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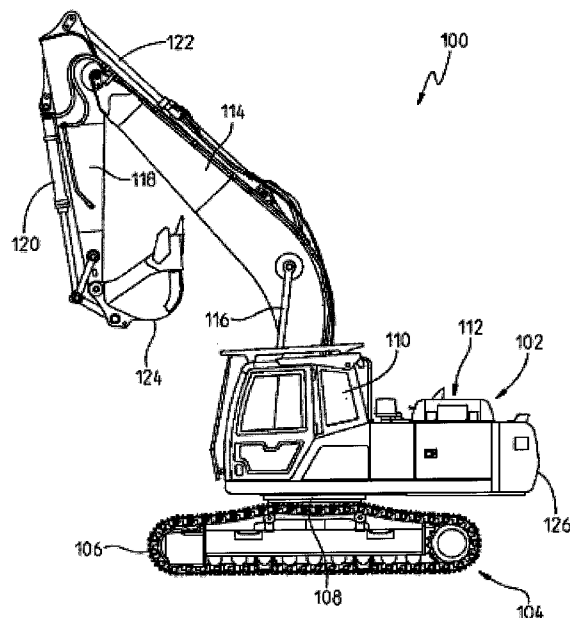


Fig. 1

(57) **Abstract:** The present disclosure provides a method of controlling a movement of a service door on a machine, where the machine includes a frame, a service door movably coupled to the frame, a cab, an engine, a monitor having user controls disposed in the cab, and a camera mounted to the frame. The method includes receiving a first input from the user controls to enable a door control program stored in the controller and determining if one or more threshold conditions is satisfied. The method also includes receiving a second input from the user controls, where the second input relates to a selection of the service door. The method further includes displaying an image on the monitor from the camera and receiving a third input from the user controls. The selected service door is controllably moved in a desired direction.

INTEGRATED DOOR CONTROL SYSTEM AND METHOD OF CONTROL THEREOF

Field of the Disclosure

[0001] The present disclosure relates to a control system and in particular an integrated control system for controlling a service door on a work machine.

Background

[0002] A conventional excavator can have several service doors coupled to the frame thereof. Each service door provides access to a mechanical, electrical, hydraulic, pneumatic, or other device of the machine. In addition, each service door pivots about its side along a hinge that is mounted to the machine frame. In this arrangement, the service door pivots between an open and closed position similar to that of a standard door. Moreover, due to the manner by which the door opens and closes, the latch or lock for accessing the door is conveniently located along the frame.

[0003] Although the conventional manner by which the door opens and closes is easily accessible, it can be difficult to complete maintenance or diagnose problems with the machine. This is due to the size of the machine and the size and location of the different mechanisms that operate with the machine (e.g., an engine or exhaust fan). In addition, conventional means for opening and closing each service door required manual operation in some instances. This can be especially difficult due to the size and weight of each door.

[0004] Therefore, it would be desirable to provide a better means for operating the opening and closing of each service door on a work machine such as an excavator. Moreover, it would be desirable to provide a method for controlling the door operation without requiring substantial manual effort.

Summary

[0005] In an exemplary embodiment of the present disclosure, a method is provided for controlling a movement of a service door of a machine. The machine includes a frame, one or more service doors movably coupled to the frame, a cab mounted to the frame, an engine

for powering the machine, a monitor and user controls disposed in the cab, a camera mounted to the frame, and an electrical interlock system. The method includes receiving a first input from the user controls to enable a door control program stored in the controller, determining if each of one or more threshold conditions is satisfied, receiving a second input from the user controls, the second input relating to a selection of the service door, displaying an image on the monitor from the camera, receiving a third input from the user controls, the third input corresponding to a movement of the selected service door in a direction, and controlling the movement of the selected service door in the direction.

[0006] In one aspect, the method includes determining if the engine is running or ignition is enabled and detecting if a hydraulic pilot control is disabled. In a second aspect, the method includes reducing engine speed to an idle speed. In another aspect, the method includes determining if the electrical interlock system includes an open switch and displaying a message on the monitor indicating one or more of the service doors is open or a ladder coupled to one of the service doors is in a down position.

[0007] In a different aspect, the method includes displaying a main screen on the monitor before the receiving a first input step. Related thereto, the method includes displaying a service door control screen after the receiving a first input step. The method can also include activating or deactivating one or more solenoids corresponding to the selected service door. The method can further include displaying a message on the monitor to check a mirror or image from the camera before the receiving a third input step.

[0008] In another embodiment, a machine includes a frame and an engine coupled to the frame, a cab coupled to one side of the frame, where the cab includes a monitor for operating the machine, and a first door and a second door coupled to the frame. The first door is disposed on the same side as the cab and the second door is disposed on a side opposite the first door. The machine also includes a controller disposed in electrical communication with the monitor and user controls. Moreover, a door control system is electrically coupled to the controller, the first door, and second door. The door control system includes computer-readable software stored in the controller for operably controlling the first and second doors. The machine further includes a camera coupled to the frame and disposed in electrical

communication with the monitor, where the camera is positioned to electrically communicate real-time images to the monitor of the second door and an area surrounding the second door.

[0009] In one aspect of this embodiment, the machine includes a plurality of solenoids electrically coupled to the controller, where at least one of the plurality of solenoids operably controls a movement of either the first door or second door between an open position and a closed position. In another aspect, the machine includes an interlock switch electrically coupled to the controller and being operably coupled to one of the first door and second door, where the switch is configured to move between an open and closed position based on movement of the door.

[0010] In a further aspect, the computer-readable software includes a main screen and a door control screen displayed on the monitor. The main screen includes a plurality of user controls for operably controlling movement of the first door and second door, where one of the plurality of user controls includes a first input. The door control screen is displayed on the monitor in response to the first input being triggered, such that the door control screen includes an image of the machine, an image of each of the first door and second door, a second input for controlling either of the first door and second door in a first direction, and a third input for controlling either of the first door and second door in a second direction. A camera image screen is displayed on the monitor in response to the second door being selected from the door control screen, wherein the first door or second door is operably controlled between an open position and closed position in response to the selection of either door and the triggering of the second input or third input from the door control screen.

[0011] In a different embodiment of the present disclosure, a method is provided of controlling an opening or closing of a service door on a machine. The machine includes a cab, a monitor disposed in the cab for controlling the machine, a camera mounted to the machine, a plurality of service doors coupled to the machine, a ladder coupled to one of the plurality of service doors, a plurality of solenoids and switch interlocks, an ignition control and an engine. The method includes displaying a first screen on the monitor such that the first screen includes a plurality of user control buttons for controlling the machine. The method also includes displaying a second screen on the monitor in response to a first user control button being selected from the monitor, the second screen including an image of the

machine and each of the plurality of service doors. In addition, the method includes displaying a plurality of icons on the second screen, where each of the plurality of icons corresponds to one of the plurality of service doors. Moreover, the method includes receiving an input in response to a second user control button being triggered, where the input corresponds to one of the plurality of service doors being selected for control. The method further includes controlling the opening or closing of the selected service door.

[0012] In one aspect of this embodiment, the method can include identifying which of the plurality of service doors is presently selected on the second screen and displaying a plurality of icons on the second screen, where each icon corresponds to one of the plurality of service doors or to one of the plurality of user control buttons. In a different aspect, the method can include displaying an image from the camera on the monitor. Moreover, the method can include displaying a message on the monitor corresponding to one of the plurality of service doors being in the opened position. In another aspect, the method can include determining if a plurality of threshold conditions is satisfied before displaying the second screen. In a further aspect, the method can include returning from the second screen to the first screen when the ignition control is switched off, the first user control button is selected, or a second user control button is selected, where the second user control button corresponds to a previous screen.

Brief Description of the Drawings

[0013] The above-mentioned aspects of the present disclosure and the manner of obtaining them will become more apparent and the disclosure itself will be better understood by reference to the following description of the embodiments of the disclosure, taken in conjunction with the accompanying drawings, wherein:

[0014] Figure 1 is a side view of an excavator;

[0015] Figure 2 is a perspective view of an exemplary embodiment of an excavator with each service door closed;

[0016] Figure 3 is a right side perspective view of the excavator of Figure 2 with each service door opened;

- [0017] Figure 4 is a left side perspective view of the excavator of Figure 2 with each service door opened;
- [0018] Figure 5 is a top view of the excavator of Figure 2 with each service door opened;
- [0019] Figure 6 is a schematic view of an exemplary main screen display;
- [0020] Figure 7 is a schematic view of a service door selection screen;
- [0021] Figure 8 is a schematic view of a service door control system; and
- [0022] Figure 9 is a flow diagram of an exemplary process for operating a service door control system.
- [0023] Corresponding reference numerals are used to indicate corresponding parts throughout the several views.

Detailed Description

[0024] The embodiments of the present disclosure described below are not intended to be exhaustive or to limit the disclosure to the precise forms disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may appreciate and understand the principles and practices of the present disclosure.

[0025] An exemplary embodiment of a work machine is shown in Figure 1. The machine is embodied as an excavator 100. The present disclosure is not limited, however, to an excavator and may extend to other work machines that have one or more service doors. As such, while the figures and forthcoming description may relate to an excavator, it is to be understood that the scope of the present disclosure extends beyond an excavator and, where applicable, the term “machine” will be used instead. The term “machine” is intended to be broader and encompass other vehicles besides an excavator for purposes of this disclosure.

[0026] Referring to Figure 1, the excavator 100 includes an upper frame 102 pivotally mounted to an undercarriage 104. The upper frame 102 can be pivotally mounted on the undercarriage 104 by means of a swing pivot 108. The upper frame 102 is rotatable about 360° relative to the undercarriage 104 on the swing pivot 108. A hydraulic motor (not shown) can drive a gear train (not shown) for pivoting the upper frame 102 about the swing pivot 108.

[0027] The undercarriage 104 can include a pair of ground-engaging tracks 106 on opposite sides of the undercarriage 104 for moving along the ground. Alternatively, the excavator 100 can include wheels for engaging the ground. The upper frame 102 includes a cab 110 in which the machine operator controls the machine. The cab 110 can include a control system (not shown) including, but not limited to, a steering wheel, a control level, control pedals, or control buttons. The operator can actuate one or more controls of the control system for purposes of operating the excavator 100.

[0028] The excavator 100 also includes a large boom 114 that extends from the upper frame 102 adjacent to the cab 110. The boom 114 is rotatable about a vertical arc by actuation of a pair of boom cylinders 116. A dipper stick or arm 118 is rotatably mounted at one end of the boom 114 and its position is controlled by a hydraulic cylinder 122. The opposite end of the boom 114 is coupled to the upper frame 102. At the end opposite the boom 114, the dipper stick or arm 118 is mounted to an excavator bucket 124 that is pivotable relative to the arm 118 by means of a hydraulic cylinder 120.

[0029] The upper frame 102 of the excavator 100 includes an outer shell cover to protect an engine assembly 112. At an end opposite the cab 110, the upper frame 102 includes a counterweight body 126. The counterweight 126 comprises a housing filled with material to add weight to the machine and offset a load collected in the bucket 124. The offset weight can improve the digging performance of the excavator 100.

[0030] In Figure 2, another embodiment of a machine in the form of an excavator 200 is shown. The excavator 200 includes many of the same features as described above and shown in Figure 1. In addition, the excavator includes a plurality of service doors coupled to the upper frame 102 of the excavator 200. In particular, the excavator includes a first door 202, a second door 204, and a third door 206. The first door 202 is disposed on the left side of the excavator behind the cab 110. The second door is positioned on the right side of the excavator 200 near the front, and therefore being disposed adjacent to the cab 110 but on the opposite side (i.e., the boom is disposed between the cab 110 and second door 204. As shown in Figure 2, the second door 204 can include metal grate-like features 208 that substantially cover exhaust fans 516 (see Figure 5) in the closed position. The third door 206 is disposed on the same side as the second door 204, but towards the rear of the excavator

200. As such, the first door 202 and third door 206 are positioned near the rear of the excavator but on opposite sides thereof. It should be understood, however, that different machines may have a different number of service doors, and that the location of each service door may depend on the machine type. Moreover, other excavators may have additional or fewer service doors, and regardless of the number, each service door may be positioned along the machine in locations that are different from that shown in Figure 2.

[0031] A camera 210 is also shown in the embodiment of Figure 2. Here, the camera 210 is coupled to a portion 212 of the upper frame 102 of the excavator 200. The camera 210 can be a video camera, a still-picture camera, a digital camera, a high-definition camera, or any known type of camera. The camera 210 is coupled to the upper frame 102 along the right side thereof, and as shown is disposed on the side opposite the cab 110. The camera 210 is disposed in a location and oriented in a direction that can provide images of either or both of the second door 204 and third door 206. In addition, the camera 210 can provide images of the area surrounding the second door 204 and third door 206. As will be described later, the camera 210 can provide visual feedback to a monitor (not shown) in the cab 110 so that an operator of the excavator 200 can have visual information of any objects near either door. This can provide additional safety to the machine and objects near the machine when either the second door 204 or third door 206 is opened.

[0032] In Figure 2, each of the service doors is shown in a closed position. Referring to Figure 3, however, each of the service doors is shown in an open position. While many conventional service doors open in a hinge-like manner along one side of the door, the service doors of the excavator 200 open in an inverse gull-wing manner. In other words, each of the service doors can pivot along its bottom edge (e.g., nearest the undercarriage 104) and pivot outwardly away from the machine.

[0033] To better understand the manner by which each service door opens, each of the service doors includes a first portion and a second portion. For instance, the first door 202 includes a first portion 300 and a second portion 400 (Fig. 4). Similarly, the second door 204 includes a first portion 302 and a second portion 304. Likewise, the third door 206 includes a first portion 306 and a second portion 308.

[0034] When each door is closed, i.e., Figure 2, the first portion of each door forms a top surface and the second portion forms a side surface. In other words, the first portion of each door is approximately perpendicular to the second portion such that each door includes a substantially L-shaped design. However, when each door opens in an inverse gull-wing manner (i.e., Figures 3 and 4), the first portion of each door is disposed approximately 90° from its orientation in the closed position. For example, in Figure 4, the first portion 300 of the first door 202 is disposed substantially vertical, whereas in Figure 2 the first portion is disposed substantially horizontal. Moreover, in the open position, the second portion 400 of the door 202 is disposed substantially horizontal. The different portions of the second door 204 and third door 206 are arranged similarly.

[0035] Turning to Figure 5, the embodiment of Figure 4 is shown with each of the service doors configured in an open position. An advantage of the inverse gull-wing manner by which the service doors open is the formation of walk-ways to obtain better access to different features of the machine. For instance, the second portion 400 of the first service door 202 defines a first walkway 500. To reach the first walkway 500, a first ladder 518 is coupled to the door 202. The first walkway 500 allows for access and maintenance of the engine or hydraulic pumps 512.

[0036] With respect to the second door 204, the second portion 304 defines a second walkway 502 for accessing cooling fans and oil coolers 516. Likewise, the second portion 308 of the third door 206 defines a third walkway 504 for accessing a second engine and hydraulic pumps 512. A second ladder 520 is coupled to the third door 206 to reach the second walkway 502 and third walkway 504.

[0037] In Figure 5, each service includes a safety interlock. For instance, the first service door 202 includes a first interlock 506. Similarly, the second door 204 includes a second interlock 508 and the third door 206 includes a third interlock 510. Each safety interlock is in electrical communication with a vehicle control unit (VCU) 802 and sends an electric signal to the VCU 802 to communicate the position of each service door. The safety interlocks can be in the form of switches, as shown in Figure 8. For instance, the first safety interlock 506 corresponding to the first service door 202 is in the form of a first switch 814. Likewise, the second safety interlock 508 corresponding to the second service door 204 is in

the form of a second switch 818. Similarly, the third safety interlock 510 corresponding to the third service door 206 is in the form of a third switch 820. The first ladder 518 and second ladder 520 can also include safety interlocks, i.e., a first ladder switch 816 and a second ladder switch 822.

[0038] In Figure 8, the VCU 802 and interlock switches form part of a service door control system 800. The system 800 can include an electrical control system that includes each interlock switch and a plurality of solenoids 810. Each of the plurality of solenoids 810 can be electrically coupled to the VCU 802 along a first electrical path 812, and likewise each of the interlock switches can be electrically coupled to the VCU 802 along a second electrical path 826. As also shown, a hydraulic pilot enable lever 824 is electrically coupled to the VCU 802 along path 826. The hydraulic pilot enable lever 824 provides hydraulic control travel, the swing, and boom operation. As will be described, it is desirable to disable the hydraulic pilot enable lever 824, which can be in the form of an interlock switch, to disable or prevent the boom, arm, or bucket from being moved or controlled when one or more service doors is in the open position.

[0039] The VCU 802 can control the activation or deactivation of the plurality of solenoids 810. In a non-limiting example, for instance, each service door can be controlled by two solenoids, one of which is an on/off solenoid and the other is a direction solenoid. If the selected door is controlled to a closed position, the direction solenoid can be deactivated. On the other hand, if the selected door is controlled to an open position, the direction solenoid can be activated. Moreover, the on/off solenoids corresponding to the two service doors not selected to be controlled can be activated, whereas the on/off solenoid corresponding to the selected door can be deactivated. In an alternative embodiment, however, the reverse can be true (i.e., the on/off solenoid for the selected door is activated and the on/off solenoids for the non-selected doors can be deactivated). In addition, the direction solenoids can activate or deactivate differently depending on the direction the selected door is controlled (e.g., opened or closed).

[0040] The VCU 802 can be electrically coupled or disposed in electrical communication with a monitor unit 804, as shown in Figure 8. The electrical communication or coupling can occur over a communication path 808, such as a Controller Area Network (CAN) Bus. The

VCU 802 can be disposed anywhere along the machine, whereas the monitor unit 804 is disposed in the cab 110 of the machine. In this manner, controlling the machine can occur from an operator's seat in the cab so that the operator of the machine is in a safe location when each service door is opened or closed. Moreover, the monitor unit 804 is electrically coupled or disposed in electrical communication with a camera 806 (e.g., video camera). Here, the communication can occur over communication path 828 as shown in Figure 8. The camera 806 refers to the camera 210 previously described and shown in Figure 2. In this system 800, the camera 806 can provide real-time images to the monitor unit 804 so that the machine operator can visually observe an area around the second service door 204 and third service door 206 before opening or closing either door. The cab 110 can include one or more mirrors mounted thereto so that the machine operator can visually inspect the area around the first service door 202 before it is opened or closed. Thus, the present embodiment provides additional safety measures to prevent harm or damage to the service door being controlled or to an object disposed in the path of movement of the service door.

[0041] In the embodiments of Figures 1-5 and 8, the machine and door control system have been described. In Figure 6-7 and 9, embodiments of a door control process are illustrated. Unlike conventional door control processes, the present disclosure provides an exemplary door control process that utilizes electronic control of different features of the machine, many of which were described above. It is to be understood that the door control process can take many different forms, and that the embodiments illustrated and described herein are only exemplary in nature.

[0042] In one aspect of the door control process, a machine operator can control the operation of one or more service doors using a monitor and user controls in the cab. As previously described, this provides additional safety when the service doors are opened or closed. Moreover, the control system can utilize electrical power from the machine to perform the control process of opening and closing each service door. In one embodiment, the control process can only control the operation of one service door at a time. The hydroelectric power of the machine can drain the machine's battery, whereby the electrical circuit of the machine does not have enough electrical power to control the operation of more

than one door at a time. In a different embodiment, however, it may be possible to control one or more doors at a time.

[0043] An exemplary embodiment of the door control process is illustrated in Figure 9. The process 900 includes a plurality of steps, one or more of which may be optional in various aspects of the process. The process 900 can include utilize the vehicle control unit (VCU) 802 that includes a memory unit (not shown) disposed therein. The VCU 802 can be microprocessor-based, and the memory unit includes instructions stored therein that are executable by the VCU 802 to control the operation of each service door of the machine. It will be understood, however, that this disclosure contemplates other embodiments in which the VCU 802 is not microprocessor-based, but is configured to control operation of each service door based on one or more sets of hardwired instructions and/or software instructions stored in the memory unit.

[0044] Referring to Figure 9, the process 900 can include a first step that utilizes the monitor unit 804. In particular, the monitor unit 804 can receive instructions from the VCU 802 to display a main screen 600 similar to the one shown in Figure 6. The main screen 600 can include a plurality of user controls for controlling the operation of each service door. The plurality of user controls can be in the form of touchscreen buttons, for example. Alternatively, the plurality of user controls can display icons or symbols of controls in the cab for controlling the operation of each service door. In Figure 6, the display 600 includes a plurality of user controls 602 for operably controlling the machine and each service door. Of the plurality of user controls 602, there can be a first control button 604 for activating the door control system or other machine system. In addition, a second button 606 in the form of a return arrow key allows a user to return to a previous screen. A third user control button 608 is provided for making a selection, i.e., a selection button. A fourth user control button 610 and fifth user control button 612 are provided in the form of up and down arrow keys, respectively. These buttons can be used by a user for scrolling through different menu options or for selecting a direction for controlling the movement of a selected service door (e.g., up for opening the door and down for closing the door).

[0045] The display 600 can include other icons, user controls, and data about the machine. For instance, time of day, mileage, gas mileage, fuel level, oil level, oil

temperature, machine speed, compass, service lights, warning lights, transmission gear range, etc. These can be displayed in any manner, and for purposes of the present disclosure, the embodiment of Figure 6 is intended only to be an example of one display.

[0046] To control a service door or activate the door control system, a machine operator (i.e., user) can select the first user control button 604 on the main screen 600. By selecting or triggering this first button 604, a signal is communicated to the VCU 802 in step 904 indicating that the machine operator desires to operate one of the service doors. As the user input is triggered from the monitor unit 804 to the VCU 802, the VCU 802 can determine whether the door control process can be enabled. For instance, in step 906, the VCU 802 can determine if one or more threshold conditions are satisfied before enabling the door control process.

[0047] In a first threshold step 908, the VCU 802 can determine whether the ignition is active (i.e., power is flowing through the electrical circuit of the machine) and/or if the engine is running. Since the communication between the VCU 802, monitor unit 804, camera 806, solenoids 810, and interlock switches is electrically-driven, the VCU 802 can ensure that at the least the ignition is active before enabling the door control process. In a related aspect, it may further be desirable that the engine is running to further reduce drain on the machine battery. In that aspect, the door control process will not proceed unless the engine is running, notwithstanding the state of the ignition.

[0048] In a second threshold step 910, the VCU 802 can determine if any one of the door or ladder safety interlock switches is open. If it is determined that one or more interlock switches is open, the VCU 802 can communicate with the monitor unit 804 and notify the operator that one of the service doors is opened or one of the ladders is in a down position. The operator may be notified of this condition before the VCU 802 will take any further action.

[0049] In a third threshold step 912, the VCU 802 can determine whether the hydraulic pilot enable switch 824 is disabled. By disabling the switch 824, there can be little to no hydraulic control of travel, swing control, boom control, etc. In other words, disabling the hydraulic pilot enable switch 824 can prevent the boom 114, arm 118, or bucket 124 from being hydraulically functional.

[0050] In another threshold step 914, it may be desirable for the engine to be running at or near an idle state (e.g., approximately 800 RPM). For instance, by maintaining or forcing the engine to a low idle state, particularly if a service door is open, the amount of energy flowing to each door is reduced. This can help with battery power and overall hydraulic power exerted by the machine. In other aspects, however, step 914 may not be a threshold condition that limits or prevents the door control process from being enabled. Instead, it may be an additional step in the process undertaken by the VCU 802 to reduce engine speed.

[0051] Once the VCU 802 determines each threshold condition in step 906 is satisfied, the door control process for operating one or more service doors is enabled. Moreover, the VCU 802 can communicate with the monitor unit 804 to display a second screen relating to the door control system in accordance with step 916. Referring to Figure 7, an exemplary door control screen 700 is shown being displayed on the monitor unit 804. The screen 700 can be fitted into the main screen display 600 of Figure 6 such that the user controls 602 are still displayed and operable for further use. For instance, in Figure 6, the portion of the screen 600 that shows the fuel level and oil temperature may be replaced by the door control screen 700 of Figure 7.

[0052] The door control screen 700, or service door selection screen, can display an image 702 of the machine. In addition, a first icon or identifier 704 can be displayed corresponding to the first service door. Similarly, a second icon or identifier 706 can be displayed corresponding to the second service door. Likewise, a third icon or identifier 708 can be displayed corresponding to the third service door. In other embodiments in which the machine includes a different number of service doors, the screen 700 can include the same number of icons or identifiers as service doors on the machine. As such, the door control process can be a set of instructions stored in the memory unit of the VCU 802 and is adapted for any type of machine.

[0053] In Figure 7, a selection icon 710 is displayed corresponding to a presently or currently selected service door. For instance, in Figure 7 the selection icon 710 identifies that the first service door is presently selected. Thus, if the operator wants to control the first service door, the door control process is prepared to take action with respect to this door. While in Figure 7 the selection icon 710 is shown encircling the first icon 704, its possible

that the selection icon can take another form such as causing the first icon 704 to blink, enlargen, change color, etc. Alternatively, the selection icon 710 can be an arrow or other display means that points to the currently selected icon. In other words, the selection icon 710 can take many forms so long as it identifies the presently selected service door to the operator.

[0054] The door control screen 700 can also include arrow icons 712 and a selection icon 714. The arrow icons 712 may simply instruct the operator to select the up arrow button 610 or down arrow button 612 to select a different service door or to control the direction of which the selected service door moves. In an alternative embodiment, it may be possible for the arrow icons 712 to form user controls such that the operator can trigger or press one of these buttons to select or control one of the service doors. Similarly, the selection icon 714 can be an instruction to the operator to trigger the select user button 608 as shown in Figure 6 to make a selection. Alternatively, the selection icon 714 can form a user control button that an operator can trigger or press to make a desired selection.

[0055] The door selection screen or door control screen 700 of Figure 7 is intended to serve only as an example. The present disclosure is not limited to this display, and additional elements or features may be displayed or removed from that shown in Figure 7. The door control screen 700 may also be dependent on the type of machine. For instance, in Figure 7, the door control screen 700 displays an excavator, whereas a different machine may be displayed differently in the door control screen.

[0056] Once the door control screen is displayed on the monitor in step 916, the operator can cycle through different options and make a selection, if desired. If the operator decides not to make a selection from the door control screen 700, the operator can trigger or select the return user control button 606 to return to the previous, main screen 600. If the operator later decides to open one of the service doors, for example, the operator can re-initiate the process by selecting the first user control button 604. Alternatively, the operator may be able to return to the main screen 600 from the door control screen 700 by selecting the first user control button 604 (i.e., without selecting the return button 606) or by turning the ignition off and disabling the door control system.

[0057] In step 918, however, if the user selects one of the service doors from the door selection screen 700, the VCU 802 can receive the user input from the monitor unit 804. Moreover, the VCU 802 can activate or deactivate the corresponding solenoids for opening or closing the selected door in step 920. Depending on which door is selected, the monitor unit 804 can display different images or messages to the operator.

[0058] For instance, in step 922, if the operator selects the first service door 202 from the door control screen 700, the VCU 802 can communicate to the monitor unit 804 to display a message corresponding to an International Organization for Standardization (ISO) message. This can be a safety message instructing the machine operator to check one or more mirrors before taking further action. It may also instruct the operator that one or more service doors is open or a ladder is in a down position. This message can be displayed in the door control screen 700 of Figure 7, or displayed in a different screen. For example, the message can be a pop up message that remains displayed for a time period (e.g., 3 or 4 seconds).

[0059] The message displayed in step 922 can also instruct the machine operator to check the monitor unit for an image from the camera 806. For example, if either the second service door 204 or third service door 206 are selected in step 918, the machine may not have a mirror to display an object disposed outside the machine and near either door. The camera 806, on the other hand, can be mounted to the frame of the machine and oriented in a direction towards the second service door 204 and third service door 206, including the area around each door. With each door opening in an inverse gull-wing manner, it is desirable to communicate a real-time image of the selected door and the area to be occupied by the door when it moves between an open position and closed position. Moreover, in some embodiments the camera can provide real-time video images that continuously provide video images to the monitor and allow the operator to visually check the monitor before opening or closing a selected door.

[0060] The image or images from the camera can be displayed on the door control screen 700. In one aspect, the message alerting the operator to an ISO safety message can be displayed first for a time period and then the message can be removed and replaced by the image or images from the camera. Although not shown, in addition to the message or image appearing on the screen, an icon corresponding to either or both the message and image can

be displayed on the door control screen. With either the message or image displayed on the monitor, the operator can return to the door control screen 700 of Figure 7 by selecting the first user control button 604 or return control button 606.

[0061] In step 924, the VCU 802 can receive additional user input from the monitor corresponding to controlling the selected door in either an opening direction or a closing direction. As such, the VCU 802 can activate or deactivate one or more of the solenoids corresponding to such control (e.g., door direction solenoid). The VCU 802 can continuously take action based on a signal electrically communicated from the monitor unit 804 in response to user input.

[0062] In the event the second service door 204 is selected, the VCU 802 can disable the cooling or exhaust fans 516 if the door 204 is moved from a closed position to an open position. Likewise, when the second service door 204 is closed, the VCU 802 can enable or activate the cooling or exhaust fans 516. The VCU 802 may take such action based on a signal received from the second door safety interlock switch 818.

[0063] In one aspect of this disclosure, when one of the service doors is controlled between an open position and a closed position, an audible alarm may be triggered as a safety precaution. Once the service door reaches either the open or closed position, the alarm may be disabled.

[0064] In another aspect, if a door is not fully closed and the machine operator attempts to control the boom 114, for example, the VCU 802 can send a warning message which is displayed on the monitor alerting the operator to the door condition. In a related aspect, if a door is in a partial or fully open position, a message indicating the same can be displayed on the monitor unit 804 once the ignition is activated. Moreover, the door which is partially or fully open may be identified on the monitor unit 804 by displaying the door control screen 700 and using the selection icon 710 to specifically identify the door. Other means may be used to identify if one or more service doors is partially or fully open. In addition, other messages may be displayed depending on the condition and type of machine.

[0065] In some aspects, the second threshold step 910 may not be a threshold condition for enabling the door control process, but rather may be a condition or warning that notifies the machine operator when the operator desires to operate the boom, arm or bucket.

Referring to the embodiment illustrated in Figure 2, for example, the VCU 802 can receive electrical communication from one of the safety interlocks shown in Figure 8. For instance, if the second service door 204 is in an open position, the interlock switch 818 corresponding to this door 204 may be in an open position. As such, a message can be electrically communicated from the VCU 802 to the monitor unit 804 to alert the operator of this condition. The VCU 802 can disable further machine operation, i.e., operation of the boom, arm, and bucket, until the operator takes action to close the second door 204.

[0066] Similarly, if the first service door 202 or third service door 206 are in an open position, the first door interlock switch 814 or third door interlock switch 820 may be open and a corresponding message can be communicated from the VCU 802 to the monitor unit 804. Likewise, if the first ladder 518 or second ladder 520 is in a down position (or in a position that opens the respective ladder interlock switch), the VCU 802 can determine that either ladder interlock switch 816, 822 is open and thus prevent the machine from operating the boom, arm and bucket. This would also be similar for other machines and is not limited to excavators.

[0067] It may also be desirable to perform or operate the door control system in the event electrical power is not available to the machine (e.g., a dead battery). In this instance, a backup battery pack or alternative electrical source (e.g., generator) may be connected to the battery or electrical circuit of the machine to drive the door control system. Alternatively, if no electrical power source is available, a mechanical means in the form of a hand-operated pump may be used to control the opening and closing of each service door.

[0068] While exemplary embodiments incorporating the principles of the present disclosure have been disclosed hereinabove, the present disclosure is not limited to the disclosed embodiments. Instead, this application is intended to cover any variations, uses, or adaptations of the disclosure using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this disclosure pertains and which fall within the limits of the appended claims.

Claims

1. A method of controlling a movement of a service door on a machine, the machine including a frame, one or more service doors movably coupled to the frame, a cab mounted to the frame, an engine for powering the machine, a monitor and user controls disposed in the cab, a controller, a camera mounted to the frame, and an electrical interlock system, the method comprising:
 - receiving a first input from the user controls to enable a door control program stored in the controller;
 - determining if each of one or more threshold conditions is satisfied;
 - receiving a second input from the user controls, the second input relating to a selection of the service door;
 - displaying an image of the machine on the monitor;
 - receiving a third input from the user controls, the third input corresponding to a movement of the selected service door in a direction; and
 - controlling the movement of the selected service door in the direction.
2. The method of claim 1, wherein the determining step comprises:
 - determining if the engine is running or ignition is enabled; and
 - detecting if a hydraulic pilot control is disabled.
3. The method of claim 1, further comprising reducing engine speed to an idle speed.
4. The method of claim 1, wherein the displaying step comprises displaying an image from the camera.
5. The method of claim 4, further comprising displaying a message on the monitor indicating one or more of the service doors is open or a ladder coupled to one of the service doors is in a down position.
6. The method of claim 1, further comprising displaying a main screen on the monitor

before the receiving a first input step.

7. The method of claim 1, further comprising displaying a service door control screen after the receiving a first input step.

8. The method of claim 1, further comprising activating or deactivating one or more solenoids corresponding to the selected service door.

9. The method of claim 1, further comprising displaying a message on the monitor to check a mirror or image from the camera before the receiving a third input step.

10. A machine, comprising:

- a frame and an engine coupled to the frame;

- a cab coupled to one side of the frame, the cab including a monitor for operating the machine;

- a first door and a second door coupled to the frame, the first door being disposed on the same side as the cab and the second door being disposed on a side opposite the first door;

- a controller disposed in electrical communication with the monitor and user controls;

- a door control system electrically coupled to the controller, the first door, and the second door, the system including computer-readable software stored in the controller for operably controlling the first and second doors; and

- a camera coupled to the frame and disposed in electrical communication with the monitor, wherein the camera is positioned to electrically communicate real-time images to the monitor of the second door and an area surrounding the second door.

11. The machine of claim 10, further comprising a plurality of solenoids electrically coupled to the controller, where at least one of the plurality of solenoids operably controls a movement of either the first door or second door between an open position and a closed position.

12. The machine of claim 10, further comprising an interlock switch electrically coupled to the controller and being operably coupled to one of the first door and second door, where the switch is configured to move between an open and closed position based on movement of the door.

13. The machine of claim 10, wherein the computer-readable software comprises:

a main screen displayed on the monitor, the main screen including a plurality of user controls for operably controlling movement of the first door and second door, where one of the plurality of user controls includes a first input;

a door control screen displayed on the monitor in response to the first input being triggered, the door control screen including an image of the machine, an image of each of the first door and second door, a second input for controlling either of the first door and second door in a first direction, and a third input for controlling either of the first door and second door in a second direction; and

a camera image screen displayed on the monitor in response to the second door being selected from the door control screen;

wherein the first door or second door is operably controlled between an open position and closed position in response to the selection of either door and the triggering of the second input or third input from the door control screen.

14. A method of controlling an opening or closing of a service door on a machine, the machine including a cab, a monitor disposed in the cab for controlling the machine, a camera mounted to the machine, a plurality of service doors coupled to the machine, a ladder coupled to one of the plurality of service doors, a plurality of solenoids and switch interlocks, an ignition control and engine, the method comprising:

displaying a first screen on the monitor, the first screen including a plurality of user control buttons for controlling the machine;

displaying a second screen on the monitor in response to a first user control button being selected from the monitor, the second screen including an image of the machine and each of the plurality of service doors;

displaying a plurality of icons on the second screen, where each of the plurality of icons corresponds to one of the plurality of service doors;

receiving an input in response to a second user control button being triggered, where the input corresponds to one of the plurality of service doors being selected for control; and
controlling the opening or closing of the selected service door.

15. The method of claim 14, further comprising identifying which of the plurality of service doors is presently selected on the second screen.

16. The method of claim 14, further comprising displaying a plurality of icons on the second screen, where each icon corresponds to one of the plurality of service doors or to one of the plurality of user control buttons.

17. The method of claim 14, further comprising displaying an image from the camera on the monitor.

18. The method of claim 14, further comprising displaying a message on the monitor corresponding to one of the plurality of service doors being in the opened position.

19. The method of claim 14, further comprising determining if a plurality of threshold conditions is satisfied before displaying the second screen.

20. The method of claim 14, further comprising returning from the second screen to the first screen when the ignition control is switched off, the first user control button is selected, or a second user control button is selected, where the second user control button corresponds to a previous screen.

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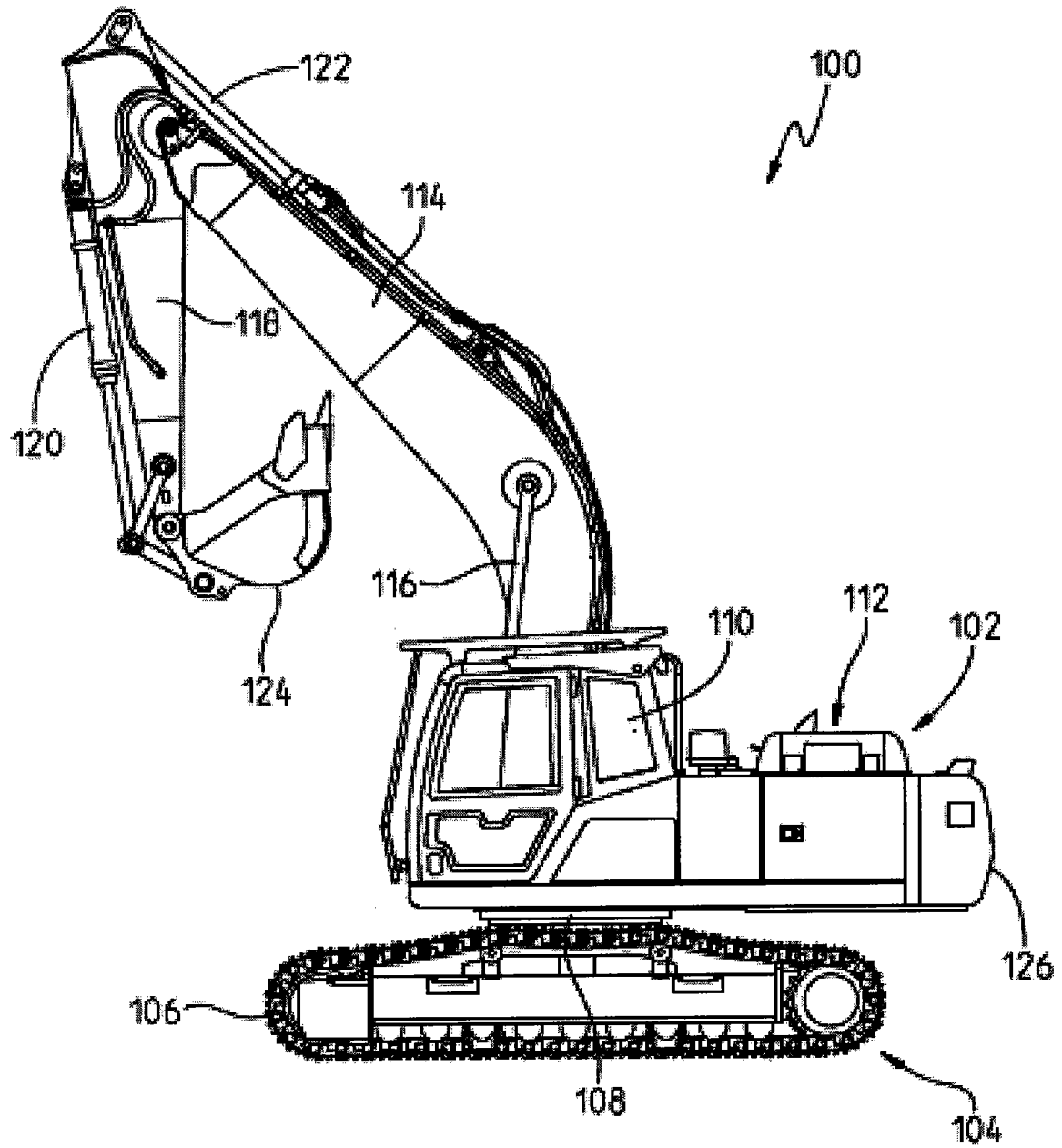


Fig. 1

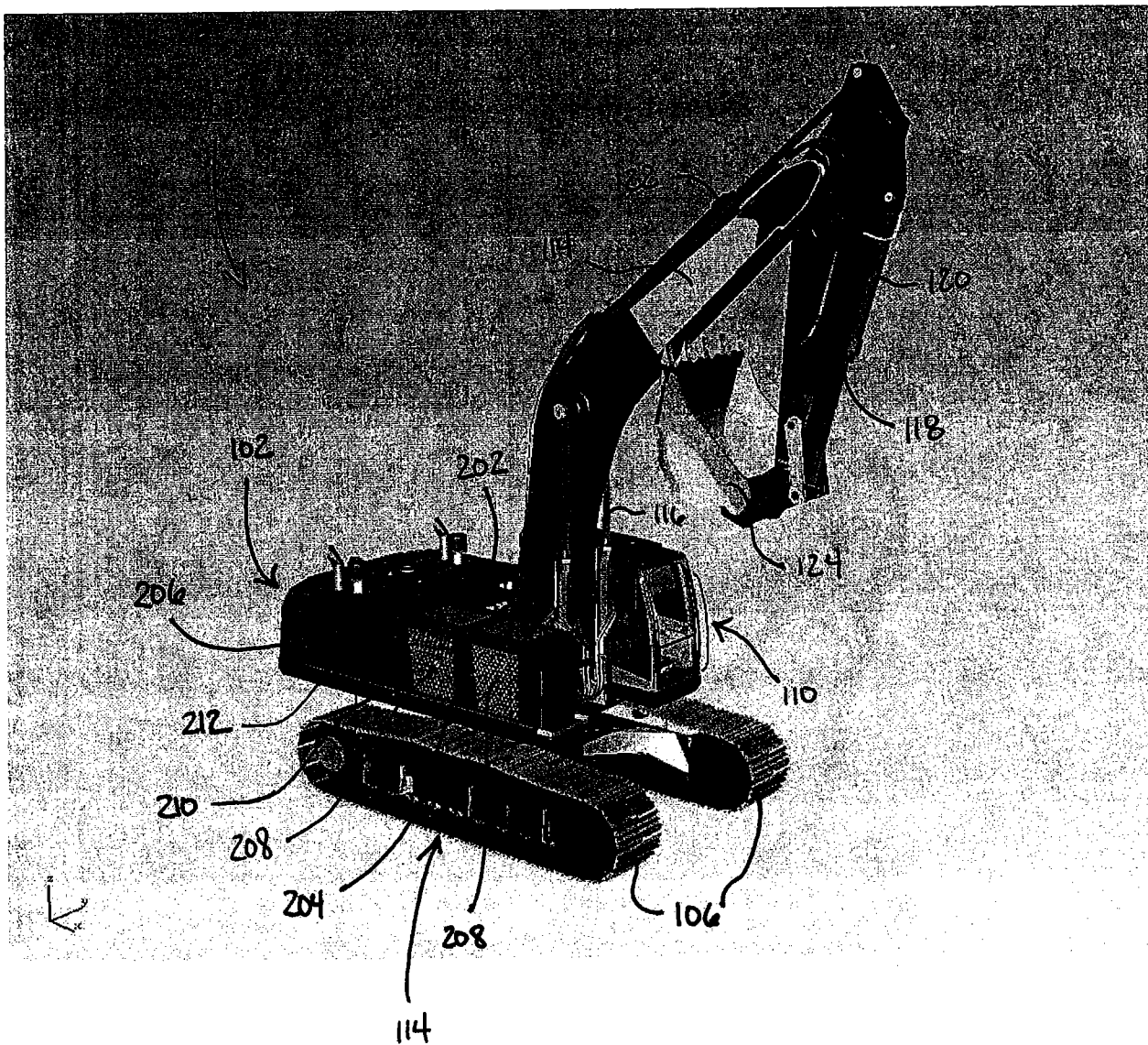


Figure 2

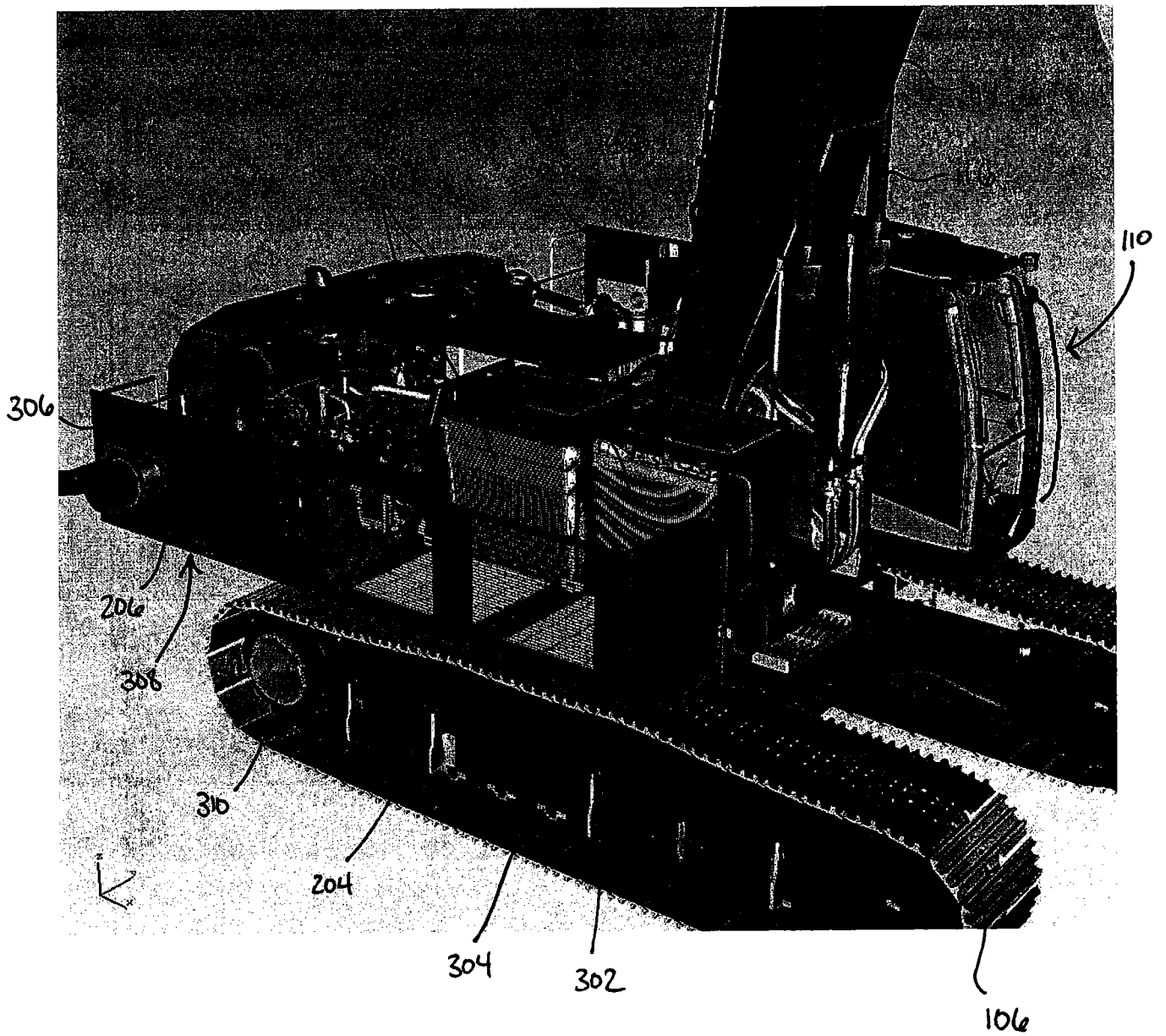


Figure 3

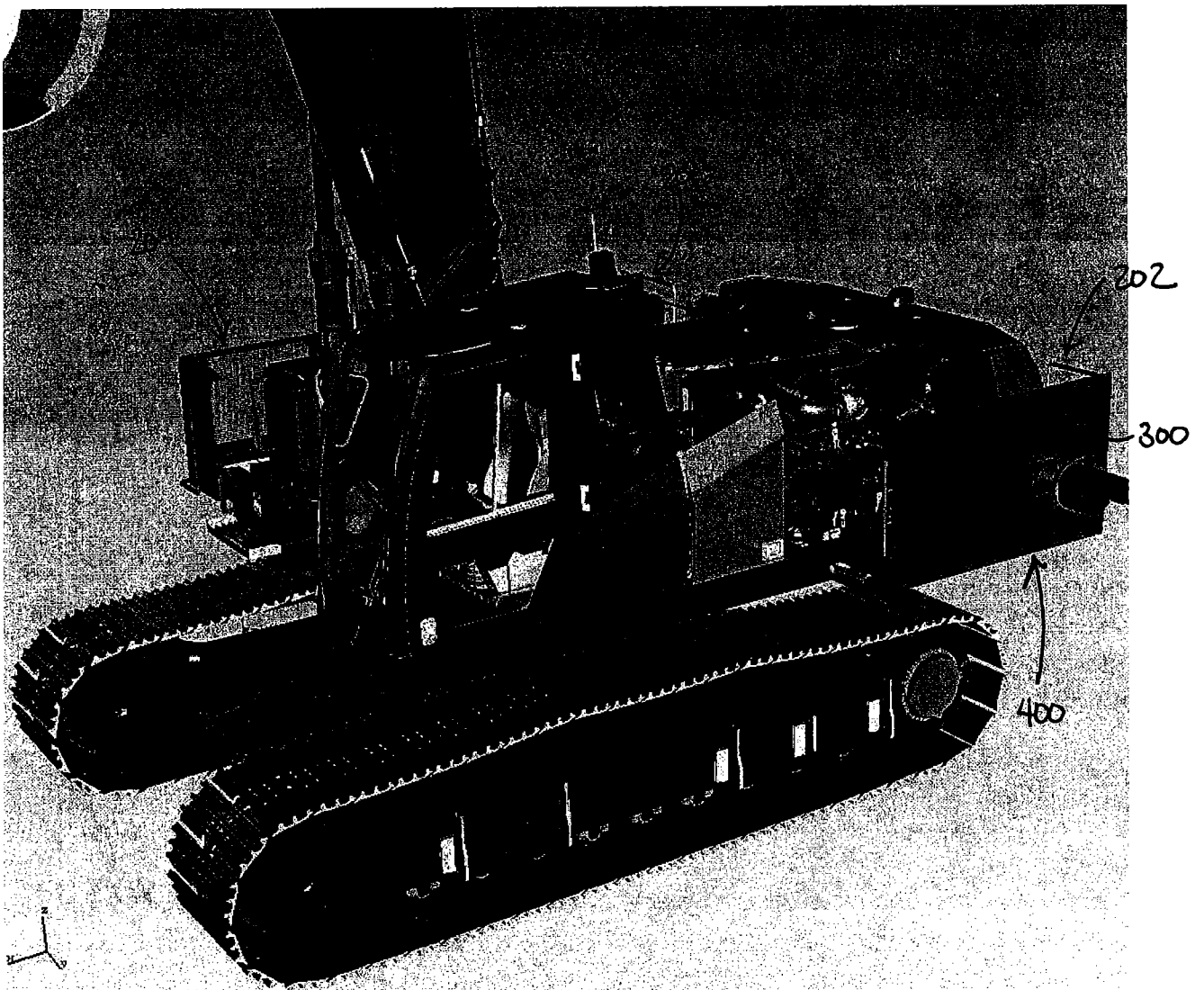


Figure 4

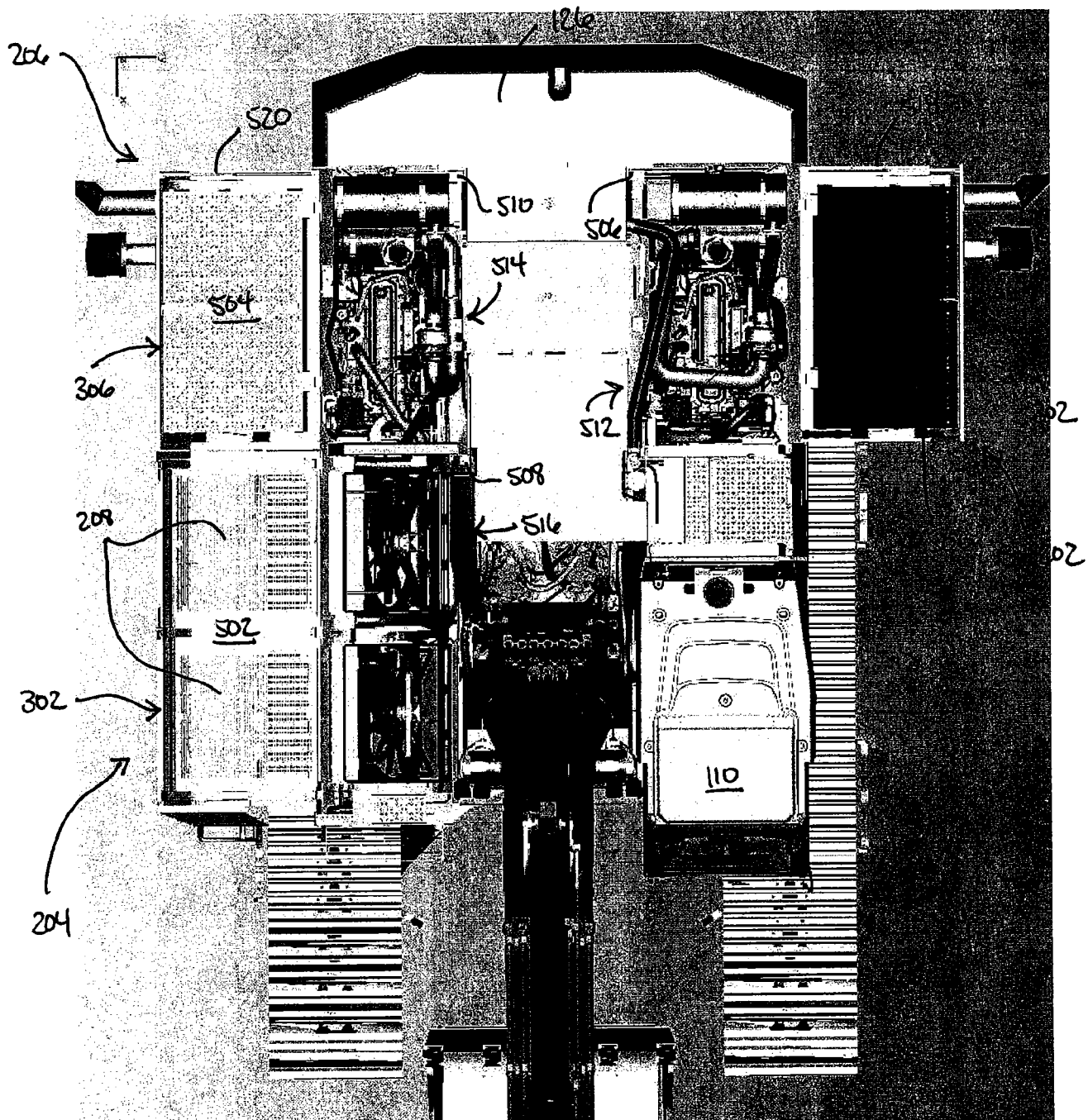


Figure 5

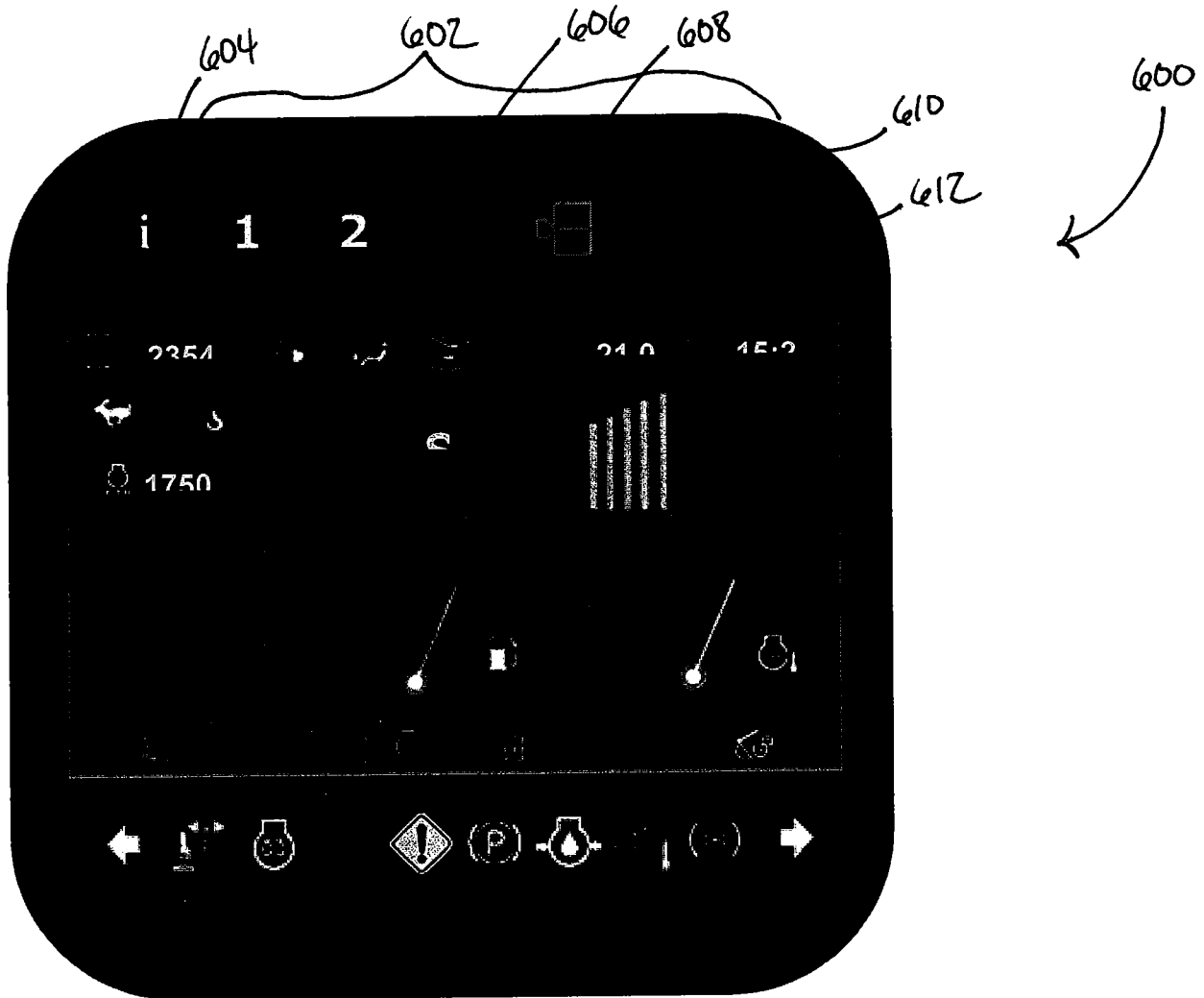
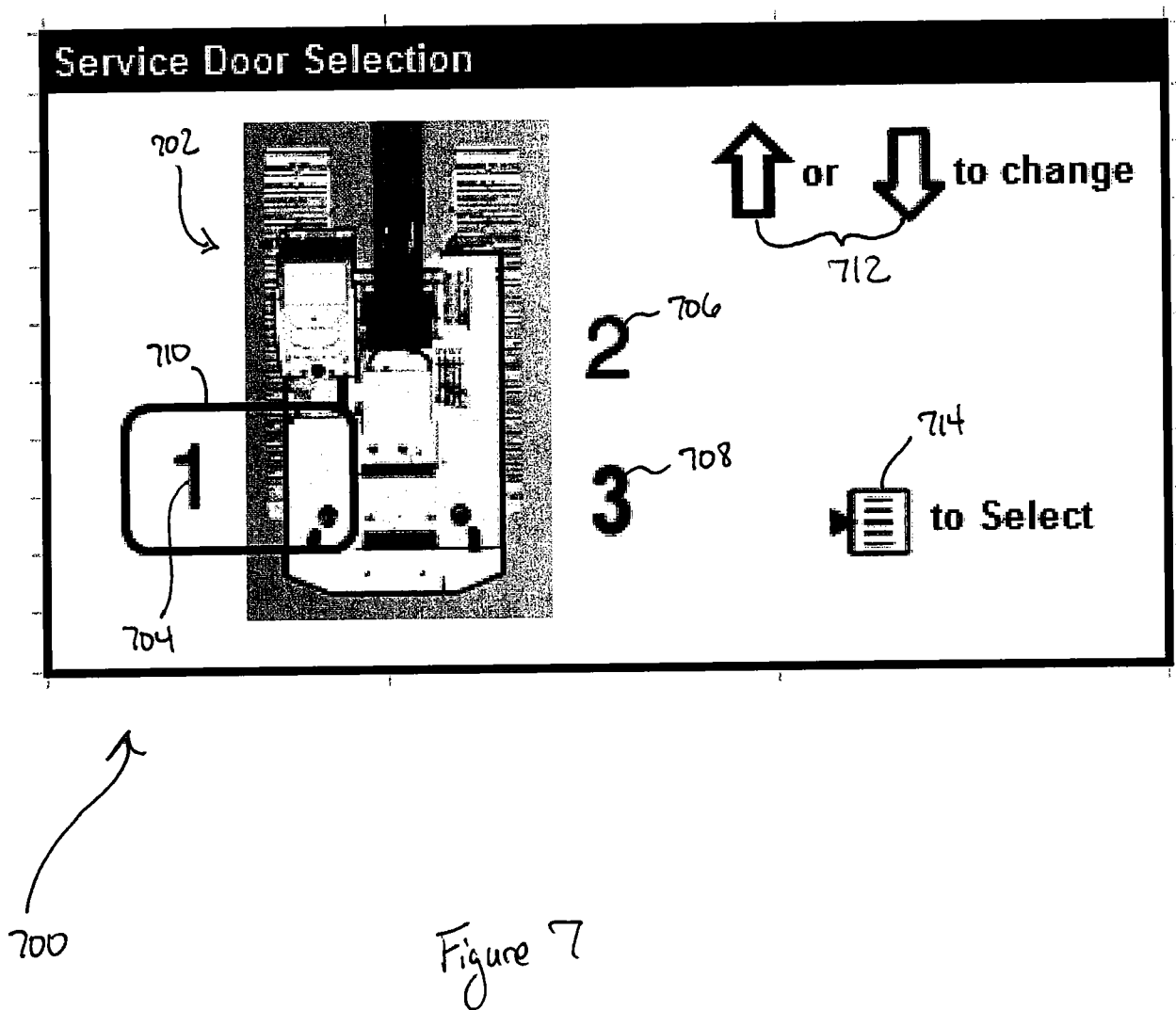


Figure 6



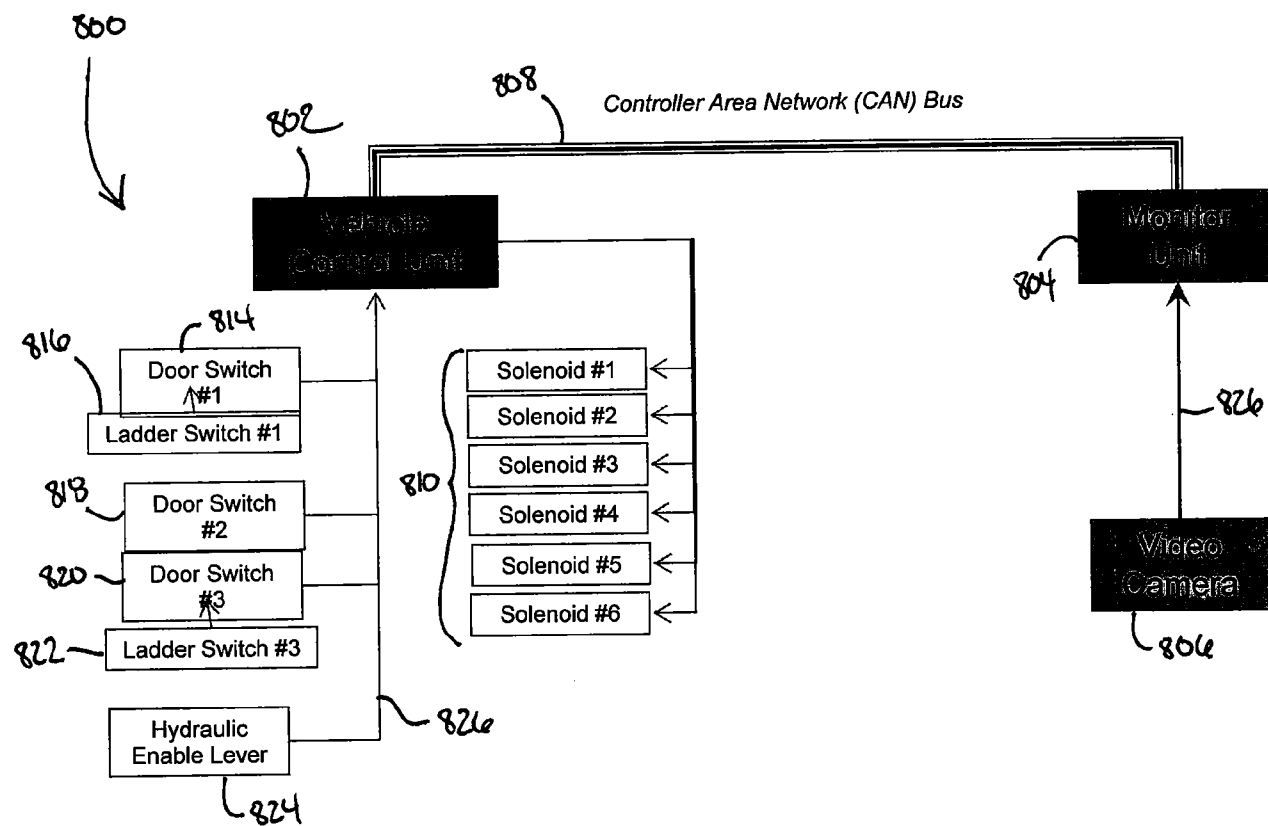


Figure 8

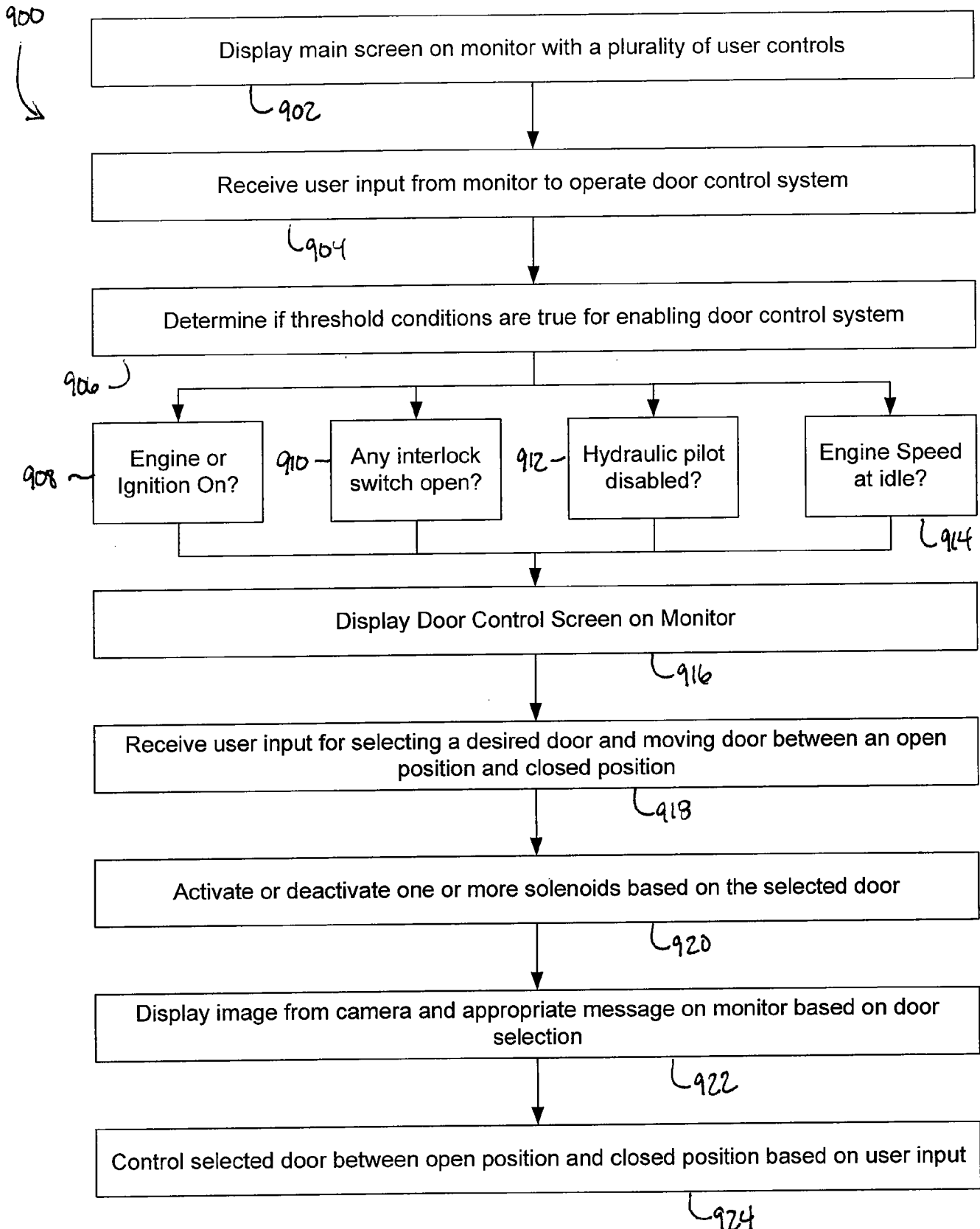


Figure 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/063519**A. CLASSIFICATION OF SUBJECT MATTER****E02F 9/20(2006.01)i, E02F 9/16(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02F 3/32; E02F 9/00; E02F 9/16; E02F 9/20; E02F 9/24; E02F 9/26; G06F 3/041; G06F 19/00; G09G 5/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: excavator, door, door control system, controller, camera and monitor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009-0133297 A1 (LEE, TAEK WOO) 28 May 2009 See paragraphs 23-34 and figures 4-5.	1-20
A	JP 2012-188899 A (KOBELCO CONSTRUCTION MACHINERY LTD.) 04 October 2012 See paragraphs 35-47 and figures 1-3.	1-20
A	US 2011-0301817 A1 (HOBENSHIELD et al.) 08 December 2011 See paragraphs 24, 38 and figures 1-4.	1-20
A	KR 10-2009-0034103 A (VOLVO CONSTRUCTION EQUIPMENT AB.) 07 April 2009 See paragraphs 33-39, 46 and figures 2-4.	1-20
A	JP 2011-179279 A (HITACHI CONSTR. MACH CO., LTD.) 15 September 2011 See abstract; paragraphs 21-25 and figures 2-5.	1-20

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

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

14 May 2013 (14.05.2013)

Date of mailing of the international search report

15 May 2013 (15.05.2013)

Name and mailing address of the ISA/KR

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AHN, Jae Yul

Telephone No. 82-42-481-8525



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/063519

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