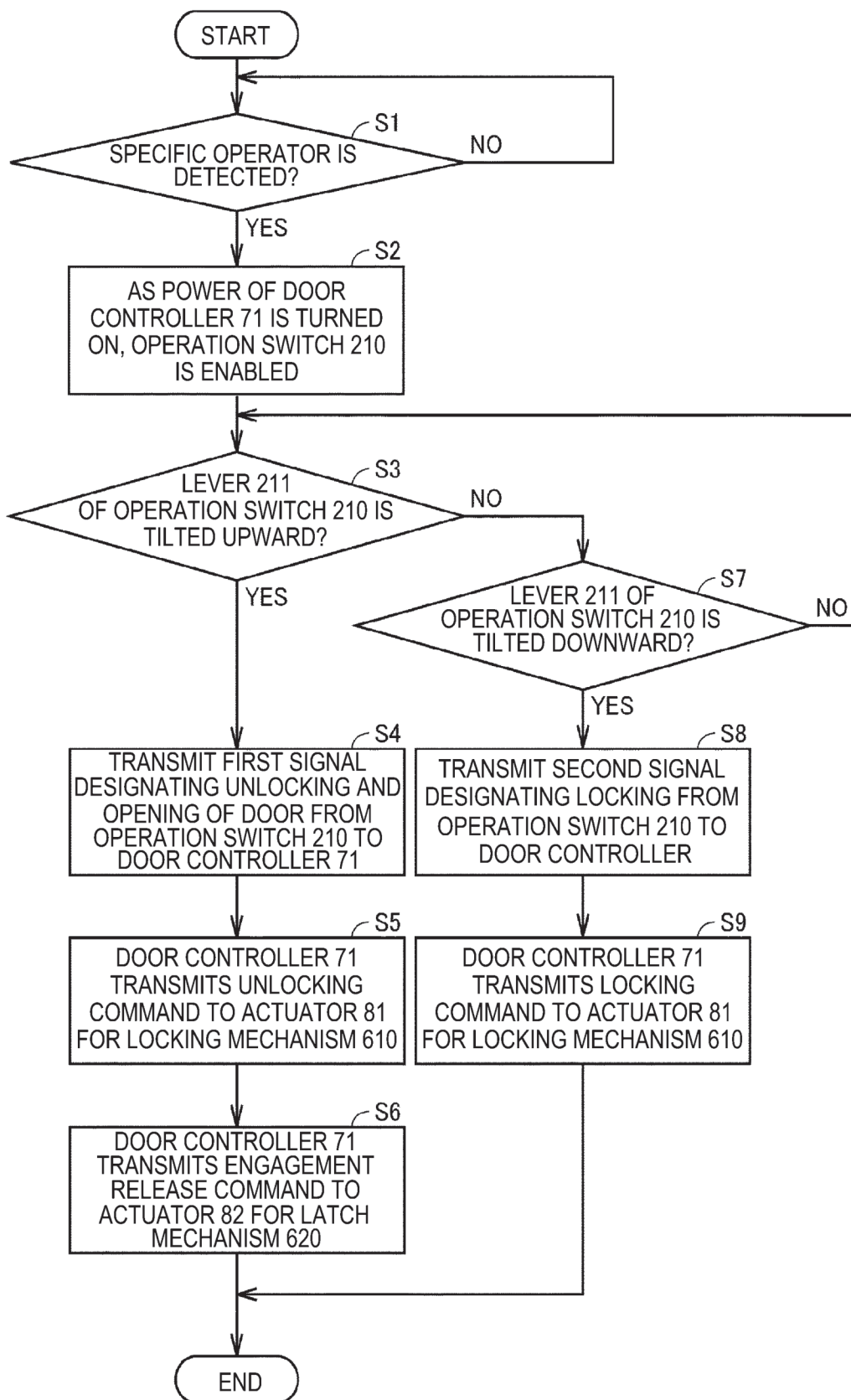


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2025/001711

A. CLASSIFICATION OF SUBJECT MATTER**E02F 9/16**(2006.01)i

FI: E02F9/16 F

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02F9/16 E05F15/77-15/78 B60J5/00-5/14 B60R25/24

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2025
 Registered utility model specifications of Japan 1996-2025
 Published registered utility model applications of Japan 1994-2025

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2019-167820 A (KOMATSU LTD.) 03 October 2019 (2019-10-03) paragraphs [0016], [0023], [0032], [0038], [0040], [0044], fig. 1	1-7, 9
A		8
Y	JP 2007-162459 A (DENSO CORPORATION) 28 June 2007 (2007-06-28) paragraphs [0021]-[0027], fig. 3	1-7, 9
A		8
Y	JP 2019-206847 A (KOMATSU LTD.) 05 December 2019 (2019-12-05) paragraphs [0032], [0040], fig. 1	2-7
A		8

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

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Date of the actual completion of the international search

10 February 2025

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Name and mailing address of the ISA/JP

Japan Patent Office (ISA/JP)
 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915
 Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2025/001711

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JP 2007-162459 A	28 June 2007	US 2007/0132552 A1 paragraphs [0026]-[0028], fig. 3	
JP 2019-206847 A	05 December 2019	EP 3719215 A1 paragraphs [0032], [0040], fig. 1 US 2021/0025130 A1 WO 2019/230114 A1	

REFERENCES CITED IN THE DESCRIPTION

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