(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 626 673 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
25.03.2020 Bulletin 2020/13

(21) Application number: **18802064.8**

(22) Date of filing: **19.01.2018**

(51) Int Cl.:
B66C 13/22 (2006.01) ***B66C 13/46*** (2006.01)

(86) International application number:
PCT/JP2018/001547

(87) International publication number:
WO 2018/211739 (22.11.2018 Gazette 2018/47)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD TN

(30) Priority: **15.05.2017 JP 2017096259**

(71) Applicant: **Hitachi Industrial Equipment Systems Co., Ltd.**
Tokyo 101-0022 (JP)

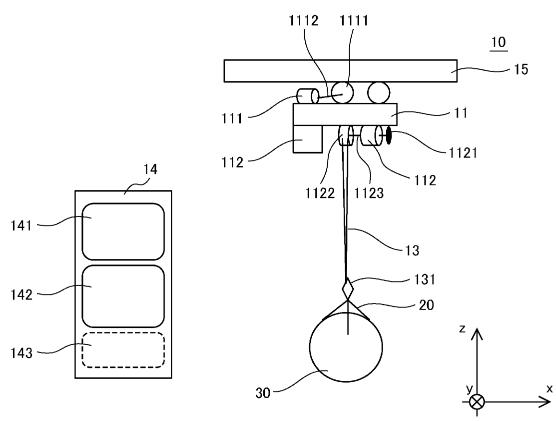
(72) Inventors:
- **ODAI Masaki**
  Tokyo 100-8280 (JP)
- **IESHIGE Koji**
  Tokyo 101-0022 (JP)
- **OIKAWA Yugo**
  Tokyo 101-0022 (JP)
- **INOUE Tomohiro**
  Tokyo 100-8280 (JP)
- **TAKAHASHI Hiroki**
  Tokyo 100-8280 (JP)

(74) Representative: **MERH-IP Matias Erny Reichl Hoffmann**
Patentanwälte PartG mbB
Paul-Heyse-Strasse 29
80336 München (DE)

(54) HOISTING MACHINE

(57) A hoisting machine includes: a trolley that is transported by self-propulsion means; a hoisting motor mounted on the trolley; a hoisting drum attached to the hoisting motor; a rope attached to the hoisting drum; a hook attached to the rope; and a controller that identifies a transport speed of the trolley. The controller identifies the transport speed of the trolley based on a center-of-gravity distance between a predetermined position and a center-of-gravity position of a suspended load suspended from the hook.

FIG. 1



EP 3 626 673 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a hoisting machine.

BACKGROUND ART

[0002] There is a demand for a reduction in load swing during transport in a hoisting machine, in order to perform safe and efficient suspended-load transport. As a technology for reducing the load swing, a load-swing inhibition control technology is known, in which a suspended load suspended by a rope is deemed as a pendulum, and a transport speed is controlled based on a model of swing of the pendulum, that is, the load swing.

[0003] The load-swing inhibition control is largely divided into feedforward control and feedback control. The feedforward control is a method in which a transport speed command is determined based on the model of the load swing, and thereby the load swing is inhibited.

[0004] The feedback control is a method in which the load swing is detected or estimated in real time and feedback is performed such that the transport speed command is determined, and thereby the load swing is inhibited. In addition, in two-degree-of-freedom load-swing inhibition control, both the feedforward control and the feedback control are performed.

[0005] In general, in the feedback control, it is possible to handle an error in a load-swing model; however, a response is slower than that in the feedforward control. In general, in the feedforward control, a response is faster than that in the feedback control; however, it is not possible to handle the error in the load-swing model. That is, if it is possible to obtain a highly accurate load-swing model, it is possible to obtain a fast response and inhibit the load swing with high accuracy. Hence, an effect of inhibiting the load swing also improves in the two-degree-of-freedom control.

[0006] Here, in the load-swing model, in order to estimate a swing cycle of the pendulum, it is necessary to obtain a pendulum length that is a length from a supporting point of swing to a center of gravity of the pendulum. In general, a rope length from a hoisting drum to a hook is used as the pendulum length. However, since a suspended load is suspended under the hook, the pendulum length is different from the rope length. There are Patent Document 1 and Patent Document 2 as a technology for obtaining a pendulum length with high accuracy.

[0007] Patent Document 1 describes a technology in which a load sensor disposed on a floor, on which a suspended load is placed, detects separation of the suspended load from the floor, and a distance from a bottom of a hook to a lower end of the suspended load is obtained from a height of a floor surface of a trolley and a rope length at the time of separation from the floor.

[0008] Patent Document 2 describes a technology in which a pendulum length is used as a rope length when there is no suspended load, and a pendulum length is obtained from the rope length and a correction value obtained in advance when there is a suspended load.

CITATION LIST

PATENT DOCUMENT

[0009]

Patent Document 1: JP 11-209067 A
Patent Document 2: JP 2000-177985 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0010] According to the technology described in Patent Document 1, it is possible to define a distance from a hoisting drum to the lower end of the suspended load as the pendulum length. Consequently, compared with a case where the rope length is used as the pendulum length, it is possible to inhibit the load swing with higher accuracy. However, the center of gravity of the suspended load is different from a position of the lower end of the suspended load, and thus there is a possibility that the load-swing model has an error and the load swing remains.

[0011] According to the technology described in Patent Document 2, the pendulum length is corrected by using a preobtained center-of-gravity position of the suspended load. Consequently, compared with a case where the rope length is used as the pendulum length, it is possible to inhibit the load swing with higher accuracy. However, the correction value changes due to only presence or absence of the suspended load, and thus it is not possible to apply the technology to a hoisting machine for various suspended loads.

[0012] An object of the invention is to reduce a load swing in a hoisting machine.

SOLUTIONS TO PROBLEMS

[0013] A hoisting machine according to an aspect of the invention includes: a trolley that is transported by self-propulsion means; a hoisting motor mounted on the trolley; a hoisting drum attached to the hoisting motor; a rope attached to the hoisting drum; a hook attached to the rope; and a controller that identifies a transport speed of the trolley. The controller identifies the transport speed of the trolley based on a center-of-gravity distance between a predetermined position and a center-of-gravity position of a load suspended from the hook.

EFFECTS OF THE INVENTION

[0014] According to an aspect of the invention, it is possible to reduce a load swing in a hoisting machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is an example of a schematic diagram of a hoisting machine.
Fig. 2 is an example of a schematic diagram illustrating a parameter of a pendulum.
Fig. 3 is a schematic diagram illustrating an example of a parameter that can be input.
Fig. 4 is an example of a schematic diagram of a hoisting machine having markers.
Fig. 5 is an example of a schematic diagram illustrating a center-of-gravity distance inputting unit.
Fig. 6 is another example of a schematic diagram illustrating the center-of-gravity distance inputting unit.
Fig. 7 is a schematic diagram illustrating an example of a relationship between a pendulum length, a rope length, and a center-of-gravity distance.
Fig. 8 is a schematic diagram illustrating another example of the hoisting machine.

MODE FOR CARRYING OUT THE INVENTION

[0016] Hereinafter, embodiments will be described with reference to the drawings.

Embodiment 1

[0017] The invention relates to a hoisting machine that mainly transports a load suspended by a rope, especially, to a hoisting machine in which a transport speed is determined based on a model of a load swing, and thereby the load swing during transport is inhibited. Additionally, the invention is also applicable to a crane that transports a suspended load in the same manner.

[0018] Fig. 1 is a diagram schematically illustrating an example of a configuration of a hoisting machine in the embodiment.

[0019] In Fig. 1, a suspended load 30 which is a transport target is suspended from a hook 131 by a sling rope 20. The hook 131 is suspended from a hoisting drum 1122 by a rope 13. Here, the suspended load 30 may be configured to be directly suspended from the hook 131 without the sling rope 20.

[0020] The hoisting drum 1122 is connected to a hoisting motor 112 and a hoisting encoder 1121 by a hoisting shaft 1123 and is disposed on a trolley 11. Consequently, rotation of the hoisting motor 112 causes the rope 13 to be hoisted or lowered, and thus the suspended load 30 can be transported in a z direction in the drawings. The transport in the z direction is referred to as hoisting.

[0021] A traversing wheel 1111 is connected to a traversing motor 111 via a traversing shaft 1112 and is disposed on the trolley 11. In addition, the traversing wheel 1111 is disposed to rotate on a beam 15 and generate a drive force when the traversing motor 111 rotates. Consequently, rotation of the traversing motor 111 enables the trolley 11 and the suspended load 30 to be transported along the beam in an x direction in the drawings. The transport in the x direction is referred to as traversing.

[0022] A transport operating unit 141 is provided in an operation terminal 14, and an operator inputs a transport operating signal which is a command of traversing, hoisting, or both the traversing and the hoisting in the transport operating unit. The input transport operating signal is transmitted through communication to the controller 12 via a communication unit 143.

[0023] A center-of-gravity distance inputting unit 142 is provided in the operation terminal 14, and the operator inputs a deemed center-of-gravity distance h to be described below is input in the center-of-gravity distance inputting unit. The input deemed center-of-gravity distance h is transmitted through communication to the controller 12 via the communication unit 143. The deemed center-of-gravity distance h is a predetermined center-of-gravity distance input by the operator.

[0024] Here, the center-of-gravity distance inputting unit 142 and the transport operating unit 141 do not need to be provided in the same operation terminal 14 and may be provided in respective separate operation terminals 14.

[0025] The controller 12 generates the transport speed command based on the transport operating signal and the deemed center-of-gravity distance h and drives the traversing motor 111, the hoisting motor 112, or both the motors. Consequently, the suspended load 30 is caused to perform traversing and is hoisted in response to a transport operation by the operator. Similarly, the suspended load 30 can be caused to perform the traversing after being hoisted, can be hoisted during the traversing, and can be caused to perform the traversing during being hoisted.

[0026] Incidentally, the suspended load 30 and the sling rope 20 are transport targets and are not a configurational element of a hoisting machine 10. In addition, a jig used to suspend the suspended load 30 is not limited to the sling rope 20 and may not be provided.

[0027] Fig. 8 is a schematic diagram illustrating another example of the hoisting machine 10.

[0028] In Fig. 8, the beam 15 is connected to a traveling beam 18 via a traveling device 16. A traveling motor 161 rotates, and thereby the traveling device 16 causes the beam 15 to move along the traveling beam 18 in the y direction in the drawings. Consequently, the trolley 11 connected to the beam 15 and the suspended load 30 suspended from the hook 131 (refer to Fig. 1) are transported in the y direction in the drawings. The transport in the y direction is referred to as traveling.

[0029] The transport operating signal that is input to the transport operating unit 141provided in the operation terminal 14 (refer to Fig. 1) includes a command signal for traveling in addition to traversing/hoisting. At least the traveling command signal of the input transport operating signals is transmitted to a traveling controller 17 via the communication unit 143 (refer to Fig. 1).

[0030] In addition, the deemed center-of-gravity distance h input in the center-of-gravity distance inputting unit 142 (refer to Fig. 1) is transmitted to the traveling controller 17 in addition to the controller 12 via the communication unit 143. The traveling controller 17 generates the transport speed command for at least the traveling based on the transport operating signal and the deemed center-of-gravity distance h and drives the traveling motor 161. Consequently, the suspended load 30 (refer to Fig. 1) is caused to perform traveling in addition to traversing/being hoisted in response to the transport operation by the operator.

[0031] Incidentally, the description that the controller 12 generates the transport speed command for traversing or hoisting, and the traveling controller 17 generates the transport speed command for traveling is provided; however, the invention is not limited to such a configuration.

[0032] For example, the controller 12 generates the transport speed commands for traversing, traveling, and hoisting, and at least the command for traveling of the generated transport speed commands may be transmitted from the controller 12 to the traveling controller 17 such that the traveling controller 17 may drive the traveling motor 161 based on the received transport speed command. In this case, the transport operating signal and the deemed center-of-gravity distance h may be transmitted to at least the controller 12 and may not need to be transmitted to the traveling controller 17.

[0033] Fig. 2 is a diagram schematically illustrating an example of a parameter of a pendulum in the embodiment.

[0034] In Fig. 2, the suspended load 30, the sling rope 20, the hook 131, and the rope 13 configure the pendulum in the hoisting machine 10.

[0035] The load swing of the suspended load 30 occurs with the hoisting drum 1122 as a supporting point due to acceleration applied to the trolley 11 during the traversing or the traveling. In this case, a load-swing frequency Fr which is a resonance frequency of the pendulum satisfies Expression 1. In Expression 1, g represents gravitational acceleration, and a pendulum length L is a distance from the supporting point to a center of gravity 301 of the suspended load illustrated in Fig. 2 (a) .

[Expression 1]

$$Fr = \frac{1}{2\pi} \cdot \sqrt{\frac{g}{L}}$$

Expression 1

[0036] When the transport speed command does not include a component of the load-swing frequency Fr, the load swing is not excited. Hence, regarding the transport speed command, the transport speed command that is configured of only a frequency lower than the load-swing frequency Fr is shaped by a bandwidth cutoff filter that cuts off a frequency bandwidth including the load-swing frequency Fr, for example. Consequently, the component of the load-swing frequency Fr is inhibited from the transport speed command, and thereby it is possible to inhibit the load swing.

[0037] Hence, in order for the controller 12 to generate the transport speed command by which it is possible to inhibit the load swing, it is necessary to identify the load-swing frequency Fr with high accuracy. When the gravitational acceleration g is constant in a use environment of the hoisting machine 10, it is necessary to identify the pendulum length L with high accuracy, in order to identify the load-swing frequency with high accuracy.

[0038] Here, as illustrated in Fig. 2(a), the pendulum length L is a value obtained by adding a rope length LO and a center-of-gravity distance H. The rope length LO is a distance from a supporting point, which is a position separated from a pulley when the rope 13 has the drum 1122 or the pulley, to a bottom of the hook 131. In other words, the rope length is a distance from a position of a top of the rope 13 to the bottom of the hook 131. The rope length LO is referred to as a first distance.

[0039] The rope length LO can be identified by a length of the rope 13 pulled out of the hoisting drum 1122, which is observed by the hoisting encoder 1121, and a length of the hook 131.

[0040] The center-of-gravity distance H is a distance from the bottom of the hook 131 to the center of gravity 301 of the suspended load, and it is difficult to identify the center-of-gravity distance in the case of using various types of suspended loads 30 or sling ropes 20. Hence, an example of an identification method will be described in another embodiment.

[0041] Here, an example of the bottom of the hook 131 is described. The bottom is a contact surface of the hook 131 with the sling rope 20 that is suspended from the hook 131. That is, the contact surface does not mean an underside of the hook 131 but a supporting point of the sling rope 20 means the bottom of the hook 131. This is because the center-of-gravity distance H is a distance from the supporting point of the sling rope 20 to the center of gravity of the suspended load. In addition, the center-of-gravity distance H is referred to as a second distance. Incidentally, the bottom of the hook 131 may not be the contact surface of the hook 131 with the sling rope 20, depending on a diameter of the sling rope 20. This is because the center-of-gravity distance is the distance from the supporting point of the sling rope 20 to the center of gravity of the suspended load, and the contact surface is not the supporting point.

[0042] The rope length LO is a unique value when it is possible to accurately measure the rope length; however, an error in value measured by the encoder 1121 or a value measured by the operator may be input as the rope length LO such that the following calculation is performed. In other words, the rope length LO may be a value obtained by offsetting a measured value. The invention is not limited thereto, and a deemed pendulum length 1 may be identified as a value obtained by adding the rope length LO and the deemed center-of-gravity distance h without an overlapping part.

[0043] Here, when it is possible to accurately measure the center-of-gravity distance H, the center-of-gravity distance becomes a unique value. Therefore, a value measured or estimated by the operator is input as the deemed center-of-gravity distance h. As the deemed center-of-gravity distance h approximates the center-of-gravity distance H, it is possible to improve accuracy of the load swing.

[0044] The value obtained by adding the rope length LO and the center-of-gravity distance h is the deemed pendulum length 1. The deemed pendulum length 1 may be obtained by offsetting the measured value of the rope length LO and the center-of-gravity distance h.

[0045] Here, with reference to Fig. 7, a difference in center-of-gravity distance H depending on the suspended load 30 or the sling rope 20 is described.

[0046] Fig. 7 is an example of a schematic diagram illustrating a relationship between the suspended load 30, the sling rope 20, and the center-of-gravity distances H. When Fig. 7(a) is compared with Fig. 7(b), the center-of-gravity distance H changes depending on the sling rope 20 that is used, although the same suspended load 30 is used.

[0047] In addition, when Fig. 7(b) is compared with Fig. 7(c), the center-of-gravity distance H changes depending on a shape of the suspended load 30. In this manner, the center-of-gravity distance H changes depending on the shape of the suspended load 30 or the sling rope 20 that is used. Therefore, it is not possible to identify the pendulum length L only by the rope length LO that can be identified by the hoisting machine 10.

[0048] Here, in Fig. 2, a method by which the operator of the hoisting machine 10 estimates a position of the center of gravity 301 of the suspended load is described. That is, the operator can identify or measure the deemed center-of-gravity distance h which is a distance between the bottom of the hook 131 and a deemed center of gravity 302 of the suspended load that is a center-of-gravity position of the suspended load 30 estimated by the operator, the center-of-gravity distance being illustrated in Fig. 2(b). Hence, the center-of-gravity distance inputting unit 142 in which it is possible to input the deemed center-of-gravity distance h is provided.

[0049] The deemed pendulum length 1 which is an estimate of the pendulum length L is identified from Expression 2, by using the deemed center-of-gravity distance h input in the center-of-gravity distance inputting unit 142 and the rope length L0. That is, even when the suspended load 30 is hoisted in response to a transport operating command, it is possible to identify the deemed pendulum length 1.

[Expression 2]

$$1 = L0 + h$$

Expression 2

[0050] A deemed load-swing frequency fr which is the estimate of the load-swing frequency Fr can be estimated from Expression 3 by using the identified deemed pendulum length 1.

[Expression 3]

$$fr = \frac{1}{2\pi} \cdot \sqrt{\frac{g}{1}}$$

Expression 3

[0051] When the deemed load-swing frequency fr is used to estimate the load-swing frequency Fr with high accuracy, a component of the deemed load-swing frequency fr is inhibited and removed from the transport speed command, as described above, for example, and thereby it is possible to inhibit the load swing.

[0052] Here, the deemed pendulum length 1 is estimated based on the deemed center of gravity 302 of the suspended load which is the estimated center-of-gravity position of the suspended load 30, and thus there is a difference between the deemed pendulum length 1 and the pendulum length L. However, the following description is clarified. The deemed center of gravity 302 of the suspended load is more likely to be present within an occupying range of the suspended load 30, compared with the case of using the rope length LO as the deemed pendulum length 1 or the case of using a distance from the supporting point to a lower end of the suspended load 30 as the deemed pendulum length 1. Hence, the deemed pendulum length 1 can be used to estimate the pendulum length L with high accuracy, and an effect of load-swing inhibition improves.

[0053] Here, the hoisting machine 10 may have a function of determining validity of the input deemed center-of-gravity distance h and notifying the operator of the validity. For example, when a negative distance is input as the deemed center-of-gravity distance h, when the obtained deemed pendulum length 1 is a distance larger than a supporting point height (Reference sign K in Fig. 3) that is a height of the hoisting drum 1122 from a floor surface (Reference sign 40 in Fig. 3), the height being input in advance, or the like, the hoisting machine can determine that the deemed center of gravity 302 is not present within the occupying range of the suspended load 30, and the operator can be notified of no presence thereof.

[0054] Fig. 3 is a diagram illustrating an example of a parameter that can be input in another center-of-gravity distance inputting unit 142.

[0055] Inputting in the center-of-gravity distance inputting unit 142 is not limited to the inputting of the deemed center-of-gravity distance h, and the deemed pendulum length 1 may be input as a deemed center-of-gravity distance, for example. In this case, the deemed center-of-gravity distance h is obtained from the input deemed pendulum length 1 and the input rope length LO.

[0056] In addition, a deemed center-of-gravity height i which is a height of the deemed center of gravity 302 from the floor surface 40 may be input as the deemed center-of-gravity distance in the center-of-gravity distance inputting unit 142, for example. In this case, the deemed center-of-gravity distance h is obtained from Expression 4 by using the input height i of the center of gravity 302 and the supporting point height K.

[Expression 4]

$$h = K - L0 - i$$

Expression 4

[0057] In addition, in the center-of-gravity distance inputting unit 142, the deemed center-of-gravity distance h and a distance that can be used to compute the deemed center-of-gravity distance h may be input. For example, the distance such as the deemed pendulum length or the deemed center-of-gravity height i may be input as a ratio with respect to a predetermined distance. The predetermined distance may be an accurately identifiable distance such as the rope length L0, the supporting point height K, or a height (K - LO) of the bottom of the hook 131 from the floor surface 40. The deemed center-of-gravity distance h can be computed by using the input ratio and the predetermined distance.

[0058] In addition, in the embodiment, the rope length LO is divided from the deemed center-of-gravity distance h based on the bottom of the hook 131, for example; however, the embodiment is not limited thereto. For example, when a reference position is set to a position separated from the bottom of the hook by a predetermined distance, the deemed pendulum length 1 and the deemed center-of-gravity distance h can be computed from the rope length LO and a distance between the reference position and the deemed center of gravity 302 of the suspended load. For example, when the reference position is set to a top of the hook 131, the deemed pendulum length 1 can be computed from the length of the hook 131, the rope length LO, and the deemed center-of-gravity distance h.

[0059] Fig. 4 is a diagram schematically illustrating an example of a marker for assisting the operator in inputting.

[0060] The hoisting machine 10 may have markers 132 for assisting in the inputting in the center-of-gravity distance inputting unit 142. For example, the center-of-gravity distance inputting unit 142 is configured to input the deemed center-of-gravity distance h based on a distance between the markers 132 or the number of the markers 132. Consequently, it is possible to reduce variations in accuracy of the deemed center-of-gravity distance h due to an individual difference of the operator.

[0061] In addition, when the number or positions of the markers are used as the deemed center-of-gravity distance h, the operator can more easily input a value, compared with the case of measuring the center-of-gravity distance H, and thus operation efficiency of a hoist improves. On the other hand, compared with the case of using the number or positions of the markers as the deemed center-of-gravity distance h, it is more easy to reduce the load swing in the case of inputting the measured center-of-gravity distance H as the deemed center-of-gravity distance h.

[0062] For example, the markers 132 can be realized by coloring or the like of the rope 13 or the hook 131 at constant intervals. That is, the markers have a color different from that of the rope 13. In addition, the entire rope 13 can have the ground color, and the markers 131 can be colored with a color different from the ground color of the rope 13. The entire rope 13 may be colored, and a part of the rope may have the ground color as the markers 132. In addition, a method for providing the markers is not limited to coloring and may have a different shape.

[0063] A display section may be provided in the inputting unit 142, and the input center-of-gravity distance may be displayed. In addition, input means of the inputting unit 142 may be a touch panel, a push button, or a potentiometer (volume).

[0064] The push button includes an add button and a subtract button and is set to input a number that can be seen to the operator, and thereby it is easy for the operator to perform identification and an input operation of the center-of-gravity distance h by using the markers.

[0065] In addition, the potentiometer (volume) may be a device for changing a value in a stepwise manner. In this case, it is easy to perform inputting when the number of markers and the steps of the potentiometer have a corresponding relationship. The number of markers is displayed around the volume, and thereby it is easy to input the number of markers.

[0066] Here, the hoisting machine is not limited to the embodiment described above. For example, the communication unit 143 may not use wireless communication but may use wired communication. In addition, the center-of-gravity distance inputting unit 142 and the transport operating unit 141 may be provided in different operation terminals 14, for example. In addition, the inputting in the center-of-gravity distance inputting unit 142 may be performed by an inputter other than the operator, for example.

[0067] Here, the deemed center-of-gravity distance h is a value that is measured or identified by the operator and is input by input means or an estimate of the center-of-gravity distance that is identified by calculating or correcting the input value. Hence, the deemed center-of-gravity distance does not mean a unique and exact value of the center-of-gravity distance H but means the estimate of the center-of-gravity distance H. The same is true of another deemed pendulum length 1, another deemed center-of-gravity height i, another deemed center of gravity of the suspended load, or the like. Further, a predetermined value of the deemed center-of-gravity distance h that can be used when the operator does not input the deemed center-of-gravity distance h or the like may be set. Consequently, the predetermined value of the center-of-gravity distance h is set or the like based on a condition of the suspended load that is more widely used. In this manner, it is possible to improve estimation accuracy of the pendulum length L, and it is possible to reduce the load swing, even when the operator does not input the deemed center-of-gravity distance h.

Embodiment 2

[0068] Fig. 5 is a diagram illustrating an example of another configuration of the center-of-gravity distance inputting unit 142.

[0069] In Fig. 5, the center-of-gravity distance inputting unit 142 is configured to have a camera 1421, a displaying/inputting section 1422, and a calculator 1423. The displaying/inputting section 1422 displays an image acquired from the camera 1421 by the operator. The calculator 1423 calculates the deemed center-of-gravity distance h based on the image. The calculated deemed center-of-gravity distance h is transmitted to the controller 12 via the communication unit 143 so as to be used for determination of the transport speed command.

[0070] In Fig. 5, a rope (captured image) 13a, a hook (captured image) 131a, a marker (hook, captured image) 132a, a marker (captured image) 132b, a sling rope (captured image) 20a, and a suspended load (captured image) 30a are the image displayed on the displaying/inputting section 1422.

[0071] For example, the calculator 1423 identifies the suspended load (captured image) 30a through image processing, and thereby it is possible to estimate a deemed center of gravity (calculation result) 302a of the suspended load in the image. In the case of using only the image captured from one direction, it is possible to estimate the deemed center of gravity (calculation result) 302a of the suspended load when the suspended load 30 has a uniform density or depth, for example. When images captured from multiple directions are used, accuracy of the deemed center of gravity (calculation result) 302a of the suspended load to be estimated improves.

[0072] In addition, the center-of-gravity distance inputting unit 142 may have a function of assisting calculation processing performed by the calculator 1423. For example, candidates of an archetypal shape of the suspended load 30 are provided, and the operator selects the most approximate candidate. In this manner, it is possible to assist in the image processing and the deemed center of gravity (calculation result) 302a of the suspended load.

[0073] Here, the deemed center of gravity (calculation result) 302a of the suspended load may be displayed on the displaying/inputting section 1422. Consequently, the operator can confirm a position of the deemed center of gravity (calculation result) 302a of the suspended load in the image. Further, a configuration may be employed, in which the operator can adjust the position of the deemed center of gravity (calculation result) 302a of the suspended load displayed on the displaying/inputting section 1422. This can be realized when the displaying/inputting section 1422 is configured of a touch panel or the like.

[0074] In addition, regarding the deemed center of gravity (calculation result) 302a of the suspended load, the operator may input, in the displaying/inputting section 1422, the deemed center of gravity 302a of the suspended load estimated in the image by the operator without using the image processing. This can be realized when the displaying/inputting section 1422 is configured of a touch panel or the like. For example, the deemed center-of-gravity distance h in real space is obtained by the following calculation performed by the calculator 1423, by using the identified deemed center of gravity (calculation result) 302a of the suspended load.

[0075] A distance between the identified deemed center of gravity (calculation result) 302a of the suspended load and the marker (hook captured image) 132a can be obtained as a distance by a unit of pixels in the image. Similarly, an interval of the markers (captured image) 132b can be obtained as a distance by a unit of pixels in the image. Here, an interval of the markers 132 in real space and a distance between a position disposed in the hook among the markers 132 (corresponding to the marker (hook captured image) 132a in the image) and the bottom of the hook 131 are input in advance.

[0076] A distance between the deemed center of gravity (calculation result) 302a of the suspended load and the marker (hook captured image) 132a can be converted into a distance between the deemed center of gravity 302 of the suspended load and the marker 132 (disposed in the hook) in real space, by using the interval of the markers (captured images) 132b by a unit of pixels and the interval of the markers 132 in real space. Further, the deemed center-of-gravity distance h in real space can be calculated by using a distance between the marker 132 (disposed in the hook) and the bottom of the hook 131, which is input in advance.

[0077] As described above, the deemed center-of-gravity distance h in real space is obtained by the calculator 1423 by using the deemed center of gravity (calculation result) 302a of the suspended load identified in the image.

Embodiment 3

[0078] Fig. 6 is a diagram illustrating an example of another configuration of the center-of-gravity distance inputting unit 142.

[0079] In Fig. 6, the operator inputs, in a suspended-load ID inputting section 1425, an ID of the suspended load 30 that is to be transported or has been transported. Regarding the suspended load 30, the deemed center-of-gravity distance h identified by the method described above in Embodiment 1 or 2 is input in a center-of-gravity distance displaying/inputting section 1426. The operator presses a register button 1427 or the like, and thereby a registration command of the suspended load 30 is issued. Consequently, the center-of-gravity distance inputting unit 142 stores the suspended-load ID and the deemed center-of-gravity distance h in a memory 1424. Then, the deemed center-of-gravity distance h read from the memory 1424 is transmitted to the controller 12 via the communication unit 143.

[0080] The operator inputs the ID of the suspended load 30 to be transported in the suspended-load ID inputting section 1425 and presses a read button 1428 or the like, and thereby a reading command of the suspended load 30 is issued. Consequently, the center-of-gravity distance inputting unit 142 reads the deemed center-of-gravity distance h associated with the input suspended-load ID from the memory 1424, and the deemed center-of-gravity distance is transmitted to the controller 12 via the communication unit 143. In this case, the deemed center-of-gravity distance h read from the memory 1424 may be displayed on the center-of-gravity distance displaying/inputting section 1426.

[0081] Here, transmission of the registered or read deemed center-of-gravity distance h to the controller 12 via the communication unit 143 may be performed by an instruction from the operator through issuing a transmission command or the like.

[0082] In addition, a configuration of the suspended-load ID inputting section 1425 may be employed as long as the suspended load 30 can be identified, and the configuration thereof is not limited to inputting of an ID number. For example, a name of the suspended load 30 may be input. In addition, when a barcode or the like for managing the suspended load 30 is attached, the suspended-load ID inputting section 1425 may have a configuration of a barcode reader, for example. In addition, when the center-of-gravity distance inputting unit 142 also has the configuration in Fig. 5, the suspended-load ID may include an image, and the center-of-gravity distance inputting unit may have a configuration in which the image of the same suspended load 30 is searched from the suspended-load IDs recorded in the memory 1424 by using the image of the suspended load 30 such that the image is displayed to the operator and is selected.

[0083] Further, other information may also be recorded, in addition to the suspended-load ID and the deemed center-of-gravity distance h, in the memory 1424. For example, a type of the sling rope 20 used can be recorded as the other information, and thereby it is possible to record the deemed center-of-gravity distance h for each combination of the suspended load 30 and the sling rope 20. Consequently, when various types of sling ropes 20 are used with respect to the same suspended load 20, it is possible to identify the deemed pendulum length 1 with higher accuracy.

[0084] In addition, when the suspended load 30 is identified with a suspended-load ID by a reading command, the recorded type of sling rope 20 is displayed, and thereby the operator can identify the type of sling rope 20 that needs to be used.

REFERENCE SIGNS LIST

[0085]

10	Hoisting machine
11	Trolley
111	Traversing motor
1111	Traversing wheel
1112	Traversing shaft
112	Hoisting motor
1121	Hoisting encoder
1122	Hoisting drum
1123	Hoisting shaft
12	Controller
13	Rope
131	Hook
132	Marker
14	Operation terminal
141	Transport operating unit
142	Center-of-gravity distance inputting unit
1421	Camera
1422	Displaying/inputting section
1423	Calculator
1424	Memory
1425	Suspended-load ID inputting section
1426	Center-of-gravity distance displaying/inputting section
1427	Register button

1428 Read button
143 Communication unit
15 Beam
16 Traveling device
161 Traveling motor
17 Traveling controller
18 Traveling beam
20 Sling rope
30 Suspended load
301 Center of gravity of suspended load
302 Deemed center of gravity of suspended load
40 Floor surface

Claims

1. A hoisting machine comprising:

a trolley that is transported by self-propulsion means;
a hoisting motor mounted on the trolley;
a hoisting drum attached to the hoisting motor;
a rope attached to the hoisting drum;
a hook attached to the rope; and
a controller that identifies a transport speed of the trolley,
wherein the controller identifies the transport speed of the trolley based on a center-of-gravity distance between a predetermined position and a center-of-gravity position of a suspended load suspended from the hook.

2. The hoisting machine according to claim 1,
wherein the predetermined position is a bottom of the hook, and
wherein the center-of-gravity distance is an estimate of a center-of-gravity distance between the bottom of the hook and the center-of-gravity position of the suspended load.

3. The hoisting machine according to claim 1,
wherein the predetermined position is a reference position separated from a bottom of the hook by a predetermined distance, and
wherein the center-of-gravity distance is an estimate of a center-of-gravity distance between the reference position and the center-of-gravity position of the suspended load.

4. The hoisting machine according to claim 1,
wherein the predetermined position is a position of a floor surface, and
wherein the center-of-gravity distance is an estimate of a center-of-gravity distance between the position of the floor surface and the center-of-gravity position of the suspended load.

5. The hoisting machine according to claim 1,
wherein the predetermined position is a supporting position of the hoisting drum, and
wherein the center-of-gravity distance is an estimate of a center-of-gravity distance between the supporting position and the center-of-gravity position of the suspended load.

6. The hoisting machine according to claim 1,
wherein the predetermined position is a top of the hook, and
wherein the center-of-gravity distance is an estimate of a center-of-gravity distance between the top of the hook and the center-of-gravity position of the suspended load.

7. The hoisting machine according to claim 1,
wherein the controller has functions of
identifying an estimate of a pendulum length between a supporting position of the hoisting drum and the center-of-gravity position of the suspended load by using a length of the rope and the center-of-gravity distance,
identifying a load-swing frequency which is an estimate of a load-swing frequency of the suspended load by using the identified estimate of the pendulum length, and
removing a component of the load-swing frequency from the transport speed of the trolley.

8. The hoisting machine according to claim 1,
wherein an estimate of the center-of-gravity distance can be set.

9. The hoisting machine according to claim 1,
wherein a center-of-gravity distance inputting unit, in which the center-of-gravity distance is input, is provided.

10. The hoisting machine according to claim 9,
wherein a default value of an estimate of the center-of-gravity distance can be set, and the default value is used when the center-of-gravity distance is not input.

11. The hoisting machine according to claim 9,
wherein the center-of-gravity distance inputting unit is provided in an operation terminal that includes a transport operating unit which issues a command of the transport speed of the trolley and a communication unit which transmits the center-of-gravity distance and the transport speed to the controller.

12. The hoisting machine according to claim 9,
wherein the rope has markers at predetermined intervals.

13. The hoisting machine according to claim 12,
wherein the markers have colors or shapes different

from a color or a shape of the rope.

14. The hoisting machine according to claim 12, wherein the center-of-gravity distance inputting unit has an imaging device and a calculator, wherein the imaging device captures the rope having the plurality of markers, the hook, and the suspended load suspended from the hook, wherein the calculator identifies the center-of-gravity distance based on an image captured by the imaging device, and wherein the communication unit transmits the identified center-of-gravity distance to the controller.

15. The hoisting machine according to claim 9, wherein the center-of-gravity distance inputting unit has a suspended-load ID inputting section in which an ID of the suspended load is input, an inputting section in which the center-of-gravity distance is input, and a storage section that stores the ID of the suspended load and the center-of-gravity distance in an associating manner, and wherein the center-of-gravity distance associated with the ID of the suspended load input from the suspended-load ID inputting section is read from the storage section, and the read center-of-gravity distance is transmitted to the controller via the communication unit.

16. The hoisting machine according to claim 15, wherein the suspended load is suspended from the rope by holding means, wherein the center-of-gravity distance for each combination of the suspended load and types of holding means is stored in the storage unit, wherein the center-of-gravity distance associated with a combination of the suspended load and the jig is read from the storage unit, and wherein the read center-of-gravity distance is transmitted to the controller via the communication unit.

17. The hoisting machine according to claim 16, wherein the storage section stores a type of sling rope as the type of holding means, the sling rope being provided between the hook and the suspended load.

F I G. 1

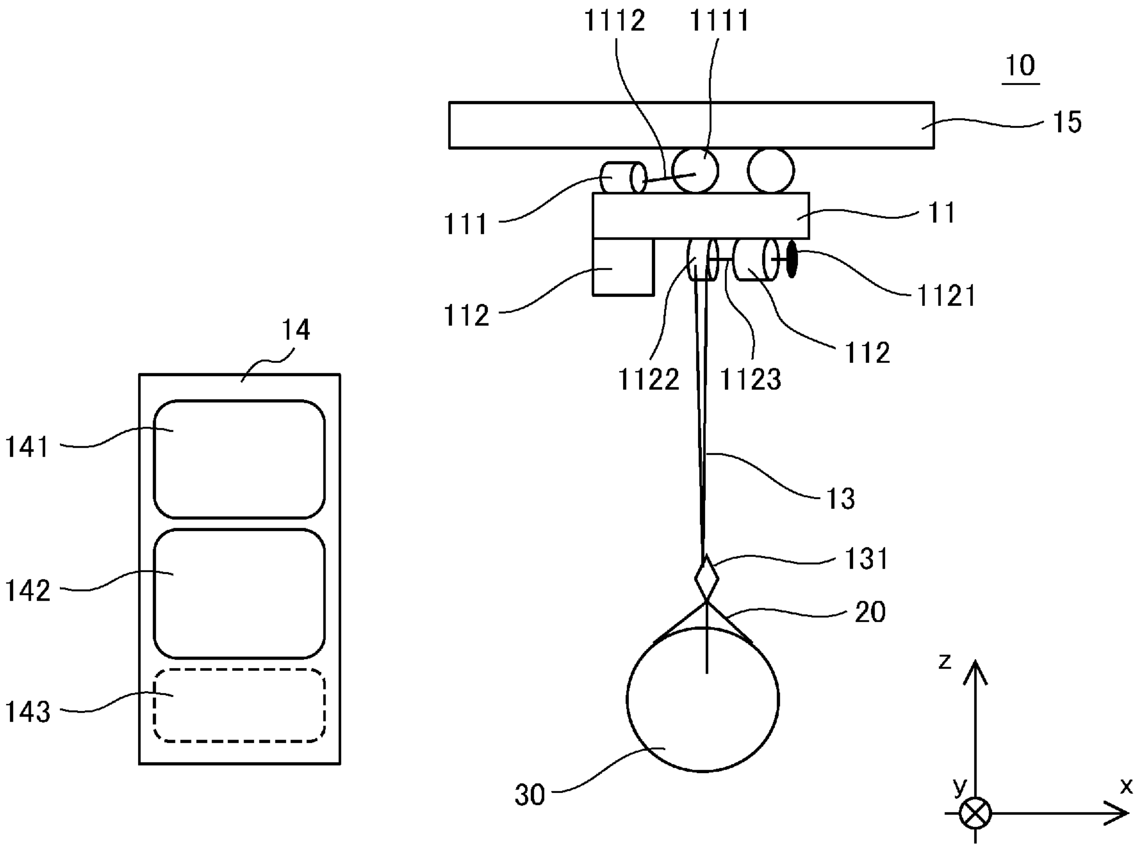
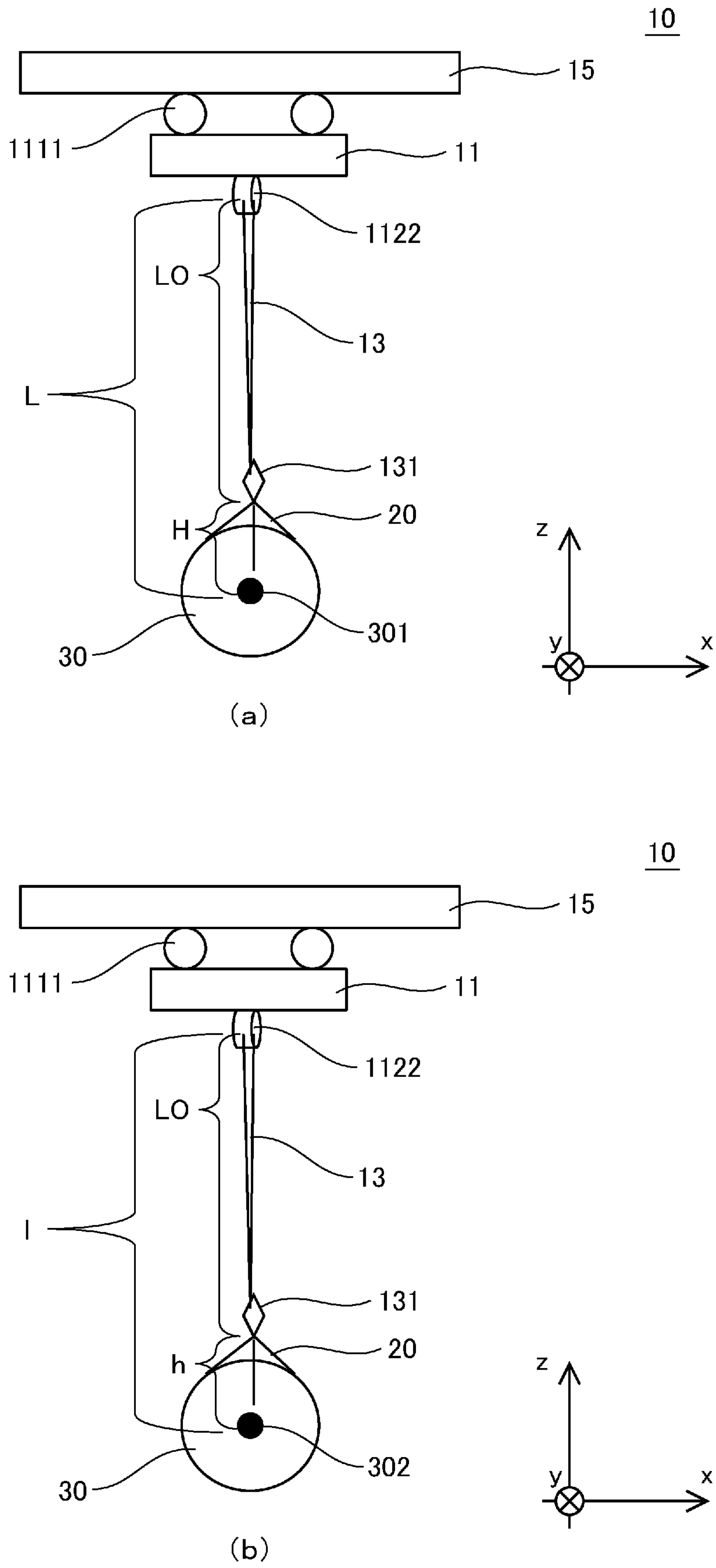
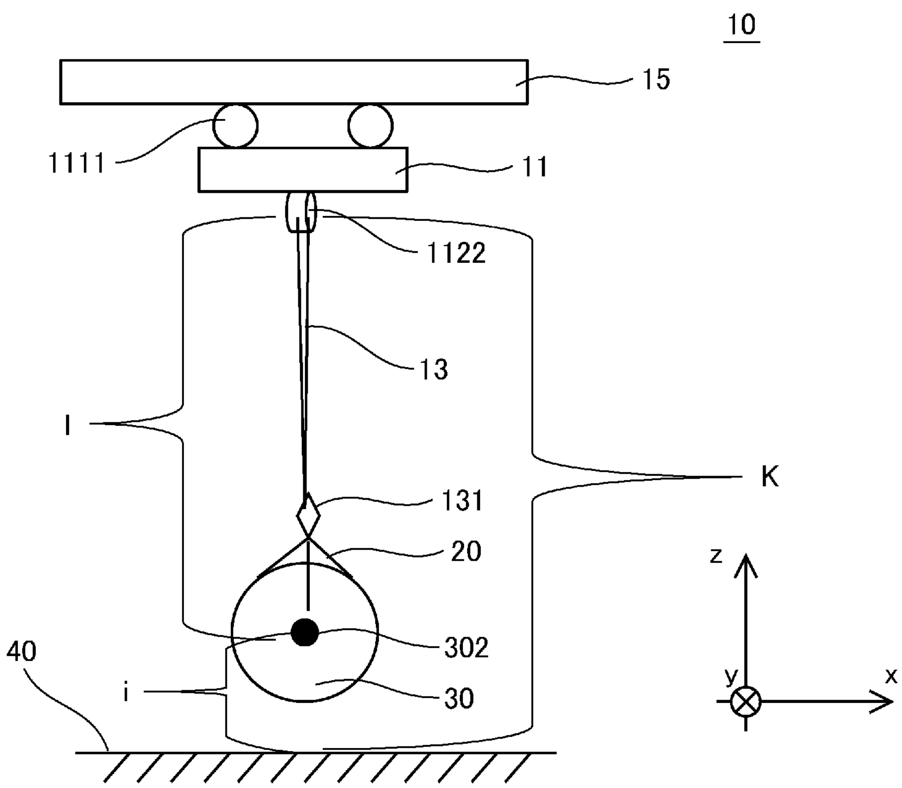

1112
1111
10
15
111
11
112
1121
112
1122
1123
14
141
142
143
13
131
20
30
z
y
x

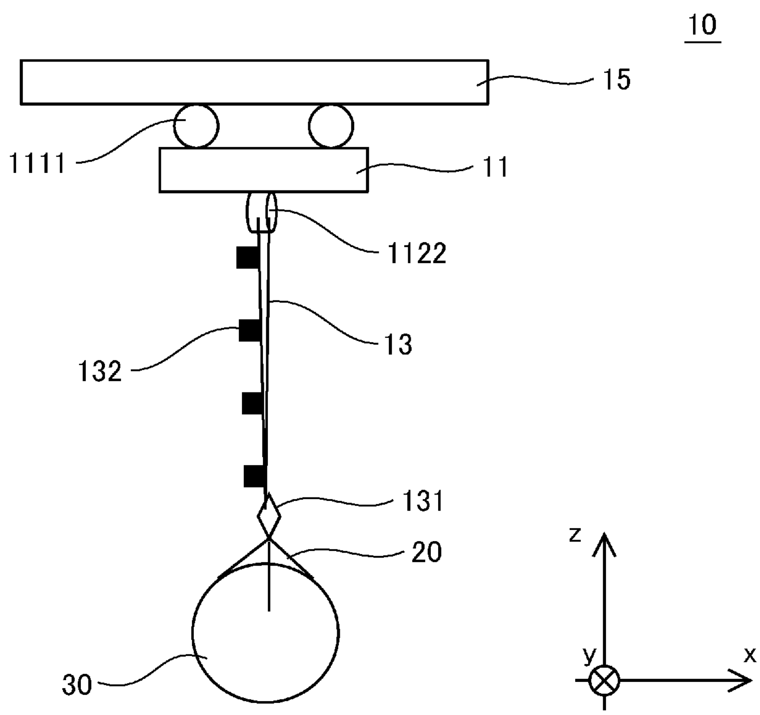
FIG. 2


10
15
1111
11
1122
LO
13
L
131
20
H
30
301
z
y
x
(a)
10
15
1111
11
1122
LO
13
l
131
20
h
30
302
z
y
x
(b)

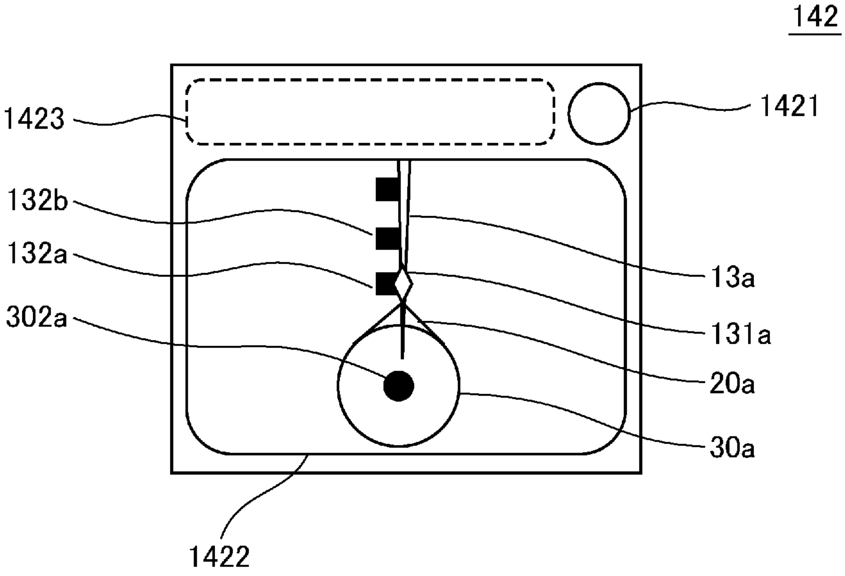
F I G. 3


10
15
1111
11
1122
13
I
K
131
20
302
30
40
i
z
y
x

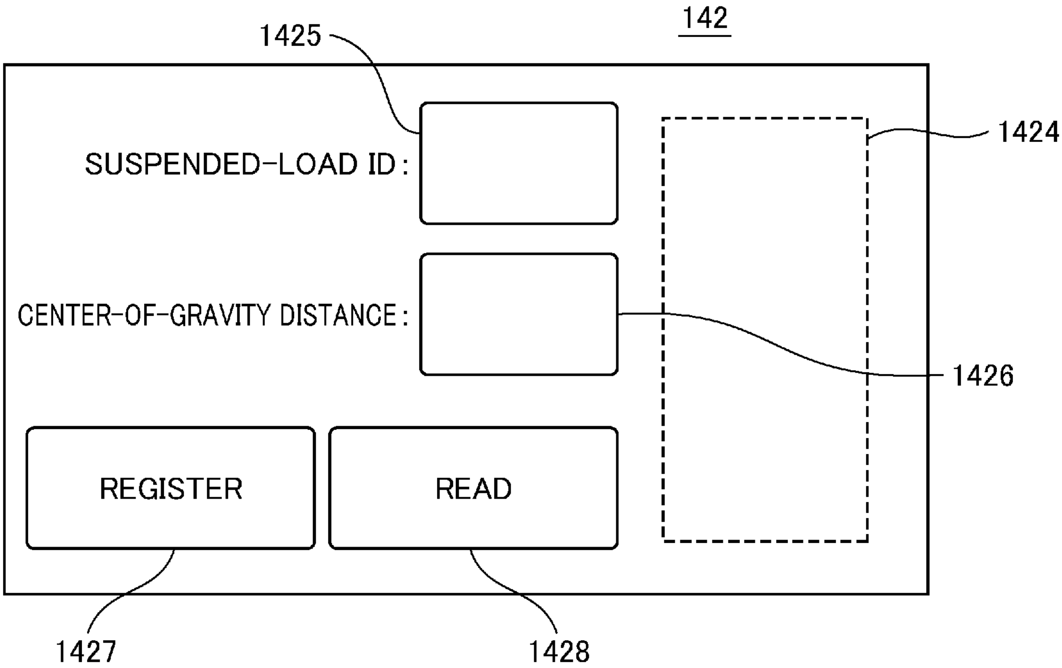
F I G. 4


10
15
1111
11
1122
13
132
131
20
30
z
y
x

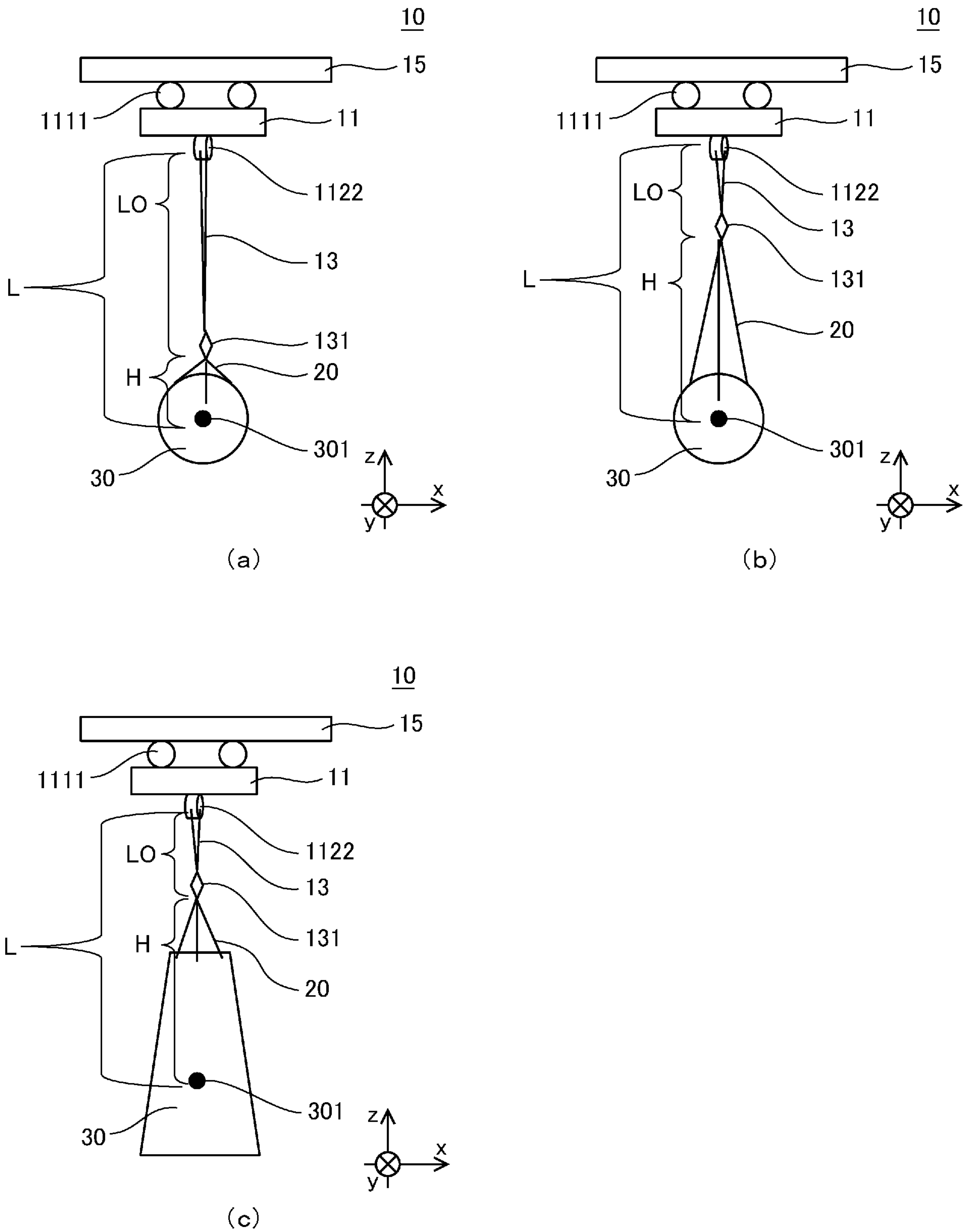
F I G. 5


142
1423
1421
132b
132a
302a
13a
131a
20a
30a
1422

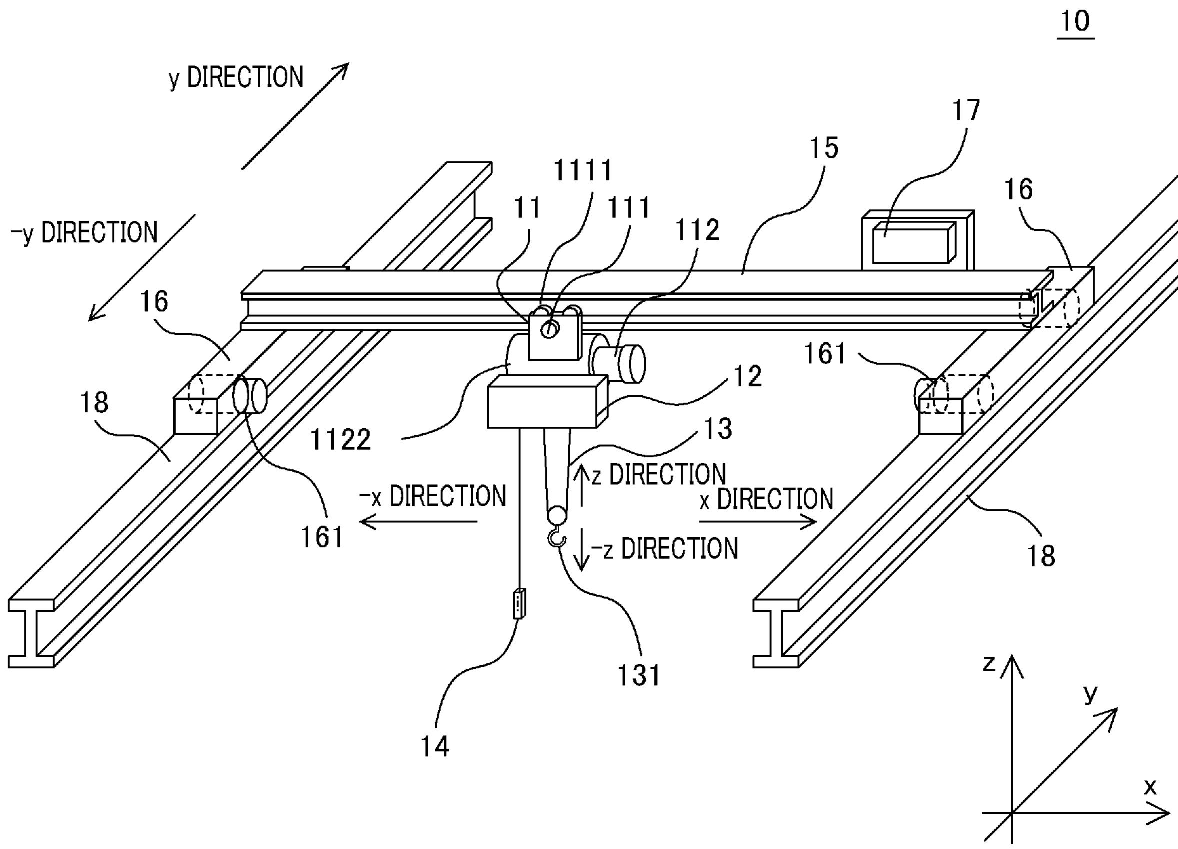
F I G. 6


142
1425
SUSPENDED-LOAD ID :
1424
CENTER-OF-GRAVITY DISTANCE :
1426
REGISTER
READ
1427
1428

F I G. 7


10
15
1111
11
1122
LO
13
L
131
H
20
301
30
z
x
y
(a)
10
15
1111
11
1122
LO
13
131
L
H
20
301
30
z
x
y
(b)
10
15
1111
11
1122
LO
13
131
L
H
20
301
30
z
x
y
(c)

F I G. 8


10
y DIRECTION
−y DIRECTION
17
15
1111
11
111
112
16
16
161
18
12
1122
13
z DIRECTION
−x DIRECTION
x DIRECTION
161
−z DIRECTION
18
131
14
z
y
x

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/001547

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B66C13/22(2006.01)i, B66C13/46(2006.01)i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. B66C13/22, B66C13/46

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	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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.
X Y A	WO 2005/012155 A1 (SINTOKOGIO, LTD.) 10 February 2005, paragraphs [0023]-[0076], fig. 1-6 & US 2008/0275610 A1, paragraphs [0028]-[0080], fig. 1-6 & EP 1652810 A1 & CN 1832898 A	1, 7 2-6, 8-13 14-17
Y	JP 11-209065 A (SANWA SEIKI LTD.) 03 August 1999, paragraphs [0010]-[0032], fig. 1-12 (Family: none)	2-6, 8-13

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 February 2018 (27.02.2018)	06 March 2018 (06.03.2018)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/001547

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-168529 A (SUMITOMO FORESTRY CO., LTD.) 17 June 2004, paragraphs [0013]-[0021], fig. 1-3 (Family: none)	12-13
A	JP 4-159998 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 03 June 1992 (Family: none)	1-17

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 11209067 A **[0009]**
- JP 2000177985 A **[0009]**