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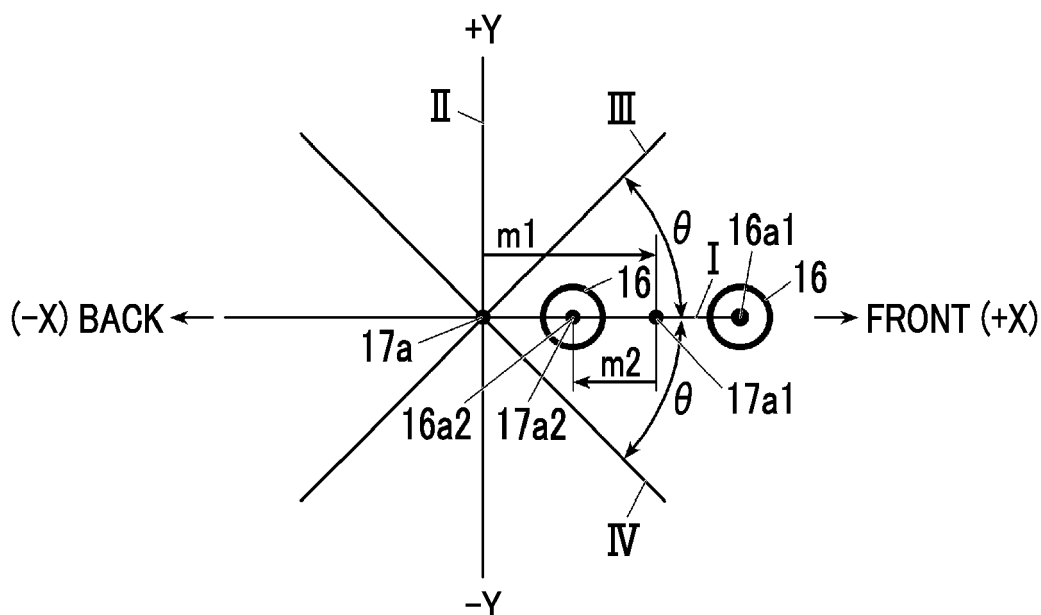
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(54) **CRANE**

(57) Provided is a crane capable of effectively suppressing the swing of the suspended object when the work to transport the suspended object is stopped. A crane (1) includes a boom (2) and a suspended object 16 suspended from the boom (2). The crane (1) is configured to perform, when in plane coordinates as seen vertically downward from above the crane, a position where the suspended object 16 is suspended from the boom (2) without swinging is defined as a reference position of the suspended object 16, a first control to operate,

in a case where the suspended object 16 is at a first shifted position 16a1 shifted with respect to a first reference position, the boom 2 to approach the first shifted position 16a1 in the plane coordinates, and a second control to operate, in a case where the suspended object 16 is at a second shifted position 16a2 shifted from a second reference position that is a reference position after the first control, the boom 2 to approach the second shifted position 16a2 in the plane coordinates.

FIG. 6A



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a crane.

Description of Related Art

[0002] In the past, a technique has been developed in which a crane transports a suspended objects (a suspended load hooked onto a hook or a hook-and-hook) to a predetermined position while suppressing swing of the suspended object (refer to Japanese Unexamined Patent Publication No. 2004-284735) .

SUMMARY OF THE INVENTION

[0003] However, a crane is required to more effectively suppress swing of a suspended object in a case where the suspended object is swung due to some reason (for example, residual vibration at the time of stopping, earthquake, wind, or the like) when work to transport the suspended object is stopped.

[0004] The present invention has an object to provide a crane capable of more effectively suppressing swing of a suspended object when work to transport the suspended object is stopped.

[0005] A crane according to the present invention includes a boom and a suspended object suspended from the boom. Then, the crane according to the present invention is configured to perform, when in plane coordinates as seen vertically downward from above the crane, a position where the suspended object is suspended from the boom without swinging is defined as a reference position of the suspended object, a first control to operate, in a case where the suspended object is at a first shifted position shifted with respect to a first reference position, the boom to approach the first shifted position in the plane coordinates, and a second control to operate, in a case where the suspended object is at a second shifted position shifted from a second reference position that is a reference position after the first control, the boom to approach the second shifted position in the plane coordinates.

[0006] The crane according to the present invention is capable of more effectively suppressing the swing of the suspended object when work to transport the suspended object is stopped.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Fig. 1 is a side view of a crane according to an embodiment of the present invention.

Fig. 2 is a partially omitted plan view of the crane

according to the embodiment of the present invention.

Fig. 3 is a partially enlarged view of the crane shown in Fig. 1.

Fig. 4 is a block diagram showing the functional configuration of the crane according to the embodiment of the present invention.

Fig. 5 is a plan view schematically showing the relationship between a maximum amplitude position of a suspended object and a surrounding structure at a work site.

Figs. 6A and 6B are diagrams showing a first example of swing stop processing for the suspended object.

Fig. 7A is a plan view showing a second example of the swing stop processing for the suspended object, and Fig. 7B is a plan view showing a third example of the swing stop processing for the suspended object.

Fig. 8 is a flowchart showing a flow of the swing stop processing for the suspended object.

DETAILED DESCRIPTION OF THE INVENTION

[0008] Hereinafter, an embodiment of the present invention will be described in detail with reference to the drawings.

(Configuration of Crane)

[0009] Fig. 1 is a side view of a crane 1 according to an embodiment of the present embodiment. Further, Fig. 2 is a plan view of the crane 1 according to the embodiment of the present invention with some parts (a boom 2, a derricking rope 3, and the like) omitted. Further, Fig. 3 is a partially enlarged view of the crane 1 shown in Fig. 1 and is a diagram showing an attachment structure of a camera 4.

[0010] As shown in Figs. 1 and 2, the crane 1 is a so-called mobile crawler crane. Specifically, the crane 1 includes a self-propelled crawler-type lower traveling body 5 and a rotating platform 6 rotatably mounted on the lower traveling body 5.

[0011] In the following, the front-back and right-left directions as seen from an occupant of the crane 1 will be described as the front-back and right-left directions of the crane 1.

[0012] The boom 2 is mounted on the front side of the rotating platform 6 to be able to perform derricking. A counterweight 7 for the weight balance between the boom 2 and a suspended load is mounted on a rear part of the rotating platform 6.

[0013] A cabin 8 in which an operator seats and operates the crane 1 is disposed at a front right part of the rotating platform 6.

[0014] A derricking operation of the boom 2 is performed by winding or unwinding the derricking rope 3 by a derricking winch 10.

[0015] One end of a hoisting rope 11 is connected to a hook 12, and the hook 12 is suspended by the hoisting rope 11 wrapped around a point sheave 17 at the tip of the boom 2. The other end of the hoisting rope 11 is wound around a hoisting winch 13 on the rotating platform 6, and the hoisting rope 11 is wound or unwound by the driving of the hoisting winch 13, so that the hook 12 moves up and down. A suspended load 14 is suspended from the hook 12 by a suspending material 15 in the form of a string, a chain, or the like. Then, in the present embodiment, the hook 12 and the suspended load 14 configure a suspended object 16 that is suspended from the boom 2.

[0016] For convenience of description, the portion of the hoisting rope 11, which extends away from the point sheave 17 to the hook 12, will be referred to as a suspended load rope 11a, and the length of the suspended load rope 11a will be referred to as a rope length. Further, in a case where the suspended load 14 is not suspended from the hook 12, the suspended object 16 is only the hook 12.

[0017] The crane 1 shown in Fig. 1 shows a state when work to transport the suspended object 16 is stopped, and the suspended object 16 is located vertically below a center 17a of the point sheave 17 disposed at the tip of the boom 2, and is suspended by the suspended load rope 11a without swinging. Then, in the crane 1 shown in Fig. 1, the position where it is assumed that the suspended object 16 is suspended from the boom 2 without swinging (the position on a reference line VL extending vertically downward from the center 17a of the point sheave 17) is defined as a reference position of the suspended object 16. Further, for convenience of description, the center 17a of the point sheave 17 is defined as a suspending position of the suspended object 16 in the boom 2. Further, in the crane 1 shown in Fig. 2, in a case of considering the swing of the suspended object 16 in the right-left direction (the direction along a Y axis), the position where it is assumed that the suspended object 16 is suspended from the boom 2 without swinging (the position on an imaginary line extending vertically downward from the center position of the point sheave 17 in the right-left direction) is defined as the reference position. Further, in the crane 1 shown in Fig. 1, a working time refers to a working time when the boom 2 is moved relative to the ground plane of the crane 1, or when the suspended load rope 11a is moved to move the suspended object 16 to a predetermined location. For example, the working time refers to a working time such as the derricking of the crane 1, the turning of the crane 1, or the winding or unwinding of the suspended load rope 11a. Further, the working time does not include, for example, a working time when, in a case where the crane 1 includes a surrounding monitoring device, the surroundings are monitored by the surrounding monitoring device.

[0018] As shown in Figs. 1 and 3, the camera 4 as a detection unit is suspended from the tip end side of the

boom 2 through a fixture 18. The fixture 18 includes a base portion 20 fixed to the boom 2, a support post 21 whose one end is rotatably supported by the base portion 20, and a cover 22 fixed to the other end of the support post 21. In the fixture 18, the support post 21 and the cover 22 are maintained in a downward posture due to their own weight regardless of the derricking operation of the boom 2. The camera 4 is accommodated inside the cover 22. As a result, the camera 4 is maintained in a downward posture, as with the support post 21 and the cover 22 of the fixture 18, regardless of the derricking operation of the boom 2.

[0019] The camera 4 is configured to image the suspended object 16 and the work site around the suspended object 16, and transmit the acquired image data to a control unit 23.

[0020] Fig. 4 is a block diagram showing the functional configuration of the crane 1.

[0021] As shown in Fig. 4, the crane 1 includes, in addition to the configuration described above, the control unit 23, a drive unit 24, an operation unit 25, a display unit 26, a communication unit 27, the camera (detection unit) 4, and a storage unit 28.

[0022] The control unit 23 is configured to include, for example, a central processing unit (CPU) and the like, and controls the operation of each part of the crane 1. The control unit 23 includes the function of an electronic control unit (ECU), and is disposed in the rotating platform 6. Specifically, the control unit 23 operates the drive unit 24, based on the operation input of the operator, or the like, and executes various processing in cooperation with programs 31 (31a to 31c) stored in advance in the storage unit 28 (described later), and the like.

[0023] The drive unit 24 is a drive source that operates each part of the crane 1, and includes the derricking winch 10 described above, the hoisting winch 13, a turning device 30 for the rotating platform 6, and other various motors and actuators, and the like.

[0024] The operation unit 25 is operating means through which the operator performs various operations. The operation unit 25 includes, for example, a steering wheel, a pedal, a lever, various buttons, and the like, and outputs operation signals corresponding to the contents of these operations to the control unit 23.

[0025] The display unit 26 is, for example, a liquid crystal display, an organic electroluminescence display, or other display, and displays images of or various information on the suspended object 16 and the work site around the suspended object 16, based on display signals that are input from the control unit 23. The display unit 26 may be a touch panel that also serves as a part of the operation unit 25.

[0026] The communication unit 27 is, for example, a communication device capable of transmitting and receiving various information to and from an information terminal (not shown) or the like.

[0027] The camera 4 as the detection unit outputs the image data of the suspended object 16 and the work site

around the suspended object 16 to the control unit 23, as described above. Further, in a case where the camera 4 has a distance measurement function, the camera 4 acquires distance data to the suspended object 16 and outputs the distance data to the control unit 23. The detection unit may use a stereo camera, a laser sensor such as LiDAR, a global navigation satellite system (GNSS), or the like, in addition to a monocular camera. Further, the distance data to the suspended object 16 is distance data from the camera 4 to the hook 12 in a case where the suspended load 14 is not suspended from the hook 12. Further, the distance data to the suspended object 16 may be distance data from the camera 4 to the hook 12 even in a case where the suspended load 14 is suspended from the hook 12. In the present embodiment, the camera 4 is disposed on the tip end side of the boom 2. However, there is no limitation thereto, and the camera 4 is disposed at a position (for example, an intermediate portion of the boom 2, a lower end portion of the boom 2, or the rotating platform 6) where the image data of the suspended object 16 and the work site around the suspended object 16 can be acquired.

[0028] The storage unit 28 is a memory configured with, for example, a random access memory (RAM), a read only memory (ROM), or the like, and stores various programs and data, and also functions as a work area for the control unit 23. The storage unit 28 of the present embodiment stores in advance a swing stop processing program 31 for executing swing stop processing for the suspended object 16 (refer to Fig. 8), which will be described later. The swing stop processing program 31 includes a suspended object position measurement program 31a, an obstacle detection program 31b, and a boom operation control program 31c.

[0029] The suspended object position measurement program 31a uses the image data acquired by the camera 4 to calculate the maximum amplitude, swing direction, and swing period of the suspended object 16.

[0030] The obstacle detection program 31b uses the image data acquired by the camera 4 to detect an obstacle (an object) that may cause a collision with the suspended object 16, and determine a swing stop direction for the suspended object 16. For example, the obstacle detection program 31b uses the image data acquired by the camera 4 to calculate a horizontal distance (the shortest distance in the X-Y plane of Fig. 5) L between the maximum amplitude position of the suspended object 16 and the surrounding structure (object) 32 at the work site. Then, the obstacle detection program 31b compares the horizontal distance L with a management dimension La determined in advance, and recognizes the surrounding structure (object) 32 as an obstacle in a case where the horizontal distance L is the same as or smaller than the management dimension La. Next, the obstacle detection program 31b determines the swing stop direction for the suspended object 16 in the swing stop processing (described later) to be a direction (-X direction in Fig. 5) away from the obstacle (32), and moves a suspending position

(17a) of the boom 2 in first control (described later) in a direction away from the obstacle (32).

[0031] The boom operation control program 31c calculates the turning angle of the boom 2 and/or the derricking angle of the boom 2 for suppressing swing of the suspended object 16, based on the calculation result of the suspended object position measurement program 31a and the determination result by the obstacle detection program 31b.

(First Example of Swing Stop Processing)

[0032] Figs. 6A and 6B are diagrams showing a first example of the swing stop processing for the suspended object 16, and show a case where the maximum amplitude direction of the suspended object 16 is a vibration pattern I along an X-axis direction. Further, Figs. 6A and 6B show the swing stop processing for the suspended object 16 in a case where an obstacle (32) is not detected by the obstacle detection program 31b. Fig. 6A is a plan view showing the first example of the swing stop processing for the suspended object 16, and Fig. 6B is a side view showing the first example of the swing stop processing for the suspended object 16.

[0033] As shown in Figs. 6A and 6B, the boom operation control program 31c calculates the derricking angle of the boom 2 with a focus on the fact that the vibration of the suspended object 16 is suppressed when the center 17a of the point sheave 17 (which is the fulcrum of the amplitude of the suspended object 16 and the position where the suspended object 16 is suspended from the boom 2) approaches the maximum amplitude position (a position shifted with respect to the reference position, which is a position on the reference line VL) of the suspended object 16.

[0034] In the present embodiment, a case is exemplified in which the swing stop of the suspended object 16 is performed in two steps, so that the amplitude of vibration of the suspended object 16 becomes equal to or lower than a setting value determined in advance (refer to steps S4 to S9 in Fig. 8). That is, in the swing stop of the suspended object 16, the first control, which is a first swing stop, is performed when the suspended object 16 moves in the maximum amplitude position direction from the reference position (a first reference position) on the reference line VL (a first reference line (VL1)). In the first control, the boom operation control program 31c calculates the derricking angle of the boom 2, based on the calculation results (the maximum amplitude, swing direction, and swing period of the suspended object 16) of the suspended object position measurement program 31a, and the like, such that, in a case where the suspended object 16 is at a first shifted position 16a1 shifted with respect to the first reference position, the boom 2 approaches the first shifted position 16a1 (the suspending position 17a can move to the distance of m1 (a suspending position 17a1 (on a second reference line VL2)) from the position on the first reference line (VL1)). The first

control is performed when the crane 1 is not working, and the suspending position (17a) is brought close to the suspended object 16. Then, the control unit 23 operates the derricking winch 10, based on the calculation result of the boom operation control program 31c, to perform the derricking of the boom 2. The boom 2 is folded down in a case where the suspending position (17a) is moved toward the tip end side in a +X direction, and raised in a case where the suspending position (17a) is pulled back from the tip end side in the +X direction. Further, in the first control, the timing of movement of the suspending position (17a) is when the suspended object 16 moves from the reference position on the first reference line VL1 to the maximum amplitude position. Due to the movement at such a timing, the boom 2 can be moved in the same direction as the moving direction of the suspended object 16, so that the swing can be more easily suppressed. Further, a neutral state (a neutral brake state) in terms of a manual operation is established between the first control and a second control (described later). In this case (the neutral brake state), when the crane is a hydraulic crane, a hydraulic brake is applied to the operation of the crane 1. The setting value of the amplitude of the suspended object 16 is optionally determined depending on the situation of the work site, and the like.

[0035] The second control, which is a second swing stop of the suspended object 16, is a control in a reverse direction (opposite direction) to the first control, and in a case where the suspended object 16 is at a second shifted position 16a2 shifted from the second reference position on the second reference line VL2 that is the reference position after the first control, the boom 2 is operated to approach the second shifted position 16a2. That is, in the second control, the boom operation control program 31c calculates a distance m2 (a distance to a suspending position (17a2)) from the suspending position (17a1) at the time of the end of the first control to the maximum amplitude position (the second shifted position 16a2) of the next suspended object 16, and the boom operation control program 31c also calculates the derricking angle of the boom 2 corresponding to the distance m2. The control unit 23 operates the derricking winch 10, based on the calculation results of the boom operation control program 31c, to perform the derricking of the boom 2. In the second control, the timing of movement of the suspending position (17a1) is when the suspended object 16 moves from the second reference position on the second reference line VL2 at the suspending position (17a1) at the time of the end of the first control to the maximum amplitude position (the position at the distance m2). Further, the second control is not limited to the case of the control in the reverse direction to the first control, and the suspending position (17a1) at the time of the end of the first control may be moved in accordance with the moving direction of the suspended object 16 that is returning toward the first shifted position 16a1 side (the control in the same direction as the first control is also acceptable). That is, the second control may be performed in the same

direction as the first control after the suspended object 16 passes the second reference line (VL2) twice after the neutral state (the neutral brake state) between the first control and the second control is established.

[0036] In such swing stop processing for the suspended object 16, the swing stop of the suspended object 16 is performed in a plurality of steps, so that the acceleration acting on the suspended object 16 becomes lower compared to a case where the swing stop of the suspended object 16 is performed only once, and it becomes possible to smoothly and reliably perform the swing stop of the suspended object 16.

[0037] Further, in the swing stop processing for the suspended object 16 shown in Figs. 6A and 6B, the second control is performed to move the suspending position (17a) in the opposite direction to the first control, so that the moving distance of the suspending position (17a) can be reduced.

[0038] Further, as described above, in the second control of the swing stop processing for the suspended object 16 shown in Figs. 6A and 6B, the timing of movement of the suspending position (17a1) is when the suspended object 16 moves from the second reference position on the second reference line VL2 at the suspending position (17a1) at the time of the end of the first control to the maximum amplitude position (the position at the distance m2). Therefore, the swing stop processing for the suspended object 16 according to the present embodiment can be expected to have a great swing stop effect.

[0039] The swing stop processing for the suspended object 16 shown in Figs. 6A and 6B is performed in the +X direction. However, there is no limitation thereto, and the swing stop processing may be performed in the -X direction. In this manner, in a case where the swing stop processing for the suspended object 16 is performed in the -X direction, the movement of the suspending position (17a) in Fig. 6A is performed by raising the boom 2.

[0040] Further, the swing stop processing for the suspended object 16 shown in Figs. 6A and 6B is performed in two steps, that is, the first control and the second control. However, there is no limitation thereto, and in a case where the amplitude of the suspended object 16 does not become equal to or lower than a setting value determined in advance, or the like, the swing stop processing may be performed in three or more steps (refer to steps S8 to S11 in Fig. 8). In this manner, in a case where the swing stop processing for the suspended object 16 is performed in three or more steps, the moving distance of the suspending position (17a) is determined to be an optimal numerical value depending on the number of times of the swing stop processing. A case is exemplified in which the first example of the swing stop processing is performed based on the amplitude of the suspended object 16. However, there is no limitation thereto, and the first example of the swing stop processing may be performed based on the number of times of the swing stop processing.

[0041] Further, it is preferable that the swing stop

processing for the suspended object 16 is performed in an even number of times in order to make it easier for forces acting on the suspending position (17a) to be canceled out. For example, when the first control and the second control constitute one set, the swing stop processing for the suspended object 16 may be performed by performing a plurality of sets of the first control and the second control. In this manner, in a case of performing a plurality of sets of the first control and second control with reverse control directions, the moving distance of the boom 2 at the time of the start and the time of the end of the swing stop processing is reduced, so that a position is not easily shifted before and after the start. Further, there is no need to secure a large space when the crane is not working, and it is particularly effective when the crane is not working. The swing stop processing for the suspended object 16 may be ended without performing the second control, in a case where the amplitude of the suspended object 16 becomes equal to or lower than the installation value at the time of the end of the first control after performing one set of the first control and the second control,

[0042] Further, in the swing stop processing for the suspended object 16, either the first control or the second control may be executed multiple times.

[0043] Further, in the present embodiment, the swing stop of the suspended object 16 is automatically performed by the control unit 23 and the like by using the swing stop processing program 31. However, there is no limitation thereto, and the operator may manually operate the operation unit 25 to bring the suspending position (17a) close to the suspended object 16. In the case of such a manual operation of the crane 1 by the operator, for example, the display unit 26 gives instructions to the operator, and the operator performs the actual operation. In Fig. 6B, the suspending position (17a2) and the suspended object 16 may not completely match, and the suspending position (17a2) and the suspended object 16 may be misaligned.

(Second Example of Swing Stop Processing)

[0044] Fig. 7A is a plan view showing a second example of the swing stop processing for the suspended object 16, and shows a case where the maximum amplitude direction of the suspended object 16 is a vibration pattern II along a Y-axis direction. Further, Fig. 7A shows the swing stop processing for the suspended object 16 in a case where an obstacle (32) is not detected by the obstacle detection program 31b. In the description of the second example of the swing stop processing for the suspended object 16, the description common to the description of the first example will be omitted appropriately.

[0045] As shown in Fig. 7A, the boom operation control program 31c calculates the turning angle of the boom 2 with a focus on the fact that the vibration of the suspended object 16 is suppressed when the center 17a of the point sheave 17 (which is the fulcrum of the amplitude of the

suspended object 16 and the position where the suspended object 16 is suspended from the boom 2) approaches the maximum amplitude position of the suspended object 16. Then, in the second example, the swing stop processing for the suspended object is performed in a +Y-axis direction, and the first control and the second control are performed in the same manner as in the first example.

[0046] In such a second example, the movement of the suspending position (17a) is performed by turning the boom 2, and the boom operation control program 31c calculates the turning angle of the boom 2, based on the calculation results (the maximum amplitude, swing direction, and swing period of the suspended object 16) of the suspended object position measurement program 31a, and the like. Then, the control unit 23 operates the turning device 30, based on the calculation result of the boom operation control program 31c, to turn the rotating platform 6 and the boom 2.

[0047] In such a second example, the swing stop for the suspended object 16 can be performed in the same manner as in the first example.

[0048] In the second example, the swing stop processing for the suspended object 16 is performed in the +Y-axis direction. However, there is no limitation thereto, and the swing stop processing for the suspended object 16 can be performed in a -Y-axis direction.

[0049] Further, in the second example, in a case of turning the boom 2, a neutral state (a turning neutral free state) in terms of a manual operation is established between the first control and the second control. In the turning neutral free state, the boom 2 turns with the inertia of the rotating platform 6 (oil circulates depending on the rotation by the inertia of a hydraulic motor for turning).

[0050] Further, in the neutral state of the second example, when the boom 2 turns with the inertia of the rotating platform 6, a brake may be applied to the turning of the boom 2. For example, a hydraulic brake may be separately provided at the hydraulic motor for turning, and a brake may be applied by the hydraulic brake. In this case, the turning speed of the boom 2 is further reduced by the hydraulic brake.

(Third Example of Swing stop Processing)

[0051] Fig. 7B is a plan view showing a third example of the swing stop processing for the suspended object 16, and shows a case where the maximum amplitude direction of the suspended object 16 is a vibration pattern III in the direction inclined by θ in the counterclockwise direction with respect to the X-axis direction. Further, Fig. 7B shows the swing stop processing for the suspended object 16 in a case where an obstacle (32) is not detected by the obstacle detection program 31b. In the description of the third example of the swing stop processing for the suspended object 16, the description common to the description of the first example will be omitted appropriately.

[0052] As shown in Fig. 7B, the boom operation control

program 31c calculates the turning angle and derricking angle of the boom 2 with a focus on the fact that the vibration of the suspended object 16 is suppressed when the center 17a of the point sheave 17 (which is the fulcrum of the amplitude of the suspended object 16 and the position where the suspended object 16 is suspended from the boom 2) approaches the maximum amplitude position of the suspended object 16. Then, in the third example, the swing stop processing for the suspended object is performed in a first quadrant, and the first control and the second control are performed in the same manner as in the first example.

[0053] In such a third example, the movement of the suspending position (17a) is performed by the turning and derricking of the boom 2, and the boom operation control program 31c calculates the turning angle and derricking angle of the boom 2, based on the calculation results (the maximum amplitude, swing direction, and swing period of the suspended object 16) of the suspended object position measurement program 31a, and the like. Then, the control unit 23 operates the turning device 30, based on the calculation results of the boom operation control program 31c, to turn the rotating platform 6 and the boom 2, and operates the derricking winch 10, based on the calculation results of the boom operation control program 31c, to perform the derricking of the boom 2.

[0054] In such a third example, the swing stop for the suspended object can be performed in the same manner as in the first example.

[0055] In the third example, the swing stop processing for the suspended object 16 is performed in the first quadrant. However, there is no limitation thereto, and the swing stop processing for the suspended object 16 can be performed in a third quadrant.

[0056] Further, the third example can be applied to the case of a vibration pattern IV in which the maximum amplitude direction of the suspended object 16 is inclined by θ in the clockwise direction with respect to the X-axis direction.

(Flow of Swing Stop Processing)

[0057] Fig. 8 is a flowchart showing a flow of the swing stop processing for the suspended object 16 in the crane 1 according to the present embodiment.

[0058] In the present embodiment, the swing stop processing for the suspended object 16 is executed by the control unit 23 reading out and developing the swing stop processing program 31 from the storage unit 28, based on, for example, an operator's operation. The swing stop processing program 31 may be read out and developed after other automatic operations, without being based on an operator operation.

[0059] First, the maximum amplitude, swing direction, and swing period of the suspended object 16 are calculated by the suspended object position measurement program 31a (step S1). The image data acquired by the camera 4 is used to calculate the maximum amplitude

and the like of the suspended object 16.

[0060] Next, a recognition of an obstacle that may collide with the suspended object 16 is performed by the obstacle detection program 31b (step S2). The recognition of an obstacle by the obstacle detection program 31b is performed using the image data acquired by the camera 4.

[0061] In a case where it is determined by the obstacle detection program 31b that there is an obstacle, a swing stop direction to avoid collision with the obstacle is determined by the obstacle detection program 31b (step S3).

[0062] In a case where it is determined by the obstacle detection program 31b that there is no obstacle, the swing stop processing for the suspended object 16 is executed in the swing stop direction optionally set in advance (steps S4 to S9) (refer to the first to third examples of the swing stop processing for the suspended object), and in a case where it is determined by the obstacle detection program 31b that there is an obstacle, the swing stop processing for the suspended object 16 is executed in the swing stop direction determined in step 3 (steps S4 to S9). In a case where an obstacle is recognized by the obstacle detection program 31b after the swing stop processing is started (for example, after the first control is ended), the second control in the direction in which the obstacle is recognized is not performed. Further, in the first control, the first shifted position 16a1 is located on the opposite side across the first reference position with respect to an object (an obstacle) that may come into contact with the suspended object 16, among the objects detected by the camera (detection unit) 4. In this manner, in the swing stop processing for the suspended object 16 of the present embodiment, since the suspended object 16 is moved to avoid an obstacle, collision between the suspended object 16 and the obstacle can be avoided, so that safer work execution becomes possible.

[0063] In the swing stop processing, first, the first reference position and the first shifted position 16a1 of the suspended object 16 are detected (step S4). The detection of the first reference position and the first shifted position 16a1 of the suspended object 16 is performed by, for example, the camera 4 or the operator. Here, it is possible to recognize whether or not there is an obstacle.

[0064] Next, the boom 2 is moved from the first reference position toward the first shifted position 16a1 (step S5).

[0065] Next, the camera 4, the operator, or the like detects that the suspending position 17a (the reference position) of the boom 2 is located on the side opposite to the first shifted position 16a1 across the suspending position 17a1 (the first reference position) of the boom 2 (step S6). Here, it is possible to recognize whether or not there is an obstacle.

[0066] Next, the boom 2 is moved from the second reference position toward the second shifted position 16a2 (step S7).

[0067] Next, the amplitude of the suspended load 14

(the suspended object 16) is detected by the camera 4, the operator, or the like (step S8).

[0068] Next, it is determined whether or not the amplitude of the suspended load 14 (the suspended object 16) detected in step S8 is equal to or lower than a value set in advance (a setting value) (step S9), and in a case where it is determined that the amplitude is equal to or lower than the setting value, the swing stop processing for the suspended object 16 (the first control and the second control) is ended. As a result, the swing of the suspended object 16 can be reliably suppressed. The swing stop processing may be stopped in a case where the processing in the number of times (multiple times) determined in advance has been ended. Further, the swing stop processing may be stopped in a case where the amplitude of the suspended object 16 is equal to or lower than a predetermined setting value and the number of times of the swing stop processing including the first control and the second control becomes an even number.

[0069] (In this case, in the case of NO in step S9 of Fig. 8, the routine returns to step S4 through a dotted line). In a case where the conditions are set in this manner, the moving distance before and after the swing stop processing can be made smaller, and swing can be suppressed more reliably.

[0070] On the other hand, in a case where it is determined that the amplitude exceeds the setting value (step S9), an N-th reference position and an N-th shifted position are detected (step S10), the boom 2 is moved from the N-th reference position toward the N-th shifted position (step S11), the amplitude of the suspended load 14 (the suspended object 16) is detected (step S8), and the swing stop processing in steps S10, S11, S8, and S9 is repeated until the amplitude becomes equal to or lower than the setting value (step S9). In the present embodiment, N is a numerical value of 3 or more and is incremented by 1 each time the number of times of the swing stop processing increases.

[0071] The swing stop processing according to the embodiment described above is an example in which control is performed such that the amplitude of the suspended object 16 becomes equal to or lower than the setting value. However, there is no limitation thereto, and control may be performed with the number of times of the swing stop processing (the number of times optionally set in advance). For example, the number of times of the swing stop processing may be two times, as shown in steps S4 to S7 in Figs. 6A and 6B, 7A and 7B, and 8.

(Effect of the Present Embodiment)

[0072] The crane 1 according to the present embodiment is capable of effectively suppressing the swing of the suspended object 16 when the work to transport the suspended object 16 is stopped.

[0073] Further, the crane 1 according to the present embodiment is configured to perform the swing stop of the suspended object 16 by performing the swing stop

processing multiple times, and therefore, even if the suspended object 16 includes the hook 12 and the suspended load 14, the acceleration acting on the hook 12 and the suspended load 14 can be reduced compared to a case where the swing stop of the suspended object 16 is performed with one swing stop processing, and the occurrence of double vibration between the hook 12 and the suspended load 14 can be prevented.

10 (Other Embodiments)

[0074] In the crane 1 according to the present invention, the installation angle of the camera 4 may be variably set by a movable mechanism unit (not shown) such as a servomotor.

[0075] In the crane 1 of the present embodiment, the state of the suspended load is detected by the camera 4 and the swing stop processing is executed. However, the crane 1 may be operated by an operation method in which the operator monitors the state of the suspended load and performs the first control and the second control. In this case as well, the swing of the suspended object 16 can be effectively suppressed when the work to transport the suspended object 16 is stopped.

[0076] Further, in the present invention, the type of crane is not particularly limited, and the present invention can be applied to all types of cranes such as a harbor crane, an overhead crane, a portal crane, an unloader, and a fixed crane, in addition to mobile cranes such as a crawler crane, a wheel crane, and a truck crane.

[0077] Further, the present invention also includes a crane which is a loading shovel having a boom, an arm, a rope suspended from the arm, and a hook attached to the rope, and various modifications and improvements can be made within the scope of the present invention described in claims.

Brief Description of the Reference Symbols

40 **[0078]**

- 1: crane
- 2: boom
- 16: suspended object
- 16a1: first shifted position
- 16a2: second shifted position

Claims

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1. A crane (1) comprising:

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- a boom (2); and
 - a suspended object (16) suspended from the boom (2),
- wherein the crane is configured to perform, when in plane coordinates as seen vertically downward from above the crane (1), a position

where the suspended object (16) is suspended from the boom (2) without swinging is defined as a reference position of the suspended object (16),

a first control to operate, in a case where the suspended object (16) is at a first shifted position (16a1) shifted with respect to a first reference position, the boom (2) to approach the first shifted position (16a1) in the plane coordinates, and a second control to operate, in a case where the suspended object (16) is at a second shifted position (16a2) shifted from a second reference position that is a reference position after the first control, the boom (2) to approach the second shifted position (16a2) in the plane coordinates.

wherein the first control is started when a turning operation and a derricking operation of the boom (2) are not performed and a winding and unwinding operation of the suspended object (16) is not performed.

2. The crane (1) according to claim 1, wherein the second control is performed after the suspended object (16) is located on a side opposite to the first shifted position (16a1) across the second reference position.
3. The crane (1) according to claim 2, wherein the second control is performed in a case where the suspended object (16) is at the second shifted position (16a2) on the side opposite to the first shifted position (16a1) across the second reference position.
4. The crane (1) according to claim 3, wherein in a case where the first control and the second control constitute one set, a plurality of sets of the first control and the second control are repeatedly performed.
5. The crane (1) according to any one of claims 1 to 4, wherein the first control and the second control are ended when an amplitude of the suspended object (16) becomes equal to or lower than a predetermined value.
6. The crane (1) according to any one of claims 1 to 4, further comprising:

a detection unit (4) that detects objects around the suspended object (16),

wherein in the first control, the first shifted position (16a1) is located on an opposite side across the first reference position with respect to an object that is likely to come into contact with the suspended object (16), among the objects detected by the detection unit (4).
7. The crane (1) according to any one of claims 1 to 4, wherein a start timing of the first control or the second control is when the suspended object (16) moves from the reference position to a maximum amplitude position.
8. The crane (1) according to any one of claims 1 to 4,

FIG. 1

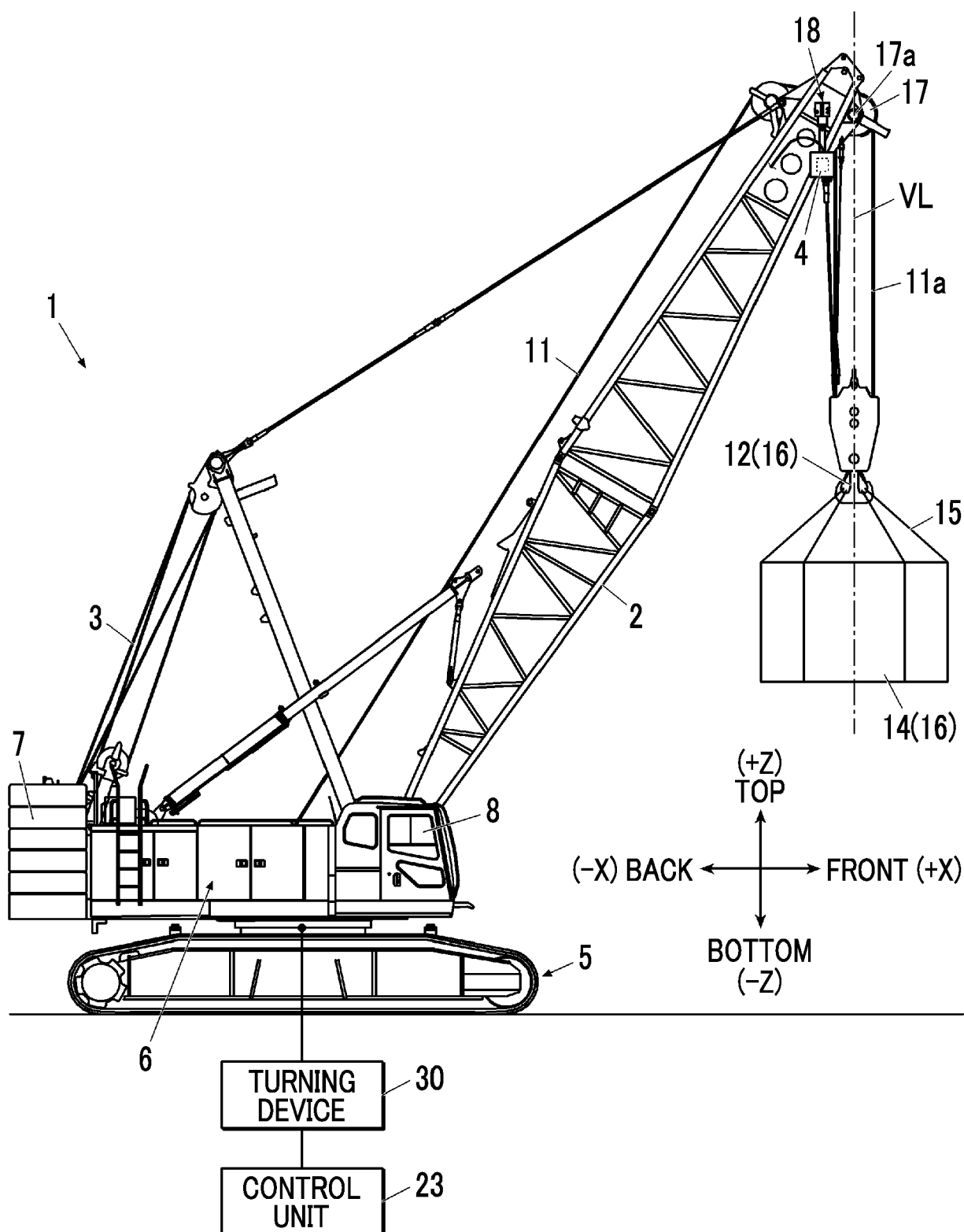


FIG. 2

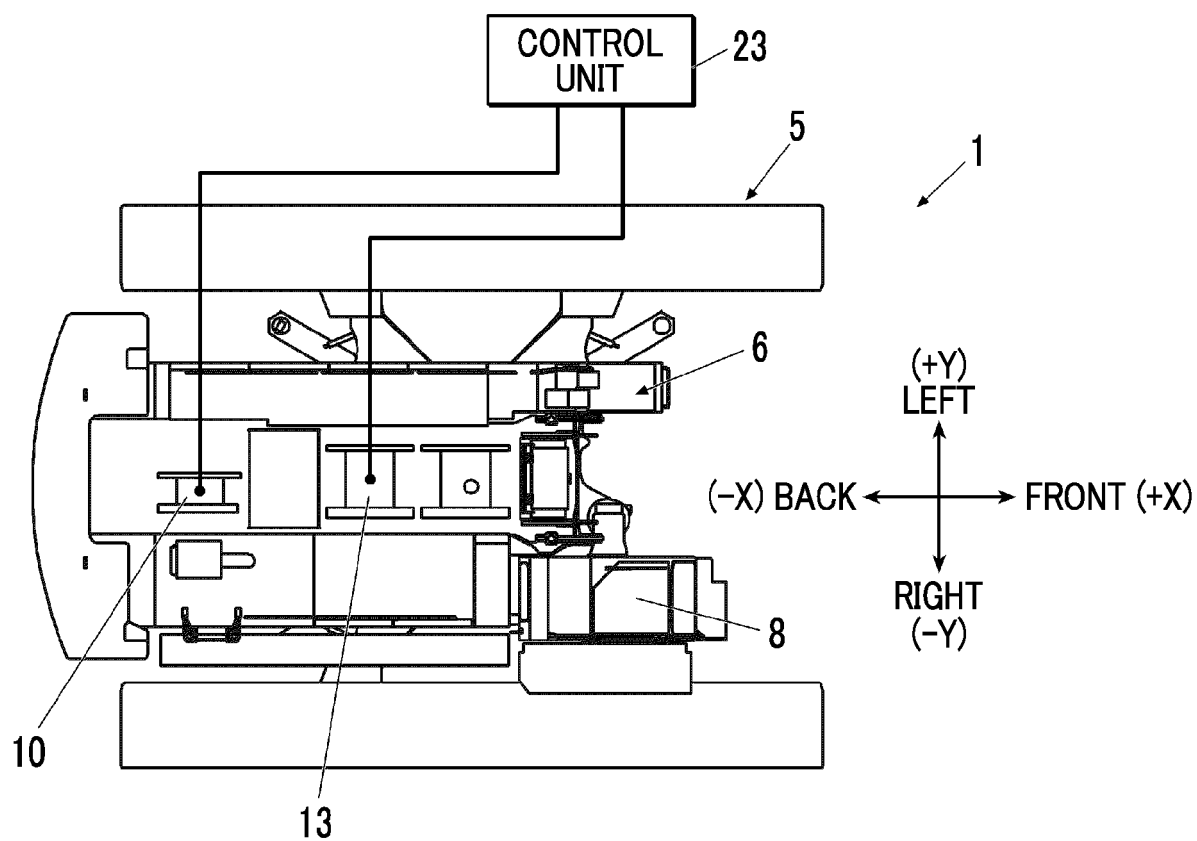


FIG. 3

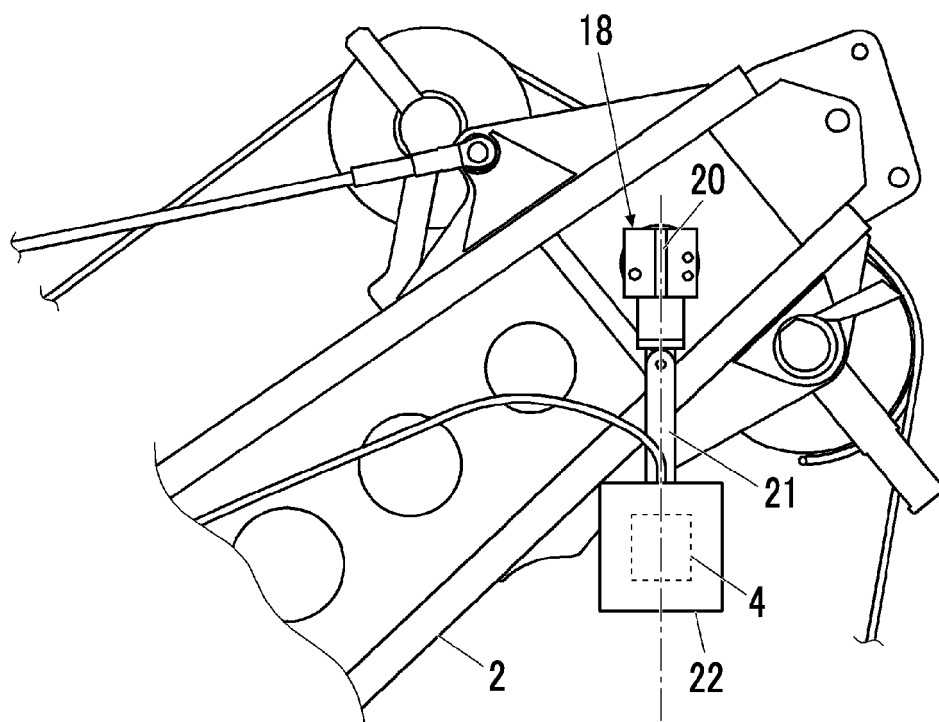


FIG. 4

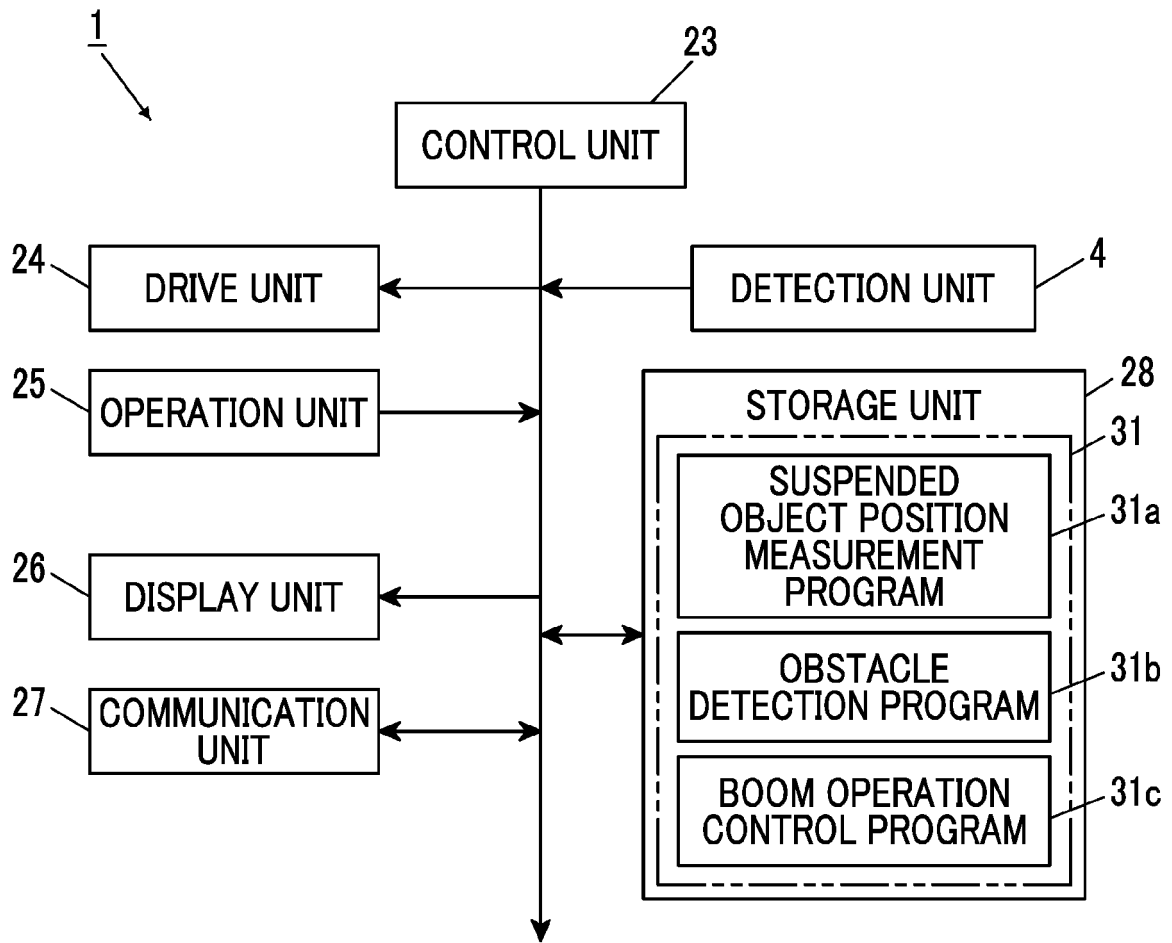


FIG. 5

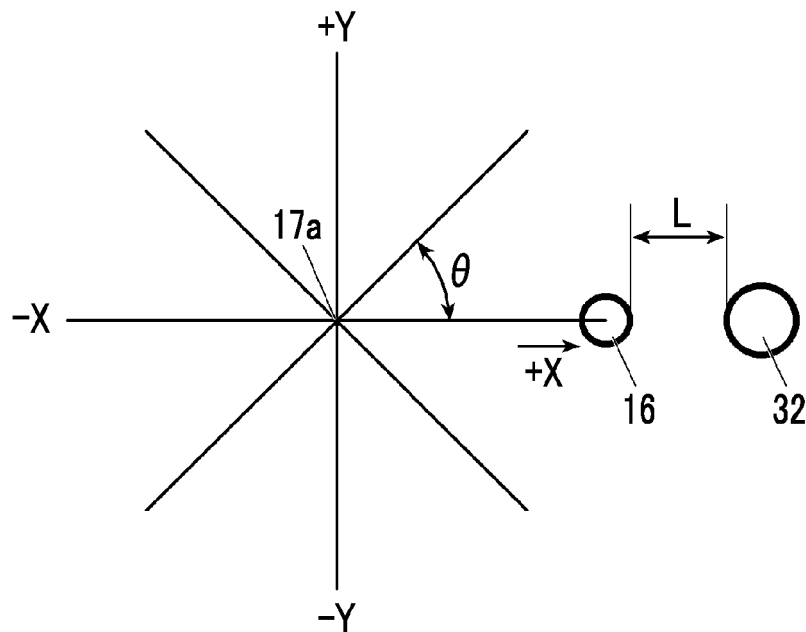


FIG. 6A

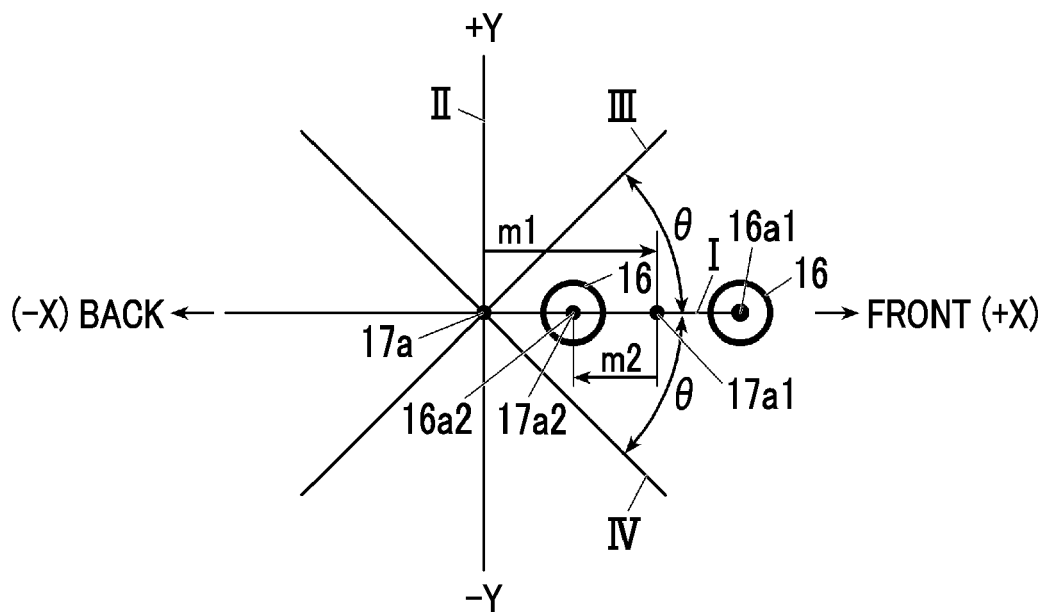


FIG. 6B

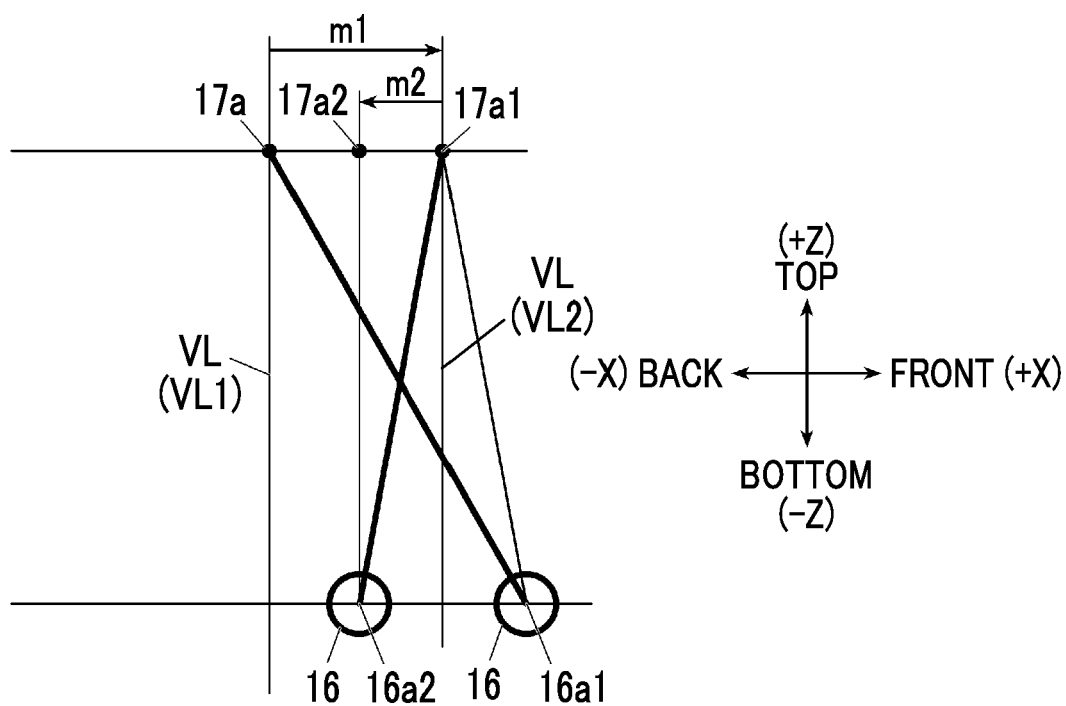


FIG. 7A

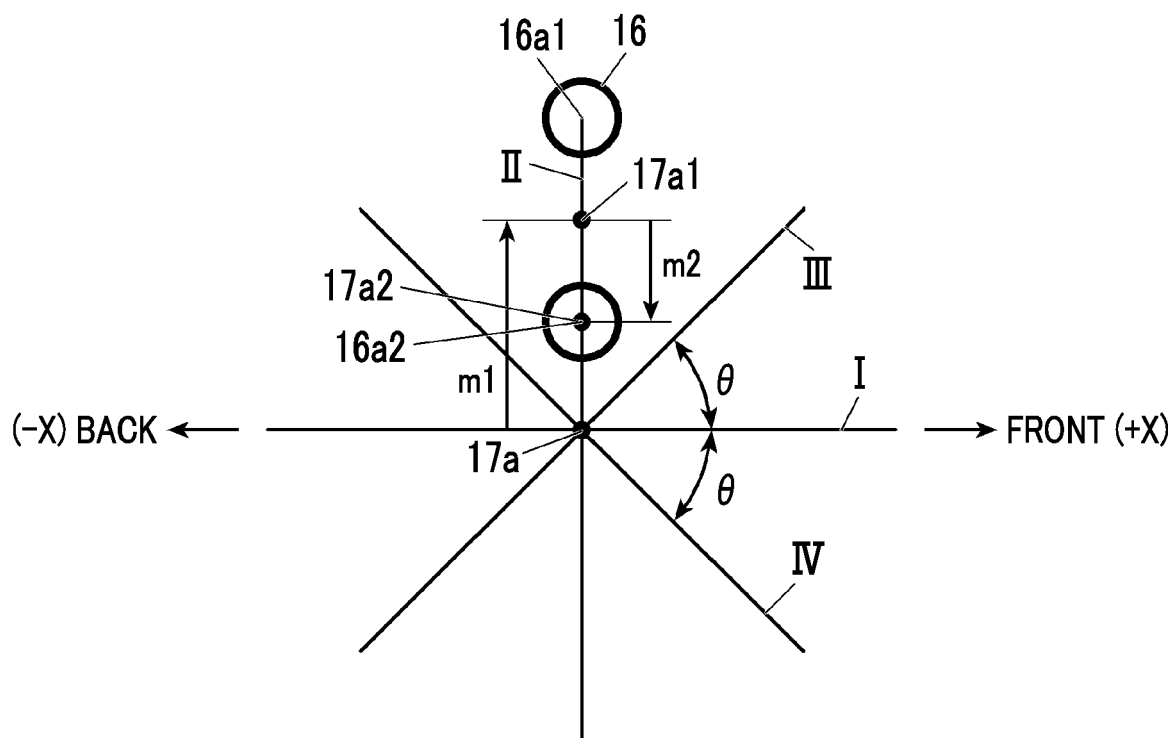


FIG. 7B

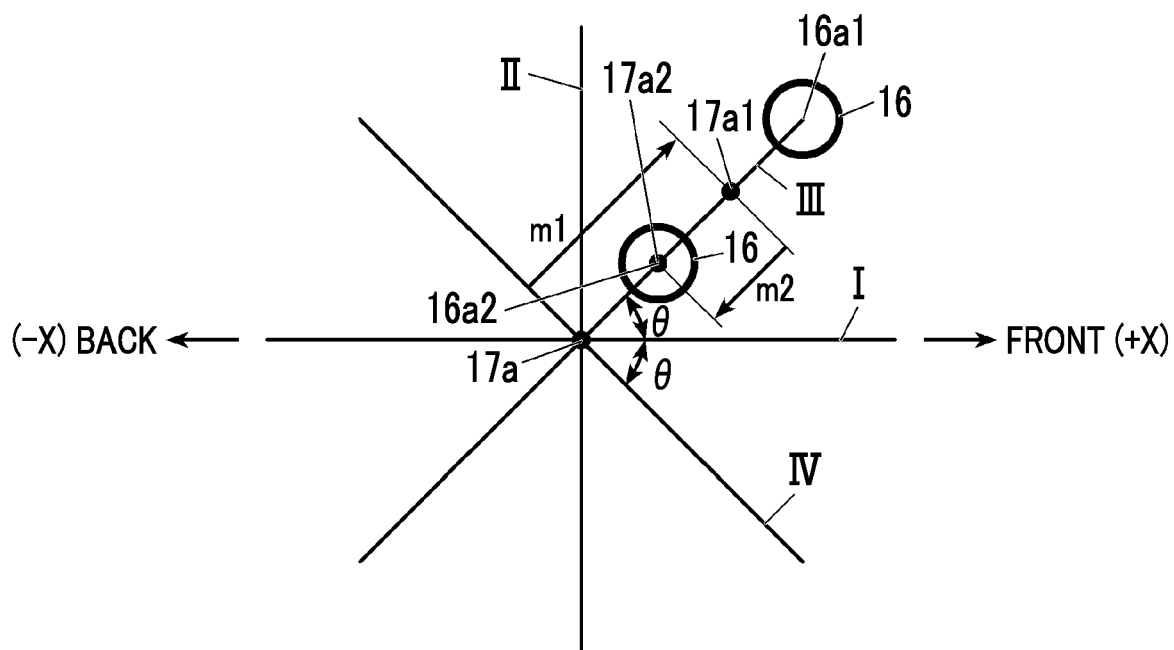
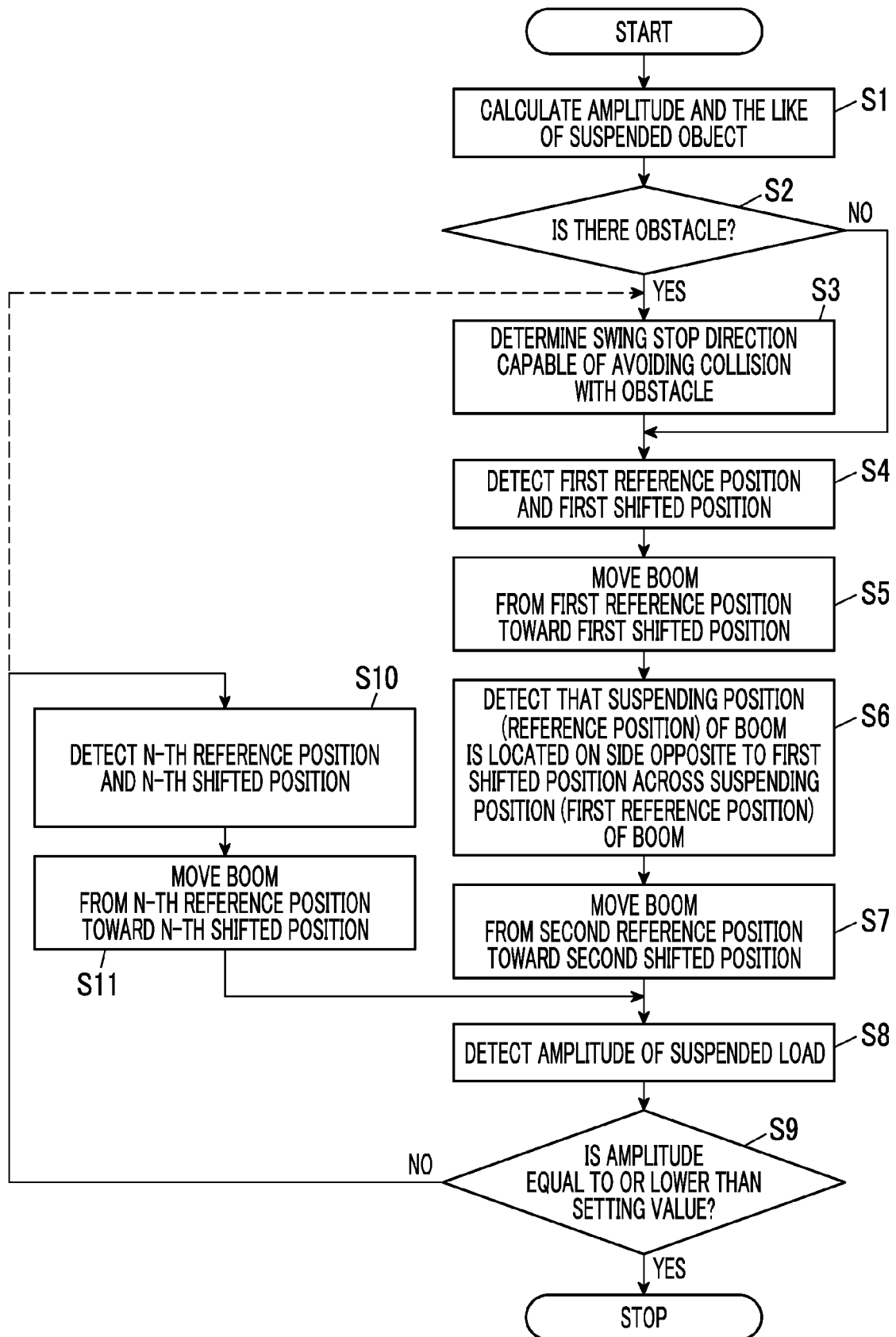


FIG. 8





EUROPEAN SEARCH REPORT

Application Number

EP 23 20 4231

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP 2004 284735 A (ISHIKAWAJIMA TRANSP MACHINERY; ISHIKAWAJIMA HARIMA HEAVY IND) 14 October 2004 (2004-10-14) * BACKGROUND OF THE INVENTION; figures 7, 8 *	1-8	INV. B66C13/22 B66C13/48
A	US 6 308 844 B1 (OKADA HISAKO [JP] ET AL) 30 October 2001 (2001-10-30) * DESCRIPTION OF THE PREFERRED EMBODIMENTS, Fig. 1, Fig. 8 *	1	
A	JP 6 772642 B2 (KOBELCO CONTSTRUCTION MACHINERY LTD) 21 October 2020 (2020-10-21) * paragraph [0066] - paragraph [0069]; figures 1-6 *	1	
A	JP 2010 235249 A (TADANO LTD) 21 October 2010 (2010-10-21) * paragraphs [0002], [0003], [0008] - [0013], [0069] - [0075] *	1	TECHNICAL FIELDS SEARCHED (IPC) B66C
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		11 March 2024	Verheul, Omiros
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11-03-2024

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