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HOIST HOOK AND TRANSPORTING METHOD OF ARTICLE USING THE HOIST HOOK

Abstract

A hoist hook includes a main plate, a first slide plate, a second slide plate, a first base, a second base, a pair of hooks, a generator, and a rack. The first slide plate and the second slide plate are fixed to each other and are configured to be suspended from a radio-controlled unmanned aircraft and to slide vertically relative to the main plate while sandwiching the main plate. The first base and the second base are fixed to each other and are configured to slide vertically relative to the main plate while sandwiching the main plate. The pair of hooks are each rotatably linked to the first base and the second base. The generator is rotatably fixed to the main plate. The rack is linked to the generator and is fixed to the first slide plate.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a Continuation of International Patent Application No. PCT/JP2023/036975, filed on Oct. 12, 2023, which claims the benefit of priority to U.S. Provisional Patent Application No. 63/426, 133, filed on Nov. 17, 2022, the entire contents of which are incorporated herein by reference.

FIELD

[0002] An embodiment of the present invention relates to a hoisting device for suspending articles from a radio-controlled unmanned aircraft (hereinafter, also referred to as a drone) and transporting the articles and a transporting method of the articles using the hoisting device.

BACKGROUND

[0003] In recent years, drones have been used in a variety of fields, and drones are not only utilized for taking pictures from the sky but are also applied as a means for transporting articles such as luggage and materials. For example, Japanese laid-open patent applications No. 2002-128455, 2022-128632, 2021-050064, 2021-102521, and 2022-128628 disclose a hoisting device (hereinafter, referred to as a hoist hook) for transporting articles using a drone.

SUMMARY

[0004] An embodiment of the present invention is a hoist hook. The hoist hook includes a main plate, a first slide plate, a second slide plate, a first base, a second base, a pair of hooks, a generator, and a rack. The first slide plate and the second slide plate are fixed to each other and are configured to be suspended from a radio-controlled unmanned aircraft and to slide vertically relative to the main plate while sandwiching the main plate. The first base and the second base are fixed to each other and are configured to slide vertically relative to the main plate while sandwiching the main plate. The pair of hooks are each rotatably linked to the first base and the second base. The generator is rotatably fixed to the main plate. The rack is linked to the generator and is fixed to the first slide plate.

[0005] An embodiment of the present invention is a method for transporting an article. The method includes: suspending an article from a hoist hook; moving the hoist hook using a radio-controlled unmanned aircraft; and releasing the article from the hoist hook. The hoist hook includes a main plate, a first slide plate, a second slide plate, a first base, a second base, a pair of hooks, a generator, and a rack. The first slide plate and the second slide plate are fixed to each other and are configured to be suspended from a radio-controlled unmanned aircraft and to slide vertically relative to the main plate while sandwiching the main plate. The first base and the second base are fixed to each other and configured to slide vertically relative to the main plate while sandwiching the main plate. The pair of hooks are each rotatably linked to the first base and the second base. The generator is rotatably fixed to the main plate. The rack is linked to the generator and is fixed to the first slide plate.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0006] FIG. **1** is a schematic front view of a hoist hook according to an embodiment of the present invention.

[0007] FIG. **2** is a schematic back view of a hoist hook according to an embodiment of the present invention.

[0008] FIG. **3** is a schematic perspective view of a hoist hook according to an embodiment of the present invention.
[0009] FIG. **4** is a schematic perspective view of a hoist hook according to an embodiment of the present invention.
[0010] FIG. **5** is a schematic front view of a hoist hook according to an embodiment of the present invention.
[0011] FIG. **6** is a schematic front view of a hoist hook according to an embodiment of the present invention.
[0012] FIG. **7** is a schematic front view of a hoist hook according to an embodiment of the present invention.
[0013] FIG. **8** is a schematic front view of a hoist hook according to an embodiment of the present invention.
[0014] FIG. **9** is a schematic back view of a hoist hook according to an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0015] Hereinafter, each embodiment of the present invention is explained with reference to the drawings. The invention can be implemented in a variety of different modes within its concept and should not be interpreted only within the disclosure of the embodiments exemplified below.
[0016] The drawings may be illustrated so that the width, thickness, shape, and the like are illustrated more schematically compared with those of the actual modes in order to provide a clearer explanation. However, the drawings are only an example, and do not limit the interpretation of the invention. In the specification and the drawings, the same reference number is provided to an element that is the same as that which appears in preceding drawings, and a detailed explanation may be omitted as appropriate.
[0017] Hereinafter, a hoist hook **100** and a transporting method of articles using the hoist hook **100** according to an embodiment of the present invention are described. The hoist hook **100** is a hook capable of being suspended from a drone and is further configured to suspend articles. As described below, the hoist hook **100** is able to automatically open the hooks and release the articles from the hoist hook **100** when unloading the articles to the ground without the hook being unintentionally opened during transport of the articles, i.e., during flight of the drone.

1. Structure

[0018] FIG. **1** and FIG. **2** are respectively schematic front and back views of the hoist hook **100** according to an embodiment of the present invention, and FIG. **3** and FIG. **4** are schematic perspective views of the hoist hook **100**. FIG. **5** to FIG. **9** are schematic front or back views showing a process of suspending an article from the hoist hook **100**. Note that a latch **120**, a first spring **110**, and the like described below are not depicted in FIG. **6** and FIG. **7** for visibility. Hereafter, a vertical direction in a state where the hoist hook **100** is suspended by a drone or the like is referred to as a vertical or z-direction. The direction perpendicular to the z-direction and a normal direction with respect to a main surface of a main plate **102** described below is referred to as a x-direction, while the direction perpendicular to the z-direction and the x-direction is referred to as a y-direction.
[0019] As can be understood from these drawings, the hoist hook **100** has the following fundamental components. These components may include a metal such as iron, aluminum, and copper or an alloy such as stainless steel and brass or may include a resin such as an epoxy resin, a phenolic resin, and a fluororesin. The resin may be a fiber-reinforced plastic containing glass or carbon fibers. [0020] Main plate **102** [0021] A pair of slide plates (first slide plate **104**, second slide plate **106**) [0022] Latch **120** [0023] A pair of bases (first base **130**, second base **132**) [0024] First spring **110** [0025] Second spring **112** [0026] Hook **140** [0027] Rack **150** [0028] Pinion gear **152** [0029] Generator **160**

(1) Main Plate

[0030] The main plate **102** is a part for supporting the various components attached to the main plate **102**. The main plate **102** is provided with grooves **102***b* and **102***c* for the hook **140** to rotate while moving vertically, a groove **102***a* for the latch **120** to move vertically, a groove **102***f* for the first base **130** and the second base **132** to move vertically (see FIG. **7**.), grooves **102***g* for the first slide plate **104** and the second slide plate **106** to move vertically (see FIG. **8**), and the like. Moreover, although not illustrated, an opening is also provided in the main plate **102** for inserting a shaft of the pinion gear **152**.

(2) First Slide Plate, Second Slide Plate, and First and Second Springs

[0031] The first slide plate **104** and the second slide plate **106** are secured to each other with one or a plurality of slide pins **170** so as to face each other while sandwiching at least a portion of the main plate **102**. Since the main plate **102** is provided with one or a plurality of grooves **102***g* for vertically moving the slide pins **170** while being inserted therethrough, the main plate **102** is capable of moving vertically relative to the first slide plate **104** and the second slide plate **106**. In addition, the first slide plate **104** and the second slide plate **106** are provided with hanging holes **104***a* and **106***a*, respectively, for suspending the hoist hook **100** from the drone. The grooves **102***g* provided in the main plate **102** for the slide pins **170** to move are formed so as not to overlap the hanging holes **104***a* and **106***a* in the y-direction when the main plate **102** moves vertically relative to the first slide plate **104** and the second slide plate **106**.

[0032] The rack **150** extending in the vertical direction is fixed to the first slide plate **104**. The first slide plate **104** is also provided with the first spring **110**. Specifically, one terminal of the first spring **110** is linked to the first slide plate **104**, while the other terminal is linked to the latch **120**. Since the first spring **110** is also linked to the first slide plate **104** and the latch **120** with the slide pins **173** and **172**, respectively, the first spring **110** is capable of rotating about an axis of the slide pin **173**, i.e., an axis perpendicular to the main surface of the first slide plate **104**.

[0033] The second spring **112** is provided to the second slide plate **106**. Similar to the first spring **110**, since one terminal of the second spring **112** is also linked to the second slide plate **106** with the slide pin **173**, the second spring **112** is capable of rotating about the axis of the slide pin **173**, i.e., an axis perpendicular to the main surface of the second slide plate **106**.

(3) First Base, Second Base, and Latch

[0034] The first base **130** and the second base **132** are arranged to sandwich the main plate **102** and are secured to each other with a plurality of slide pins **174**, **176**, and **178**. As mentioned above, the main plate **102** is provided with the grooves **102***b* which are arranged so that the slide pins **178** securing the first base **130** and the second base **132** pass therethrough and move vertically. Thus, the first base **130** and the second base **132** are also capable of moving vertically relative to the main plate **102**.

[0035] The other terminal of the second spring **112** is linked to the second base **132** with the slide pin **174**. Meanwhile, the other terminal of the first spring **110** is connected to the first base **130** via the latch **120**. The latch **120** is a part having a function to temporarily fix the positions of the first base **130** and the second base **132** with respect to the main plate **102** and has an L-shape. The other terminal of the first spring **110** is linked to a bent portion of the L-shape of the latch **120** via the slide pin **172**. Furthermore, the main plate **102** is provided with the groove **102***a* so that the slide pin **172** linking the latch **120** and the first spring **110** is able to pass therethrough and move vertically as described above. In addition, the latch **120** is linked to the first base **130** via the slide pin **174** at one terminal (one terminal of the two straight sections connected through the bent portion). Thus, the latch **120** is able to follow the vertical movement of the first base **130** and the second base **132** and move in the vertical direction while rotating about the slide pins **172** and **174** with respect to the first spring **110** and the first base **130**, respectively.

[0036] Note that, as shown in FIG. **3**, at the lower portion of the groove **102***a* for the slide pin **172** linking the first spring **110** and the latch **120** to pass through the main plate **102**, an escape groove **102***d* (see dotted circle) is provided to temporarily secure the slide pin **172**. Hence, the groove **102***a*

is an L-shaped groove with a longitudinal portion of the L-shaped groove arranged parallel to the vertical direction (i.e., the direction in which the first slide plate **104** and the second slide plate **106** slide relative to the main plate **102**), and a lateral portion serves as the escape groove **102***d* temporarily fitting the slide pin **172** when the first base **130** and the second base **132** slide. The position and the size of the escape groove **102***d* are set so that the restoring force of the first spring **110** and the second spring **112** works when the slide pin **172** fits within the escape groove **102***d* and the slide pin **172** does not move in this state.

[0037] Here, the first spring **110** and the second spring **112** are respectively linked to the first slide plate **104** and the second slide plate **106** using the same slide pin **173**. Alternatively, the terminals of the first spring **110** and the second spring **112** at which the first spring **110** and the second spring **112** are respectively linked to the first slide plate **104** and the second slide plate **106** overlap in the y-direction. However, the first spring **110** extends on one hook **140** side while the second spring **112** extends on the other hook **140** side. Therefore, since the vector of the restoring force generated when the first spring **110** and the second spring **112** are extended is in the z-direction or substantially in the z-direction, it is possible to substantially fix the moving directions of the first base **130** and the second base **132** in the vertical direction, allowing stable vertical movement of the first base **130** and the second base **132**.

(4) Hook

[0038] The pair of hooks **140** have a hook shape and are partially sandwiched between the first base **130** and the second base **132**, where one of the slide pins **178** securing the first base **130** and the second base **132** passes through an end portion of one hook **140** and the other slide pin **178** passes through an end portion of the other hook **140** (see FIG. **1**). This configuration allows the pair of hooks **140** to be respectively linked to the first base **130** and the second base **132**. Each hook **140** is further provided with a slide pin **180** for rotation passing through the main plate **102**. The slide pins **178** are arranged in the straight grooves **102***b* extending in the z-direction and provided in the main plate **102**. The slide pins **180** for rotation, on the other hand, are disposed within curved or arc-shaped grooves **102***c* provided in the main plate **102**. The grooves **102***c* are sandwiched between the pair of straight grooves **102***b* and are provided such that the distance therebetween increases as they approach the hanging holes **104***a* and **106***a*. Thus, when the first base **130** and the second base **132** move downward relative to the main plate **102**, the slide pins **180** move along the grooves **102***c*. As a result, the pair of hooks **140** can be rotated about an axis extending in the y-direction relative to the first base **130** and second base **132**, respectively, and closed. Conversely, when the first base **130** and second base **132** are moved upward relative to the main plate **102**, the hooks are rotated in the opposite direction and opened.

(5) Rack, Pinion Gear, and Generator

[0039] The rack **150** is fixed to the first slide plate **104** and extends vertically. The pinion gear **152** engaging with this rack **150** is provided so as to pass through the main plate **102**. As shown in FIG. **1** to FIG. **4**, the generator **160** is fixed to the main plate **102** and has a generator gear **158** for driving. The generator **160** and the generator gear **158** are arranged to sandwich the main plate **102**. The generator gear **158** is linked to the pinion gear **152** directly or via one or a plurality of relay gears **154** and **156**. Hence, the generator **160** is engaged with the rack **150** through the pinion gear **152**. Thus, when the pinion gear **152** rotates due to the vertical movement of the rack **150**, this rotation is transmitted to the generator gear **158** directly or via the relay gears **154** and **156**, the generator gear **158** rotates, and power is generated in the generator **160**. The power generation may be carried out by rotating a magnet using the generator gear **158** in a coil provided in the generator **160** or may be carried out by arranging a plurality of magnets in the generator **160** and rotating a coil between the magnets using the generator gear **158**. Note that although the generator **160** and the pinion gear **152** are arranged on one side of the main plate while the generator gear **158** and the relay gears **154**, **156** are arranged on another side of the main plate in the illustrated example, the arrangement of these elements is not limited to the arrangement described above. Hence, all of the

generator **160**, the pinion gear **152**, the generator gear **158**, and the relay gears **154**, **156** may be arranged on the same side relative to the main plate **102**.

[0040] As will be described below, when the drone rises or falls rapidly during transportation of articles suspended from the hook **140**, the load of the articles on the hook **140** temporarily changes, resulting in vertical movement of the main plate **102** relative to the first slide plate **104** and the second slide plate **106**. Since the rack **150** is fixed to the first slide plate **104** and the pinion gear **152** is connected to the main plate **102**, the relative vertical movement of the main plate **102** relative to the first slide plate **104** and the second slide plate **106** causes the rack **150** to move vertically relative to the pinion gear **152**. This movement causes the pinion gear **152** to rotate, and this rotation is transmitted to the generation gear **158** to generate power in the generator **160**. Since the reaction of the induced electromotive force during the power generation creates a large resistance in the generator gear **158** which creates resistance to the rotation of the pinion gear **152**, resistance to the vertical movement of the rack **150**, i.e., resistance to the vertical movement of the main plate, can be created. In other words, the generator **160** functions as resistance to the vertical movement of the rack **150**, that is, a resistance element resisting the vertical movement of the main plate **102** relative to the first slide plate **104** and the second slide plate **106**. The magnitude of the resistance of the resistance element, i.e., the magnitude of the reaction of the induced electromotive force generated during power generation, can be adjusted by a circuit substrate **162** as appropriate. For example, the amount of current flowing through the coil in the generator **160** may be changed with the circuit substrate **162**.

2. Operation of Hoist Hook and Transporting Method of Articles

(1) Hanging of Articles

[0041] In the initial state, the slide pin **172** passing through the bent portion of the latch **120** is not located in the escape groove **102***d*, but is located in the longitudinal portion of the groove **102***a*. In this state, the latch **120** is pulled upward by the restoring force of the first spring **110** and the second spring **112**. Thus, the first base **130**, the second base **132**, and the hooks **140** linked thereto are also pulled upward, and the hooks **140** remain in an open state (see FIG. **1** to FIG. **4**).

[0042] When hanging articles, the first base **130** and second base **132** are moved downward relative to the main plate **102** so that the slide pin **172** passing through the bent portion of the latch **120** engages with the escape groove **102***d* (FIG. **5** and FIG. **6**). Since the slide pins **180** passing through the grooves **102***c* (see FIG. **1** and FIG. **2**.) move downward through the grooves **102***c* at this time, the hooks **140** are rotated and closed (FIG. **5** and FIG. **6**). Since the slide pin **174** is located at the lowermost portion of the groove **102***f*, the movement of the first base **130** and the second base **132** downward (toward the hook **140** side) with respect to the main plate **102** is restricted. Hereafter, this state is referred to as a standby state. In the standby state, the latch **120** is locked and the hooks **140** remain in the closed state because the slide pin **172** engages with the escape groove **102***d*. In this standby state, the articles can be suspended from the hoist hook **100** by hanging the articles on the hooks **140**. Normally, the full load of the articles is not applied to the hook **140** at this stage because the articles are placed on the ground, floor, or the like.

(2) Takeoff of Drone

[0043] When the drone then takes off and the articles leave the ground or the floor, the hooks **140** are subjected to the full load of the articles. Then the main plate **102** and the latch **120**, in addition to the first base **130** and second base **132** linked to the hooks **140**, move downward relative to the first slide plate **104** and second slide plate **106**. When the slide pin **170** reaches the uppermost portion of the groove **102***g*, the downward movement of the main plate **102** is restricted. The state at this point is called a transport state.

[0044] Here, the first slide plate **104** is configured to temporarily unlock the latch **120** when transitioning from the standby state to the transport state and to lock the latch **120** again in the transport state. Specifically, as shown in FIG. **5** to FIG. **8**, a side surface of the first slide plate **104** may be provided with a protruding portion **102***e* which slides the slide pin **172** in the x-direction

(i.e., along the lateral portion) to shift the slide pin **172** to the longitudinal portion of the groove **102***a* from the escape groove **102***d* while rotating the latch about the slide pin **174** when the latch **120** in the standby state moves downward relative to the first slide plate **104** and which allows the slide pin **172** to engage with the escape groove **102***d* again while rotating the latch **120** backwards when the latch **120** further moves downward. The protruding portion **102***e* is arranged so that the slide pin **172** engages with the escape groove **102***d* and the bent portion of the latch **120** is located above the protruding portion **102***e* in the standby state and that the slide pin **172** engages with the escape groove **102***d* again and the bent portion is located under the protruding portion **102***e* when the main plate **102** moves downward relative to the first slide plate **104** and the second slide plate **106**. The protruding portion **102***e* allows the latch **120** to contact the protruding portion **102***e* and the slide pin **172** to reversibly move between the escape groove **102***d* and the longitudinal portion when the main plate **102** moves vertically relative to the first slide plate **104** and the second slide plate **106**. Therefore, the latch **120** can be locked not only in the standby state but also in the transport state, allowing the hooks **140** to be maintained in a closed state.

(3) Transportation and Release of Articles

[0045] After transitioning to the transport state, the articles are moved by the drone and are transported above a predetermined location. The articles are then slowly lowered to the ground or floor. When the article contacts the ground or floor, the load of the articles on the hooks **140** gradually decreases. As a result, the main plate **102** moves upward relative to the first slide plate **104** and the second slide plate **106** due to the restoring force of the first spring **110** and the second spring **112**. When the load of the articles disappears, the protruding portion **102***e* contacts the latch **120**, and the slide pin **172** moves from the escape groove **102***d* to the longitudinal portion of the groove **102***a* (see FIG. **7**). That is, the latch **120** is unlocked. Then, the slide pin **172** moves upward along the groove **102***a* and returns to the initial state due to the restoring force of the first spring **110** and the second spring **112**, thereby opening the hooks **140**. Therefore, effort to remove the articles from the hoist hook **100** is unnecessary, thereby saving human resources and improving work efficiency related to transportation. Thus, the protruding portion **102***e* expresses a function of locking the latch **120** in the transport state and a function of automatically unlocking and releasing the hooks **140** when the drone lands.

[0046] Here, if the drone suddenly descends during flight due to an unexpected cause such as the effect of air currents or operation error, the load of the articles is instantly lost or rapidly reduced. At this time, if the hoist hook **100** attempts to return to the initial state through the standby state, the hooks **140** open unintentionally, causing the articles to fall. However, in the hoist hook **100**, the upward movement of the main plate **102**, which occurs when the load of the articles is instantaneously lost or rapidly reduced, is strictly restricted by the generator **160** functioning as a resistance against the relative vertical movement of the main plate **102**. That is, the vertical movement is delayed by the generator **160**. Furthermore, when the articles are being transported, the latch **120** is locked to prohibit vertical movement of the latch **120** along the groove **102***a*. Thus, even in the event of a momentary loss or rapid reduction in load, the upward movement of the main plate **102** with respect to the first slide plate **104** and the second slide plate **106** is delayed, and the unintended opening of the hooks **140** caused by the unlocking of the latch **120** is prevented, thereby preventing dropping of articles.

[0047] As described above, the use of the hoist hook **100** according to an embodiment of the present invention prevents the falling of articles caused by air currents or operation errors of the drone when transporting articles using the drone. Furthermore, the cumbersome task of removing the articles from the drone can be eliminated. These features not only save human resources but also contribute to the safe and highly efficient transportation of articles.

[0048] The aforementioned modes described as the embodiments of the present invention can be implemented by appropriately combining with each other as long as no contradiction is caused. Furthermore, any mode which is realized by persons ordinarily skilled in the art through the

appropriate addition, deletion, or design change of elements or through the addition, deletion, or condition change of a process on the basis of each embodiment is included in the scope of the present invention as long as they possess the concept of the present invention.
[0049] It is understood that another effect different from that provided by each of the aforementioned embodiments is achieved by the present invention if the effect is obvious from the description in the specification or readily conceived by persons ordinarily skilled in the art.

Claims

1. A hoist hook comprising: a main plate; a first slide plate and a second slide plate configured to be suspended from a radio-controlled unmanned aircraft, fixed to each other, and configured to slide vertically relative to the main plate while sandwiching the main plate; a first base and a second base fixed to each other and configured to slide vertically relative to the main plate while sandwiching the main plate; a pair of hooks each rotatably linked to the first base and the second base; a generator fixed to the main plate; and a rack linked to the generator and fixed to the first slide plate.
2. The hoist hook according to claim **2**, further comprising a first spring and a second spring, wherein a first terminal of the first spring is fixed to the first slide plate so that the first spring is rotatable relative to the first slide plate, wherein a second terminal of the first spring is connected to the first base, wherein a first terminal of the second spring is fixed to the second slide plate so that the second spring is rotatable relative to the second slide plate, and wherein a second terminal of the second spring is fixed to the second base so that the second spring is rotatable relative to the second base.
3. The hoist hook according to claim 2, further comprising a latch fixed to the first spring and the first base so as to be rotatable relative to the first spring and the first base and configured to slide vertically relative to the main plate.
4. The hoist hook according to claim 3, wherein the second terminal of the first spring is linked to the latch with a first slide pin, wherein the main plate has a L-shaped groove allowing the first slide pin to move while passing therethrough, wherein a longitudinal portion of the L-shaped groove is arranged parallel to a direction in which the first slide plate and the second slide plate slide relative to the main plate, and wherein a lateral portion of the L-shaped groove is configured so that the first slide pin temporarily fits therein when the first slide base and the second base slide.
5. The hoist hook according to claim 4, wherein a side surface of the first slide plate has a protruding portion allowing the first slide pin to reversibly move along the lateral portion when the main plate is moved vertically relative to the first slide plate and the second slide plate.
6. The hoist hook according to claim 1, wherein the generator engages the rack via a pinion gear.
7. The hoist hook according to claim 1, wherein the main plate has a pair of arc-shaped grooves, and wherein a second slide pin and a third slide pin respectively passing through the pair of hooks respectively move along the pair of arc-shaped grooves.
8. The hoist hook according to claim 1, further comprising a circuit substrate fixed to the first base and configured to control characteristics of the generator.
9. A method for transporting an article comprising: suspending an article from a hoist hook; moving the hoist hook using a radio-controlled unmanned aircraft; and releasing the article from the hoist hook, wherein the hoist hook comprises: a main plate; a first slide plate and a second slide plate configured to be suspended from a radio-controlled unmanned aircraft, fixed to each other, and configured to slide vertically relative to the main plate while sandwiching the main plate; a first base and a second base fixed to each other and configured to slide vertically relative to the main plate while sandwiching the main plate; a pair of hooks each rotatably linked to the first base and the second base; a generator fixed to the main plate; and a rack linked to the generator and fixed to the first slide plate.

10. The method according to claim 9, wherein the hoist hook further comprises a first spring and a second spring, wherein a first terminal of the first spring is fixed to the first slide plate so that the first spring is rotatable relative to the first slide plate, wherein a second terminal of the first spring is connected to the first base, wherein a first terminal of the second spring is fixed to the second slide plate so that the second spring is rotatable relative to the second slide plate, and wherein a second terminal of the second spring is fixed to the second base so that the second spring is rotatable relative to the second base.

11. The method according to claim 10, wherein the hoist hook further comprises a latch fixed to the first spring and the first base so as to be rotatable relative to the first spring and the first base and configured to slide vertically relative to the main plate.

12. The method according to claim 11, wherein the second terminal of the first spring is linked to the latch with a first slide pin, wherein the main plate has a L-shaped groove allowing the first slide pin to move while passing therethrough, wherein a longitudinal portion of the L-shaped groove is arranged parallel to a direction in which the first slide plate and the second slide plate slide relative to the main plate, and wherein a lateral portion of the L-shaped groove is configured so that the first slide pin temporarily fits therein when the first slide base and the second base slide.

13. The method according to claim 12, wherein a side surface of the first slide plate has a protruding portion allowing the first slide pin to reversibly move along the lateral portion when the main plate is moved vertically relative to the first slide plate and the second slide plate.

14. The method according to claim 9, wherein the generator engages the rack via a pinion gear.

15. The method according to claim 9, wherein the main plate has a pair of arc-shaped grooves, and wherein a second slide pin and a third slide pin respectively passing through the pair of hooks respectively move along the pair of arc-shaped grooves.

16. The method according to claim 9, wherein the hoist hook further comprises a circuit substrate fixed to the first base and configured to control characteristics of the generator.