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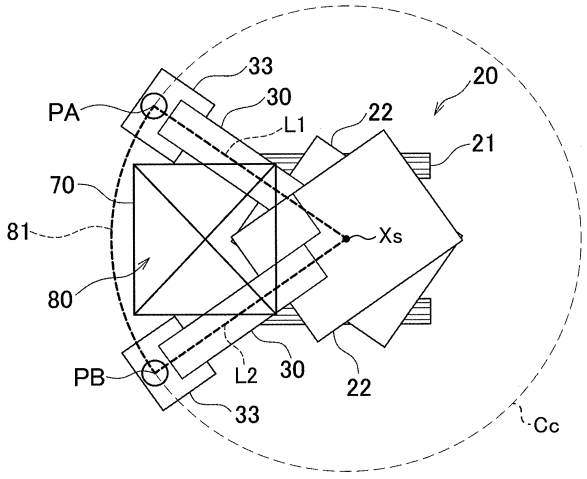
(54) WORK AREA SETTING SYSTEM

(57) Provided is a work area setting system allowing a work area to be easily set, including a first straight line setting part, a second straight line setting part, and an area setting part. The first straight line setting part sets a first straight line (L1) that is parallel to a motion surface of the attachment (30) in a plan view and passes through a first point (PA) at which the tip (33) of an attachment is located with an upper turning body (22) oriented in a first direction. The second straight line setting part sets a second straight line (L2) that is parallel to the motion surface in the plan view and passes through a second point (PB) at which the tip (33) of the attachment is located with the upper turning body (22) oriented in a second direction different from the first direction. The area setting part sets an area between the first straight line (L1) and the second straight line (L2) in the plan view as a work area (80).

FIG.3



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Description

Technical Field

[0001] The present invention relates to a work area setting system for setting a work area of a work machine.

Background Art

[0002] Patent Literature 1 discloses a technique of calculating a distance from a wheel loader to the natural ground as an excavation object or an angle of repose of the natural ground, based on measurement data provided by a three-dimensional measurement device. The literature, however, does not disclose a technique for facilitating control for making a work machine perform automatic operation to perform repeated work.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Publication No. 2019-178599

Summary of Invention

[0004] As to making a work machine perform automatic operation to perform repeated work, dividing the motion of the work machine in the repeated work allows the control of the work machine for the automatic operation to be easy. Specifically, setting a work area around a work object (for example, earth-and-sand pile) facilitates the identification of the work object in the automatic operation control or the like.

[0005] It is an object of the present invention to provide a work area setting system that allows a work area of a work machine to be easily set.

[0006] Provided is a work area setting system for setting a work area in which a work machine makes a work motion. The work machine includes a lower traveling body, an upper turning body mounted on an upper part of the lower traveling body capably of turning around a vertical turning center axis, and an attachment attached to the upper turning body capably of rotational movement in a direction along a motion surface that is a plane extending vertically to make the work motion. The work area setting system includes a first straight line setting part, a second straight line setting part, and an area setting part. The first straight line setting part sets a first straight line, which is a straight line parallel to the motion surface in a plan view in which the work machine is viewed from above and passes through a first point at which a tip of the attachment is located when the upper turning body is oriented in a first direction. The second straight line setting part sets a second straight line, which is a straight line parallel to the motion surface in the plan view in which the work machine is viewed from above and passes through a second point at which the tip of the attachment is located when the upper turning body is oriented in a second direction that is different from the first direction. The area setting part sets an area between the first straight line and the second straight line in the plan view as the work area.

Brief Description of Drawings

[0007]

FIG. 1 is a side view of a work machine according to an embodiment.

FIG. 2 is a circuit diagram showing a plurality of components of a work area setting system according to the embodiment.

FIG. 3 is a plan view of the work machine, showing a work area to be set for the work machine when a first point and a second point are located on the same circle.

FIG. 4 is a plan view of the work machine, showing a first example of a work area to be set when the first point and the second point are not on the same circle.

FIG. 5 is a plan view of the work machine, showing a second example of a work area to be set when the first point and the second point are not on the same circle.

FIG. 6 is a plan view of a work machine according to a comparative example, showing a rectangular work area that is set for the work machine.

Detailed Description

[0008] Below will be described a preferred embodiment of the present invention with reference to the drawings.

[0009] According to the above embodiment, a work area of the work machine 20 shown in FIG. 1 is set by a work area setting system 1 shown in FIG. 2. FIG. 1 is a side view of the work machine 20.

[0010] The work machine 20 according to the embodiment is a hydraulic excavator, including a machine body 25, an attachment 30, and a work driving device 40. The attachment 30 makes a work motion.

[0011] The machine body 25 includes a lower traveling body 21 and an upper turning body 22. The lower traveling body 21 is a part that makes a traveling motion, for example, including a pair of crawlers. The upper turning body 22 is mounted on the lower traveling body 21 capably of turning around a vertical turning center axis through the turning driving device 24. The turning driving device 24 is a device that turns the upper turning body 22 with respect to the lower traveling body 21, for example, including a hydraulic motor. The upper turning body 22 includes a cab (operation room) 23, which is included in the front part of the upper turning body 22.

[0012] The attachment 30 is attached to the upper turning body 22 capably of rotational movement in a direction

along a motion surface that is a vertically extending plane, namely, a vertical surface, the work motion including the rotational movement. The attachment 30 includes a boom 31, an arm 32, and a bucket 33. The boom 31 is attached to the upper turning body 22 capably of vertically rotational movement along the motion surface with respect to the upper turning body 22. The arm 32 is attached to the boom 31 capably of vertically rotational movement along the motion surface with respect to the boom 31. The bucket 33 is attached to the arm 32 capably of rotational movement along the motion surface with respect to the arm 32. The bucket 33 is a tip attachment to form a tip part of the attachment 30, being a part that makes the work motion on earth and sand as a work target. The tip of the bucket 33, thus, corresponds to the tip of the attachment 30. The work motion includes, for example, an excavation motion, a leveling motion, and a scoop motion. The work object is not limited to earth and sand but allowed to be also, for example, a stone or waste (such as industrial waste). The tip attachment is not limited to the bucket 33 but allowed to be, for example, a grapple or a lifting magnet.

[0013] The work driving device 40 hydraulically causes each of the boom 31, the arm 32, and the bucket 33 to make rotational movement. The work driving device 40 includes a plurality of hydraulic cylinders, namely, a boom cylinder 41, an arm cylinder 42, and a bucket cylinder 43, each of which is capable of making expansion and contraction motions.

[0014] The boom cylinder 41 makes the expansion and contraction motions to rotationally move the boom 31 with respect to the upper turning body 22. The boom cylinder 41 has a proximal end and a distal end opposite to the proximal end. The proximal end is rotatably coupled to the upper turning body 22. The distal end is rotatably coupled to the boom 31.

[0015] The arm cylinder 42 makes the expansion and contraction motions to rotationally move the arm 32 with respect to the boom 31. The arm cylinder 42 has a proximal end and a distal end opposite to the proximal end. The proximal end is rotatably coupled to the boom 31. The distal end is rotatably coupled to the arm 32.

[0016] The bucket cylinder 43 makes the expansion and contraction motions to rotationally move the bucket 33 with respect to the arm 32. The bucket cylinder 43 has a proximal end and a distal end opposite to the proximal end. The proximal end is rotatably attached to the arm 32. The distal end is rotatably attached to a link member 34, which is rotatably attached to the bucket 33.

[0017] The work machine 20 further includes a turning angle detector 52 and a posture detector 60.

[0018] The turning angle detector 52 detects the turning angle of the upper turning body 22 with respect to the lower traveling body 21. The turning angle detector 52 is, for example, an encoder, a resolver, or a gyro sensor. In the present embodiment, the turning angle of the upper turning body 22 with the frontward direction of the upper turning body 22 coincident with the frontward direction of the lower traveling body 21 is 0°.

[0019] The posture detector 60 detects the posture of the attachment 30. The posture detector 60 according to the embodiment includes a boom inclination angle sensor 61, an arm inclination angle sensor 62, and a bucket inclination angle sensor 63.

[0020] The boom inclination angle sensor 61 is attached to the boom 31 to detect the posture of the boom 31. The boom inclination angle sensor 61 is a sensor that acquires an inclination angle of the boom 31 with respect to a horizontal line, for example, being an inclination sensor, an acceleration sensor, a rotation angle sensor that detects a rotation angle of a boom foot pin in a proximal end of the boom 31, or a stroke sensor that detects a stroke of the boom cylinder 41.

[0021] The arm inclination angle sensor 62 is attached to the arm 32 to detect the posture of the arm 32. The arm inclination angle sensor 62 is a sensor that acquires an inclination angle of the arm 32 with respect to a horizontal line, for example, being an inclination sensor, an acceleration sensor, a rotation angle sensor that detects a rotation angle of an arm connection pin at a proximal end of the arm 32, or a stroke sensor that detects a stroke of the arm cylinder 42.

[0022] The bucket inclination angle sensor 63 is attached to the link member 34 to detect the posture of the bucket 33. The bucket inclination angle sensor 63 is a sensor that acquires an inclination angle of the bucket 33 with respect to a horizontal line, for example, being an inclination sensor, an acceleration sensor, a rotation angle sensor that detects a rotation angle of a bucket connection pin in a proximal end of the bucket 33, or a stroke sensor that detects a stroke of the bucket cylinder 43.

[0023] FIG. 2 is a circuit diagram showing a plurality of components of the work area setting system 1. The plurality of components include a controller 11 and a storage device 13.

[0024] To the controller 11 is input turning angle information, which is information on the turning angle (posture) of the upper turning body 22 with respect to the lower traveling body 21 and is acquired by the turning angle detector 52. To the controller 11 is input boom posture information, which is information on the posture of the boom 31 and is acquired by the boom inclination angle sensor 61. To the controller 11 is input arm posture information, which is information on the posture of the arm 32 and is acquired by the arm inclination angle sensor 62. To the controller 11 is input bucket posture information, which is information on the posture of the bucket 33 and is acquired by the bucket inclination angle sensor 63.

[0025] For the automatic operation of the work machine 20, the controller 11 automatically controls the motions of the work machine 20. Specifically, the controller 11 controls the motions of the upper turning body 22 and the attachment 30 so as to make the upper turning body 22 and the attachment 30 perform repeated work. More

specifically, the controller 11 automatically controls the turning drive of the upper turning body 22 by the turning driving device 24 and the drive of the attachment 30 by the work driving device 40 based on the information acquired by the turning angle detector 52 and the posture detector 60. In the present embodiment, the repeated work is work of excavating earth and sand and discharging it.

[0026] The storage device 13 stores information necessary for the automatic control. The information includes respective coordinates of the first point PA and the second point PB which are described later.

[0027] The controller 11 can serve as a first straight line setting part, which sets a first straight line L1 shown in FIG. 3. FIG. 3 is a plan view of the work machine 20. In a plan view in which the work machine 20 is viewed from above, the first straight line L1 is a straight line parallel to the motion surface, that is, a straight line parallel to the longitudinal direction of the attachment 30, passing through a first point PA at which the tip of the bucket 33 is located, when the upper turning body 22 is oriented in a first direction, which is a right oblique direction in the example shown in FIG. 3.

[0028] The controller 11 can also serve as a second straight line setting part, which sets a second straight line L2 shown in FIG. 3. In the plan view, the second straight line L2 is a straight line parallel to the motion surface, that is, a straight line parallel to the longitudinal direction of the attachment 30, passing through a second point PB at which the tip of the bucket 33 is located, when the upper turning body 22 is oriented in a second direction different from the first direction, the second direction being a left oblique direction in the example shown in FIG. 3.

[0029] Respective positions of the first and second straight lines L1 and L2, each of which is a straight line parallel to the motion surface, with respect to the width direction of the attachment 30 is not particularly limited. The width direction of the attachment 30 is a direction orthogonal to the motion surface, that is, a direction orthogonal to each of the longitudinal direction and the vertical direction of the attachment 30. Specifically, as to the width direction, each of the first and second straight lines L1 and L2 may be either a straight line passing through the widthwise center of the attachment 30, or a straight line passing through the end in the width direction, that is, a straight line along the side surface of the attachment 30.

[0030] The controller 11 can also serve as a coordinate calculation part. Specifically, the controller 11 calculates a plurality of coordinates of the first point PA for setting the first straight line L1 and calculates a plurality of coordinates of the second point PB for setting the second straight line L2. In detail, the controller 11 obtains respective R-coordinates, Z-coordinates and θ-coordinates of the first point PA and the second point PB. The R-coordinate is the coordinate in the front-rear direction of the upper turning body 22, that is, the coordinate in the turning radial direction of the upper turning body 22, and the Z-coordinate is the coordinate in the vertical direction of the lower traveling body 21, and the θ-coordinate is the coordinate in the turning direction of the upper turning body 22.

[0031] Respective coordinates in the front-rear direction of the first point PA and the second point PB, namely, the R-coordinates, and respective coordinates in the vertical direction, namely, the Z-coordinates, can be calculated, for example, from the posture of the attachment 30. The posture of the attachment 30 can be obtained from the information acquired by each of the boom inclination angle sensor 61, the arm inclination angle sensor 62, and the bucket inclination angle sensor 63. The coordinates of the first point PA and the second point PB in the turning direction, namely, the θ-coordinate, can be calculated, for example, from a turning posture that is the posture of the upper turning body 22 with respect to the lower traveling body 21. The turning posture can be obtained from the information acquired by the turning angle detector 52.

[0032] The coordinates of the first point PA and the coordinates of the second point PB using the upper turning body 22 as a reference can be calculated by a simple calculation, for example, compared with the calculation of the position information by use of coordinates based on a work site.

[0033] In the work site illustrated in FIG. 3, there is an earth-and-sand pile 70. The earth-and-sand pile 70 is laid between the first point PA and the second point PB and frontward of the upper turning body 22. In other words, the first point PA and the second point PB are set so as to locate the earth-and-sand pile 70 therebetween.

[0034] In the present embodiment, the earth and sand of the earth-and-sand pile 70 can be excavated by moving the attachment 30 along the motion surface at the turning angle at which the tip of the bucket 33 is located at the first point PA. Similarly, the earth and sand of the earth-and-sand pile 70 can be excavated by moving the attachment 30 along the motion surface at the turning angle at which the tip of the bucket 33 is located at the second point PB.

[0035] Each of the first point PA and the second point PB, alternatively, may be a position greatly deviated from the earth-and-sand pile 70. The first and second points PA and PB, thus, are not limited to excavation allowing positions, which are respective positions at which the earth and sand of the earth-and-sand pile 70 can be excavated by moving the attachment 30 at respective turning angles at which the tip of the bucket 33 is located at the first and second points PA and PB.

[0036] The controller 11 can also serve as an area setting part that sets a work area 80 for the work machine 20. Specifically, the controller 11 sets an area between the first straight line L1 and the second straight line L2 in the plan view as the work area 80.

[0037] In the present embodiment, upon the setting of the first straight line L1 and the second straight line L2, an excavation motion is actually made. The excavation

motion is not a special motion only for purpose of setting the work area 80 but serves also as a motion for excavation work. This eliminates the necessity for making the work machine 20 perform a special motion for setting the work area 80. Besides, special calculation is not required for determining a specific graphic, for example, a rectangle, in order to set the work area 80. This allows the work area 80 to be easily set.

[0038] The setting of the first and second points PA and PB for determining the first and second straight lines L1 and L2 is not limited to one performed by an actual excavation motion. For example, the first point PA and the second point PB may be taught by teaching or the like. Alternatively, the first point PA and the second point PB may be set either based on an image captured by a camera installed on or around the work machine 20 or by the input of a numerical value by an operator or the like.

[0039] Respective parallels of the first straight line L1 and the second straight line L2, each of which is the boundary of the work area 80, to the motion surface of the attachment 30 allow the tip of the bucket 33 to be moved along the boundary of the work area 80 without the turn of the upper turning body 22. This reduces the necessity of making the work machine 20 perform a complicated motion such as a motion of excavation or earth removal with turning the upper turning body 22 in order to prevent the tip of the bucket 33 from protruding beyond the work area 80. Besides, the allowability of moving the tip of the bucket 33 along the boundary of the work area 80 with no requirement for the turn of the upper turning body 22 reduces work left undone (e.g., earth left unexcavated) in the work area 80.

[0040] In the example shown in FIG. 3, the first point PA and the second point PB are located on the same circle Cc centered on a turning center axis Xs, which is the turning axis of the upper turning body 22 with respect to the lower traveling body 21. In this case, the controller 11 as the area setting part sets, in the plan view, an arc 81 interconnecting the first point PA and the second point PB along the same circle Cc as an outer boundary of the work area 80 with respect to the turning radius direction of the upper turning body 22.

[0041] The height of the first point PA and the height of the second point PB do not have to be coincident with each other. The arc 81 interconnects the first point PA and the second point PB smoothly in a side view in which the work machine 20 is viewed from the side.

[0042] Setting the arc 81 as the boundary of the work area 80 provides the following effects. In the case of performing repeated work with the turn of the upper turning body 22 while keeping the tip of the bucket 33 located most frontward with respect to the front-rear direction, i.e., most outward with respect to the turning radial direction, the work can be performed along the outer boundary of the work area 80. This eliminates the need for a complicated calculation for revising the position of the tip of the bucket 33 with the progress of the repeated work. Besides, the work can be restrained from being left undone, for example, soil can be restrained from being left unexcavated, in an outer section of the work area 80.

[0043] On the other hand, in the case where the first point PA and the second point PB are not located on the same circle centered on the turning center axis, specifically, as illustrated in FIG. 4, in the case where the first point PA is located on a first circle Ca centered on the turning center axis whereas the second point PB is located on a second circle Cb centered on the turning center axis, the first circle Ca and the second circle Cb having different radii, the controller 11 as the area setting part sets an arc-shaped curve 82 that smoothly interconnects the first point PA and the second point PB in the plan view in which the work machine 20 is viewed from above as the outer boundary of the work area 80 with respect to the turning radial direction. In FIG. 4, the radius Ra of the circle passing through the first point PA is larger than the radius Rb of the circle passing through the second point PB.

[0044] Also in the example shown in FIG. 4, the height of the first point PA and the height of the second point PB do not have to be coincident with each other. The arc-shaped curve 82 interconnects the first point PA and the second point PB smoothly in the side view in which the work machine 20 is viewed from the side.

[0045] The arc-shaped curve 82 is set, for example, as follows. As shown in FIG. 4, in the case where the length of the attachment 30 with the tip of the bucket 33 located at the second point PB, namely, the radius (turning radius) Rb of the second circle Cb, is smaller by ΔR than the length of the attachment 30 with the tip of the bucket 33 located at the first point PA, namely, the radius (turning radius) Ra of the first circle Ca, in summary, in the case where $Rb = Ra - \Delta R$, and where the turning angle of the upper turning body 22 from the first point PA to the second point PB is an angle θmax, the position R of the tip of the bucket 33 with respect to the front-rear direction when the upper turning body 22 has been turned from the first point PA by an angle θ is set so that $R = R + \theta/\theta max \times (-\Delta R)$. The curve 82 that smoothly interconnects the first point PA and the second point PB is thereby set.

[0046] Setting the curve 82 as the outer boundary of the work area 80 with respect to the turning radial direction can smooth the movement of the tip of the bucket 33 in the front-rear direction accompanying the turn of the upper turning body 22 in the repeated work that is performed while changing the position of the tip of the bucket 33 in the turning direction by the turn of the upper turning body 22, thereby reducing the sense of incongruity to be imparted to a worker.

[0047] In the case where the first point PA and the second point PB are not on the same circumference with the turning center axis as the center as described above, that is, the case where the radius Ra of the first circle Ca on which the first point PA is located is different from the radius Rb of the second circle Cb on which the second point PB is located, the controller 11 may set the outer

boundary of the work area 80 as shown in FIG. 5.

[0048] In FIG. 5, the controller 11 initially sets a third point PC located between the first point PA and the second point PB. The third point PC may be set either by actual performance of the motion of the attachment 30 corresponding to excavation work or by teaching or the like. The third point PC may be located at either a just intermediate position between the first point PA and the second point PB in the turning direction of the upper turning body 22 or a position closer to the first point PA or the second point PB than the just intermediate position.

[0049] Next, based on the position of the first point PA, the controller 11 sets a first-point-side portion of the boundary of the work area 80, which is a portion closer to the first point PA than the third point PC, in the plan view. Specifically, the controller 11 sets the first-point-side portion to the arc that passes through the first point PA and has a radius equal to the radius Ra of the first circle Ca passing through the first point PA, that is, the turning radius corresponding to the first point PA.

[0050] On the other hand, in the plan view, the controller 11 sets a second-point-side portion of the boundary of the work area 80, which is a portion closer to the second point PB than the third point PC, based on the position of the second point PB. Specifically, the controller 11 sets the second-point-side portion to the arc that passes through the second point PB and has a radius equal to the radius Rb of the second circle Cb passing through the second point PB, that is, the turning radius corresponding to the second point PB.

[0051] Also in this example, the height of the first point PA and the height of the second point PB do not have to be coincident with each other. Out of the boundary of the work area 80, the controller 11 may set the height of the first-point-side portion based on the height of the first point PA while sets the height of the second-point-side portion based on the height of the second point PB.

[0052] Such setting of the boundary of the work area 80 allows an appropriate work area 80 to be set in accordance with respective situations around the work machine 20 corresponding to the first-point-side portion and the second-point-side portion, even if the situations are different from each other.

[0053] For example, in the case of presence of an obstacle 90 such as a column near the second straight line L2 passing through the second point PB as shown in FIG. 5, setting the second point PB so as to avoid the obstacle 90 involves a difference between the radius Ra of the first circle Ca passing through the first point PA and the radius Rb of the second circle Cb passing through the second point PB. In such a case, setting the outer boundary of the work area 80 based on the position of the second point PB makes it possible to make the work machine 20 perform repeated work with avoidance of the obstacle 90.

[0054] FIG. 6 shows a comparative example for explaining the advantage of the work area 80 shown in FIGS. 3 to 5, in which example a rectangular work area 85 is set around the earth-and-sand pile 75. Among four vertices Pa, Pb, Pc, and Pd that define the work area 85, respective positions of the pair of vertices Pa and Pc that are diagonal to each other are taught to the controller by actually positioning the tip of the bucket 33 in each of the vertices Pa, Pc. The controller determines the remaining two vertices Pb, Pd by calculation based on the pair of vertices Pa, Pc. The work area 85 is thus determined.

[0055] Such setting requires making the work machine perform a special motion that is quite different from normal excavation motion or loading motion, being complicated. The calculation for determining the rectangular work area 85 based on the pair of vertices Pa and Pc is also complicated.

[0056] In contrast, the work area setting system 1 according to the embodiment can set the work area 80 during the flow of the repeated work by use of the first straight line L1 that is set when the upper turning body 22 is oriented in the first direction and the second straight line L2 that is set when the upper turning body 22 is oriented in the second direction. This eliminates the necessity for making the work machine 20 perform a special motion for only the purpose of setting the work area 80 and the necessity for performing a complicated calculation for setting the work area 80. These allow the work area 80 to be easily set.

[0057] The parallel of each of the first straight line L1 and the second straight line L2, which are boundaries of the work area 80, to the motion surface of the attachment 30 enables the tip of the bucket 33 to be moved along the boundary of the work area 80 even without the turn of the upper turning body 22. This can reduce the necessity for making the work machine 20 perform complicated motions such as excavation and earth removal while turning the upper turning body 22 in order to prevent the tip of the bucket 33 from protruding beyond the work area 80. Besides, the tip of the bucket 33 can be moved along the boundary of the work area 80 without the turn of the upper turning body 22, which reduces the work left undone in the work area 80, for example, reduces the soil left unexcavated.

[0058] The embodiment of the present invention having been described above is merely an illustrated example, not intended to limit the present invention thereto, allowing a specific configuration or the like to be modified as appropriate. The actions and effects described about the embodiments of the invention are merely listing most suitable actions and effects provided by the present invention, and the actions and effects of the invention are not limited to those described in the embodiments of the present invention.

[0059] As has been described, there is provided a work area setting system that allows a work area of a work machine to be easily set.

[0060] Provided is a work area setting system for setting a work area in which a work machine makes a work motion. The work machine includes a lower traveling body, an upper turning body mounted on an upper part

of the lower traveling body capably of turning around a vertical turning center axis, and an attachment attached to the upper turning body capably of rotational movement in a direction along a motion surface that is a plane extending vertically to make the work motion. The work area setting system includes a first straight line setting part, a second straight line setting part, and an area setting part. The first straight line setting part sets a first straight line, which is a straight line parallel to the motion surface in a plan view in which the work machine is viewed from above and passes through a first point at which a tip of the attachment is located when the upper turning body is oriented in a first direction. The second straight line setting part sets a second straight line, which is a straight line parallel to the motion surface in the plan view and passes through a second point at which a tip of the attachment is located when the upper turning body is oriented in a second direction that is different from the first direction. The area setting part sets an area between the first straight line and the second straight line in the plan view as the work area.

[0061] The area setting system allows the work area to be easily set by use of the first straight line that is set when the upper turning body is oriented in the first direction and the second straight line that is set when the upper turning body is oriented in the second direction, during the flow of the repeated work. Specifically, the setting of the work area eliminates the necessity for making the work machine perform a special motion for only the purpose of setting the work area and the need for a special calculation.

[0062] The parallel of each of the first straight line and the second straight line, each of which is the boundary of the work area, to the motion surface of the attachment enables the tip of the attachment to be moved along the boundary of the work area while not requiring any turn of the upper turning body. This can reduce the necessity for making the work machine perform a complicated motion such as a motion of performing excavation or earth removal while turning the upper turning body so as to prevent the tip of the attachment from protruding beyond the work area. Besides, the ability to move the tip of the attachment along the first and second straight lines, each of which is the boundary of the work area, without the turn of the upper turning body can reduce work left undone in the work area, for example, the soil left unexcavated.

[0063] Specifically, for the case where both the first point and the second point are located on the same circle centered on the turning center axis in the plan view, the area setting part is preferably configured to set an arc that interconnects the first point and the second point along the same circle as an outer boundary of the work area with respect to the turning radial direction of the upper turning body. This allows the work involving movement of the tip of the attachment along the outer boundary of the work area to be easily performed by a simple motion of only turning the upper turning body without changing the position of the tip of the attachment in the turning radial direction, that is, the front-rear direction of the attachment. Specifically, eliminated is the need for a complicated calculation for revising the position of the tip of the attachment in the front-rear direction (turning radial direction) with the progress of the repeated work. Besides, can be reduced work left undone in the work area, for example, the soil left unexcavated, near an outer section of the work area.

[0064] In the case where the first point and the second point are not in the same circle centered on the turning center axis in the plan view, specifically, the case where the first point is located on a first circle centered on the turning center axis whereas the second point is located on a second circle centered on the turning center axis, the first circle having a radius different from a radius of the second circle, the area setting part may set an arc-shaped curve that interconnects the first point and the second point as an outer boundary of the work area with respect to the turning radius direction. This can smooth the variation in the position of the tip of the attachment with respect to the turning radial direction in association with the turn of the upper turning body to thereby reduce the sense of incongruity to be imparted to a worker.

[0065] In the above case, the area setting part may be configured to set a third point between the first point and the second point and configured to set a first-point-side portion, which is a portion closer to the first point than the third point out of the outer boundary of the work area, based on the position of the first point and set a second-point-side portion, which is a portion closer to the second point than the third point out of the outer boundary of the work area, based on the position of the second point. This enables different outer boundaries to be set on both sides of the third point, respectively, allowing an appropriate work area to be set in accordance with respective situations around the work machine corresponding to the first-point-side portion and the second-point-side portion, even if the situations are different from each other.

[0066] Preferably, the work area setting system further includes a coordinate calculation part that calculates a plurality of coordinates for each of the first point and the second point, the plurality of coordinates including coordinates in a front-rear direction of the upper turning body, coordinates in a vertical direction of the lower traveling body, and coordinates in a turning direction of the upper turning body. The coordinates in the front-rear direction of the upper turning body 22 and the coordinates in the vertical direction of the lower traveling body can be calculated, for example, from the posture of the attachment, and the coordinates in the turning direction of the upper turning body can be calculated, for example, from the posture of the upper turning body 22 with respect to the lower traveling body 21. Hence, the plurality of coordinates of the first point and the second point can be calculated by a simpler calculation than, for example, the calculation of position information using the coordinates based on the work site.

Claims

1. A work area setting system for setting a work area in which a work machine makes a work motion, the work machine including a lower traveling body, an upper turning body mounted on an upper part of the lower traveling body capably of turning around a vertical turning center axis, and an attachment attached to the upper turning body capably of rotational movement in a direction along a motion surface that is a plane extending vertically to make the work motion, the work area setting system comprising:

   a first straight line setting part that sets a first straight line, which is a straight line parallel to the motion surface in a plan view in which the work machine is viewed from above and passes through a first point at which a tip of the attachment is located when the upper turning body is oriented in a first direction;
   a second straight line setting part that sets a second straight line, which is a straight line parallel to the motion surface in the plan view and passes through a second point at which the tip of the attachment is located when the upper turning body is oriented in a second direction that is different from the first direction; and
   an area setting part that sets an area between the first straight line and the second straight line in the plan view as the work area.

2. The work area setting system according to claim 1, wherein the area setting part is configured to set, in a case where both the first point and the second point are located on the same circle centered on the turning center axis in the plan view, an arc that interconnects the first point and the second point along the same circle in the plan view as an outer boundary of the work area with respect to a turning radial direction of the upper turning body.

3. The work area setting system according to claim 1 or 2, wherein the area setting part is configured to set an arc-shaped curve, in a case where the first point is located on a first circle centered on the turning center axis whereas the second point is located on a second circle centered on the turning center axis and having a radius different from a radius of the first circle in the plan view, the arc-shaped curve interconnecting the first point and the second point in the plan view as an outer boundary of the work area with respect to a turning radial direction of the upper turning body.

4. The work area setting system according to claim 1 or 2, wherein the area setting part is configured to set a third point between the first point and the second point in the plan view and configured to set a first-point-side portion, which is a portion closer to the first point than the third point out of the outer boundary of the work area, based on the position of the first point and set a second-point-side portion, which is a portion closer to the second point than the third point out of the outer boundary of the work area, based on the position of the second point, in a case where the first point is located on a first circle centered on the turning center axis whereas the second point is located on a second circle centered on the turning center axis and having a radius different from a radius of the first circle in the plan view in the plan view.

5. The work area setting system according to any one of claims 1 to 4, further comprising a coordinate calculation part that calculates a plurality of coordinates for each of the first point and the second point, the plurality of coordinates including coordinates in a front-rear direction of the upper turning body, coordinates in a vertical direction of the lower traveling body, and coordinates in a turning direction of the upper turning body.

FIG.1

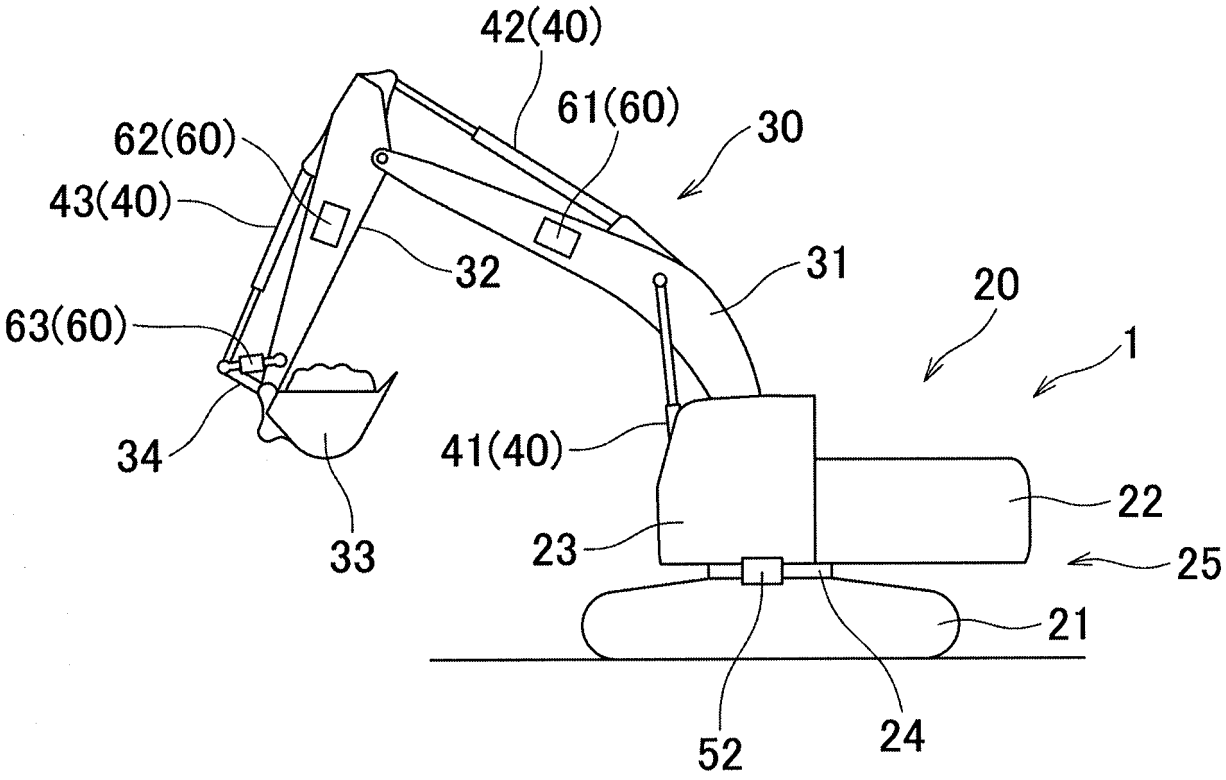


FIG.2

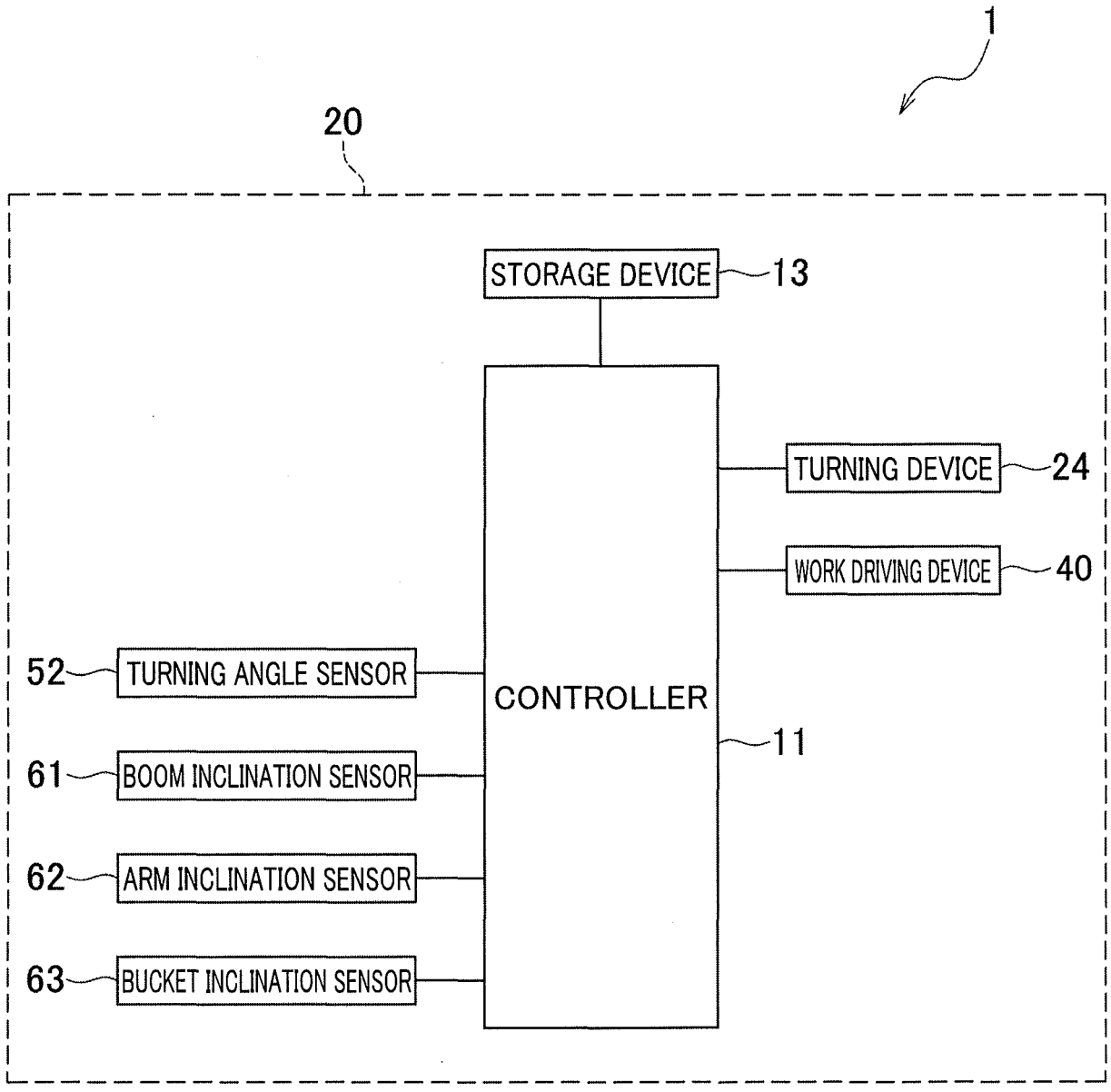

1
20
STORAGE DEVICE
13
TURNING DEVICE
24
WORK DRIVING DEVICE
40
52
TURNING ANGLE SENSOR
CONTROLLER
11
61
BOOM INCLINATION SENSOR
62
ARM INCLINATION SENSOR
63
BUCKET INCLINATION SENSOR

FIG.3

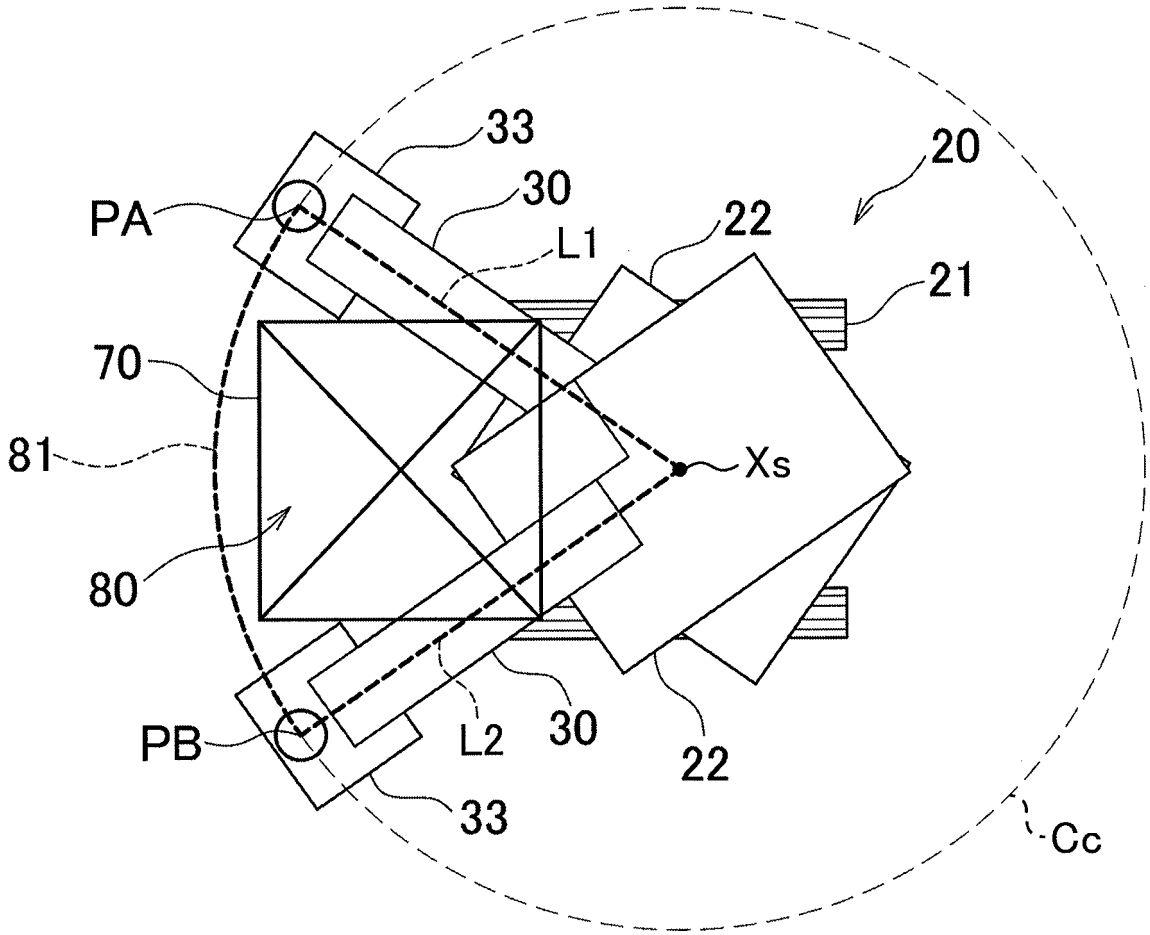


FIG.4

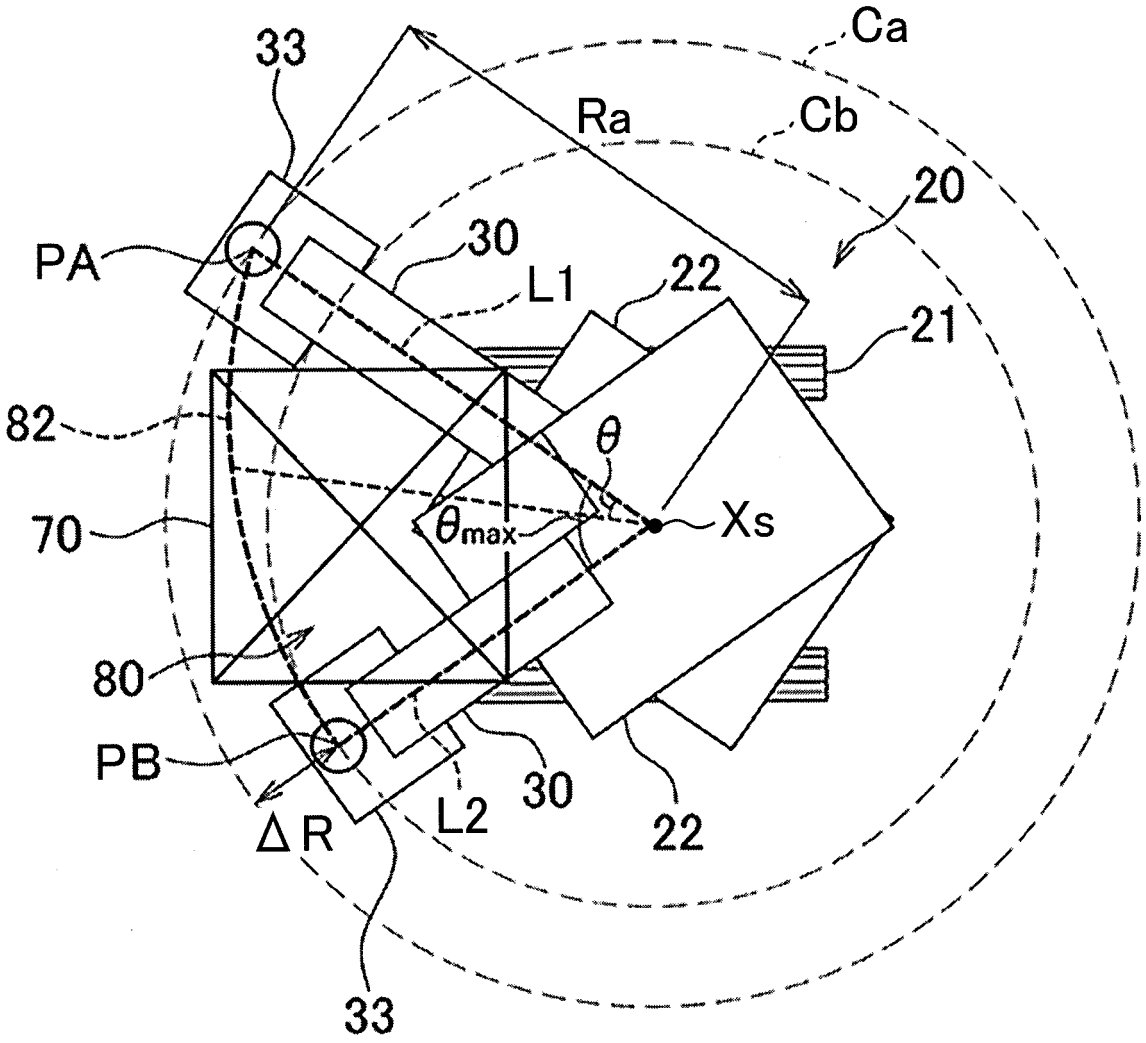


FIG.5

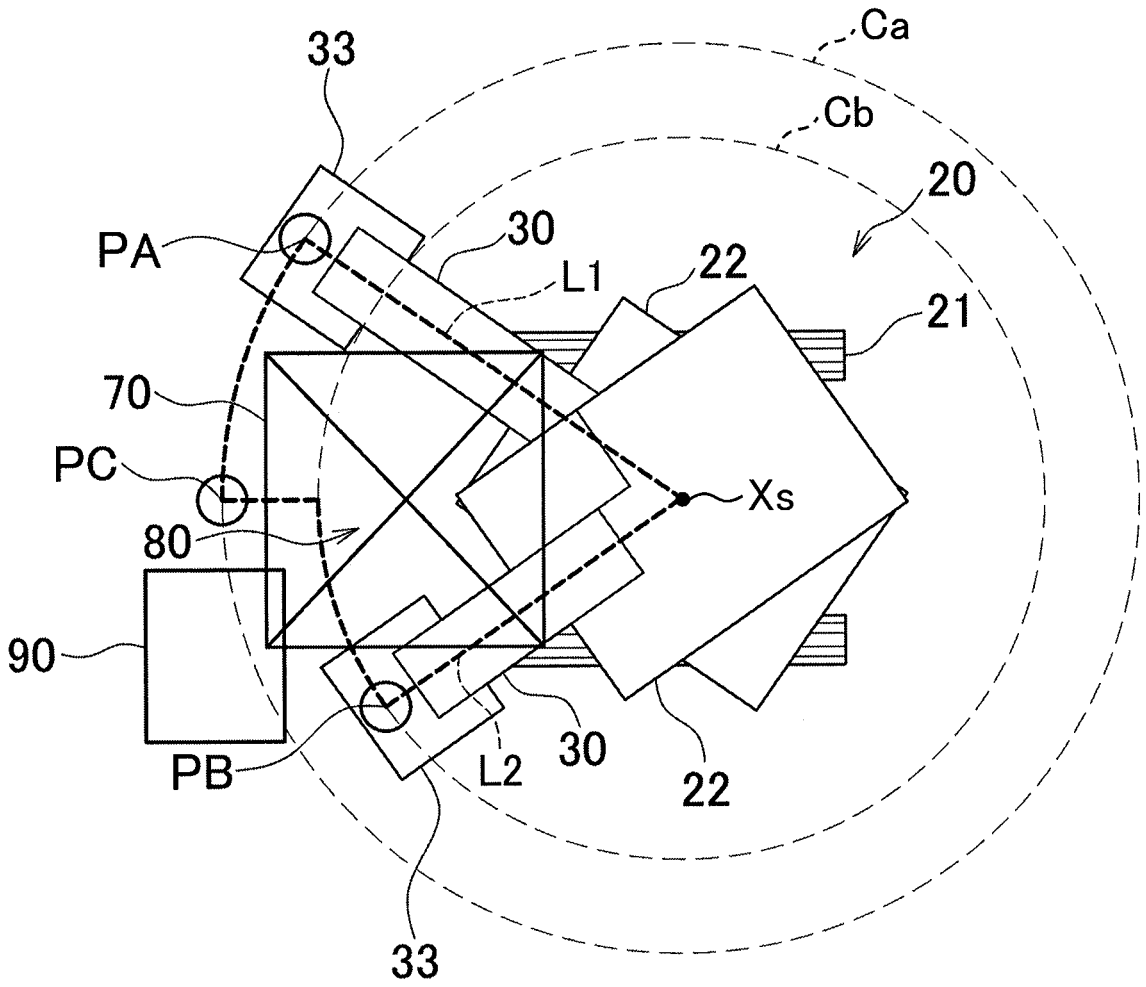
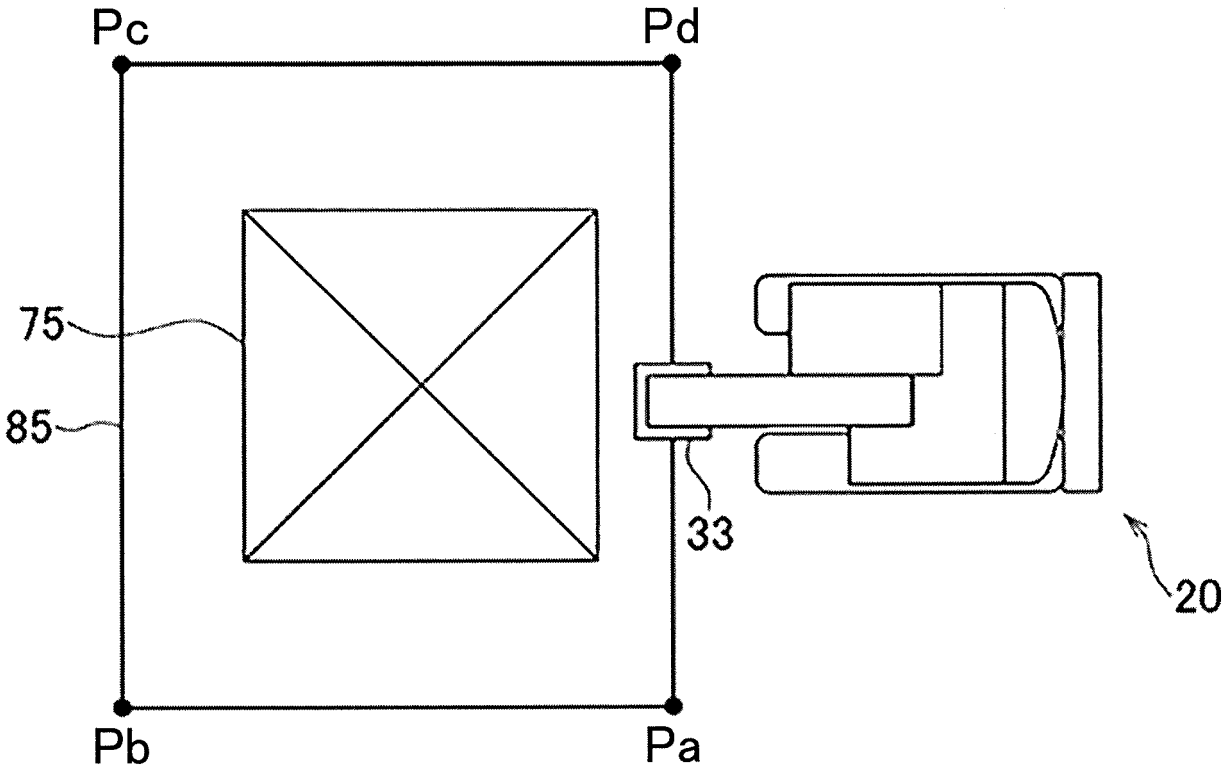


FIG.6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/002152

A. CLASSIFICATION OF SUBJECT MATTER

E02F 3/43(2006.01)i; ***E02F 9/20***(2006.01)i
FI: E02F3/43 Z; E02F9/20 C

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)

E02F3/43; E02F9/20

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2021-028444 A (KOMATSU LTD.) 25 February 2021 (2021-02-25)	1-5
A	JP 2019-039206 A (HITACHI CONSTR. MACH. CO., LTD.) 14 March 2019 (2019-03-14)	1-5
A	JP 2019-108722 A (SUMITOMO HEAVY IND., LTD.) 04 July 2019 (2019-07-04)	1-5
A	JP 4-34137 A (FUJITA CORP.) 05 February 1992 (1992-02-05)	1-5

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 February 2023	**14 March 2023**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/002152

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2021-028444 A	25 February 2021	US 2022/0243427 A1 WO 2021/029253 A1 KR 10-2022-0008339 A CN 114008272 A	
JP 2019-039206 A	14 March 2019	US 2020/0048871 A1 WO 2019/039593 A1 EP 3604688 A1 CN 110462139 A KR 10-2019-0117626 A	
JP 2019-108722 A	04 July 2019	(Family: none)	
JP 4-34137 A	05 February 1992	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2019178599 A **[0003]**