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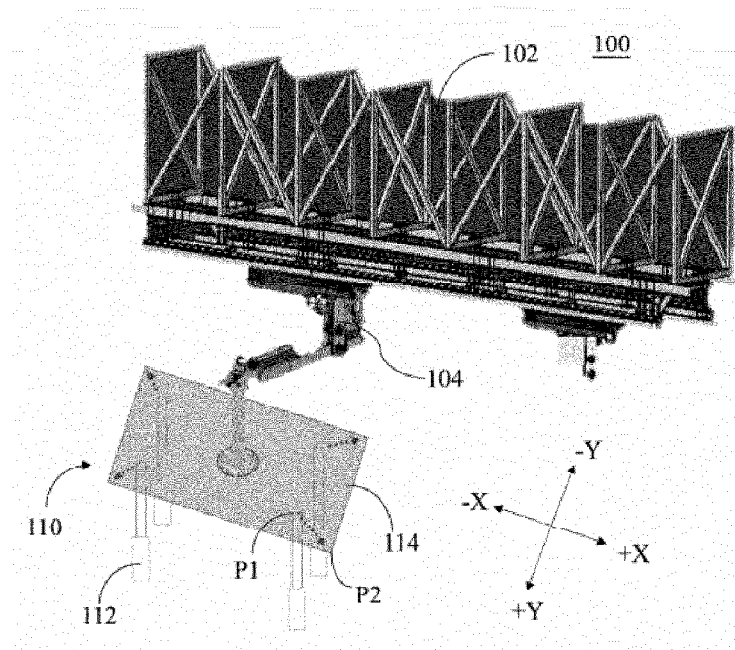


FIG. 2B

(57) Abstract: A threaded member fastening system and method for a battery module is provided according to the present disclosure. The threaded member fastening system is used for fastening the battery module simultaneously with a plurality of threaded fasteners at a plurality of fastening points of the battery module. The systems includes: an actuating mechanism including a plurality of tightening devices, each of the plurality of tightening devices being used for tightening a corresponding one of the plurality of threaded fasteners; a control unit configured for controlling the plurality of tightening devices to simultaneously tighten the plurality of threaded fasteners. The actuating mechanism is configured such that the relative positional relationship of the plurality of tightening devices is variable to allow the actuating mechanism to switch between at least two configurations. The control unit is configured for controlling the actuating mechanism to switch between the at least two configurations. The threaded member fastening method is performed by the threaded



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member fastening system. The threaded member fastening system and method according to the present disclosure can improve the assembly efficiency of the battery module, and can be applied to various battery modules.

THREADED MEMBER FASTENING SYSTEM AND METHOD FOR BATTERY MODULE

RELATED FIELD

[0001] The present disclosure relates to a threaded member fastening system and method, and more particularly to a threaded member fastening system and method for fastening a battery module in a battery pack of an electric vehicle.

BACKGROUND

[0002] At present, with the rapid development and the rapid increase in production capacity of electric vehicles, the requirements for the assembly line of electric vehicles are getting higher and higher. In particular, as shown in FIG. 1, the core of a power system of an electric vehicle is battery packs 1, and the battery pack 1 generally has multiple (for example, more than ten) battery modules 2. Each battery module 2 has multiple fastening points 3 to be fastened to a case 4 of the battery pack 1 by means of multiple bolts. In other words, there may be dozens of fastening points 3 of the battery modules 2 in one battery pack 1.

[0003] In the present assembly line of electric vehicles, bolts at the fastening points 3 are generally tightened one by one by a nutrunner 5 as shown in FIG. 1. This assembly method is time-consuming and inefficient. Moreover, tightening the bolts one by one tends to cause the position of the battery module 2 to deviate from a predetermined position during the assembly process. In addition, a heat conductive pad is generally provided between the bottom of the battery module 2 and the bottom plate of the case of the battery pack 1, and the heat conductive pad needs to be compressed by a predetermined amount to obtain good thermal conductivity. The amount of compression of the heat conductive pad depends on the distance between the bottom of the battery module 2 and the bottom plate of the case of the battery pack 1. Tightening the bolts one by one tends to cause inconsistent distances between the bottom of the battery module 2 and the bottom plate of the case of the battery pack 1 at the fastening points 3, which in turn causes the amount of compression of the heat conductive pad at the fastening points 3 to be inconsistent and deviate from a predetermined value, adversely affecting the heat conducting effect.

SUMMARY

[0004] An object of the present disclosure is to solve the above-mentioned problems in the prior art, and to propose an improved threaded member fastening system and method for a battery module.

[0005] According to a first aspect of the present disclosure, a threaded member fastening system for a battery module is provided. The threaded member fastening system is used for fastening the battery module simultaneously with a plurality of threaded fasteners at a plurality of fastening points of the battery module, wherein the threaded member fastening system comprises: an actuating mechanism comprising a plurality of tightening devices, wherein each of the plurality of tightening devices is used for tightening a corresponding one of the plurality of threaded fasteners; a control unit configured for controlling the plurality of tightening devices to simultaneously tighten the plurality of threaded fasteners; wherein the actuating mechanism is configured such that the relative positional relationship of the plurality of tightening devices is variable to allow the actuating mechanism to switch between at least two configurations, and the control unit is configured for controlling the actuating mechanism to switch between the at least two configurations.

[0006] With the actuating mechanism having the plurality of tightening devices and switchable configurations, the threaded member fastening system according to the first aspect of the present disclosure can simultaneously tighten the plurality of threaded fasteners at the plurality of fastening points of the battery module for various battery modules with different fastening-point arrangements.

[0007] According to the above technical concept, the first aspect of the present disclosure may further include one or more of the following optional forms.

[0008] In some optional forms, the actuating mechanism comprises a base, and the plurality of tightening devices are provided on the base and are movable relative to the base to allow the actuating mechanism to switch between the at least two configurations.

[0009] In some optional forms, the threaded member fastening system further comprises a detection unit communicating with the control unit, and the detection unit is configured for collecting information related to the positions of the plurality of fastening points; wherein the control unit is configured for determining whether a required configuration of the actuating

mechanism is identical to a current configuration of the actuating mechanism based on the information collected by the detection unit, and the control unit controls the actuating mechanism to switch to the required configuration in response to a determination result being no. By means of the detection unit, the threaded member fastening system can automatically switch the configuration of the actuating mechanism.

[0010] In some optional forms, the detection unit is a camera.

[0011] In some optional forms, the detection unit is provided on the actuating mechanism for facilitating collecting the information related to the positions of the plurality of fastening points.

[0012] In some optional forms, the threaded member fastening system further comprises an input unit communicating with the control unit, and the input unit is configured for generating a switching signal in response to user input; wherein the control unit is configured for controlling the actuating mechanism to switch to a required configuration based on the switching signal from the input unit. By means of the input unit, switching of configuration of the actuating mechanism can be controlled by user operation.

[0013] In some optional forms, the control unit is configured for controlling the plurality of tightening devices to simultaneously tighten the plurality of threaded fasteners at the same speed, stroke and/or torque, so as to simultaneously tighten the plurality of threaded fasteners to the same degree of tightening.

[0014] In some optional forms, the threaded member fastening system further comprises a mechanical arm, and the actuating mechanism is provided at a distal end of the mechanical arm.

[0015] According to a second aspect of the present disclosure, a threaded member fastening method for a battery module is provided. The threaded member fastening method is performed by means of the threaded member fastening system according to the first aspect of the present disclosure. The threaded member fastening method comprises: providing an actuating mechanism and a control unit; and controlling a plurality of tightening devices of the actuating mechanism by the control unit to simultaneously tighten a plurality of threaded fasteners at a plurality of fastening points of the battery module.

[0016] According to the above technical concept, the second aspect of the present disclosure may further include one or more of the following optional forms.

[0017] In some optional forms, the control unit controls the plurality of tightening devices to simultaneously tighten the plurality of threaded fasteners at the same speed, stroke, and/or torque.

[0018] In some optional forms, the threaded member fastening method further comprises controlling the actuating mechanism by the control unit to switch to a required configuration.

[0019] In some optional forms, the threaded member fastening method further comprises providing a detection unit communicating with the control unit; collecting information related to the positions of the plurality of fastening points by the detection unit; determining by the control unit whether a required configuration of the actuating mechanism is identical to a current configuration of the actuating mechanism based on the information collected by the detection unit, and controlling the actuating mechanism by the control unit to switch to the required configuration in response to a determination result being no.

[0020] In some optional forms, the threaded member fastening method further comprises providing an input unit communicating with the control unit; generating a switching signal by the input unit in response to user input; and controlling the actuating mechanism by the control unit to switch to a required configuration based on the switching signal from the input unit.

[0021] With the threaded member fastening system and method for a battery module according to the present disclosure, the plurality of threaded fasteners at the plurality of fastening points of the battery module is simultaneously tightened, the battery module is quickly fastened, and the assembly efficiency is improved, avoiding the position of the battery module deviating from the predetermined position caused by tightening the bolts one by one, and better ensuring that the tightening degree of the plurality of threaded fasteners at the plurality of fastening points is consistent. Moreover, with the threaded member fastening system and method for a battery module according to the present disclosure, different configurations are switched for battery modules with different fastening-point arrangements (for example, battery modules with different dimensions) to achieve simultaneous alignment and tightening of the plurality of fastening points, increasing the flexibility of the production line of battery modules and reducing production costs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Other features and advantages of the present disclosure will be readily understood

through the following preferred embodiments described in detail with reference to the accompanying drawings, in which the same reference numerals indicate the same or similar components.

[0023] FIG. 1 is a schematic view of a fastening method for a battery module in the prior art;

[0024] FIG. 2A is a schematic structural view of a threaded member fastening system for a battery module according to an exemplary embodiment of the present disclosure, which shows the main components of the threaded member fastening system;

[0025] FIG. 2B is a schematic perspective view of one example of the threaded member fastening system of FIG. 2A;

[0026] FIG. 3 is a flow chart of a threaded member fastening method for a battery module according to an exemplary embodiment of the present disclosure;

[0027] FIG. 4A is a schematic structural view of a threaded member fastening system for a battery module according to another exemplary embodiment of the present disclosure, which shows the main components of the threaded member fastening system;

[0028] FIG. 4B is a flow chart of a threaded member fastening method for a battery module according to another exemplary embodiment of the present disclosure;

[0029] FIG. 5 is a schematic cross-sectional view at a fastening point of a battery module to which a threaded member fastening system for a battery module according to an exemplary embodiment of the present disclosure can be applied; and

[0030] FIG. 6A and FIG. 6B respectively show schematic plan views of different battery modules to which a threaded member fastening system for a battery module according to an exemplary embodiment of the present disclosure can be applied.

DETAILED DESCRIPTION

[0031] The present disclosure will be further described below with reference to the accompanying drawings so that those skilled in the art can fully understand the present disclosure. However, it should be understood that the present disclosure is not limited to the embodiments disclosed below. It should be understood that these embodiments are discussed only to enable those skilled in the art to better understand and further realize the subject matter

described in the present disclosure, rather than to impose any limit on the scope of protection, applicability, or examples set forth in the appended claims. Modifications may be made to the functions and arrangements of the modules and units discussed herein without departing from the scope of the present disclosure. Further, various modules or units may be omitted, substituted, or added in various embodiments as needed. In addition, features described in some embodiments can also be combined in other embodiments. When describing structures and positions of components, the direction-related expressions herein, such as "upper", "lower", "top", and "bottom", are not absolute, but relative. When the components are arranged as shown in the drawings, these direction-related expressions are appropriate, but when the positions of these components in the drawings are altered, these direction-related expressions should be altered accordingly.

[0032] FIG. 2A and FIG. 2B schematically show a threaded member fastening system 100 for a battery module according to an exemplary embodiment of the present disclosure. FIGS. 5 to 6B schematically show the structure of battery modules 10 (battery modules 10a and 10b may be collectively referred to as the battery modules 10) and the structure at a fastening point 12 (fastening points 12a and 12b may be collectively referred to as the fastening points 12) of the battery module 10. The threaded member fastening system 100 can be applied to the battery module 10.

[0033] Referring to FIG. 2A, FIG. 2B, and FIG. 5 to FIG. 6B, the threaded member fastening system 100 is used for fastening the battery module 10 simultaneously with a plurality of threaded fasteners 14 at a plurality of fastening points 12 of the battery module 10, so as to fix the battery module 10 in a battery pack 20. The threaded member fastening system 100 may be a semi-automatic system, and the user can cooperate with the threaded member fastening system 100 to complete the fastening of the battery module 10, which will be described in detail below.

[0034] The threaded member fastening system 100 may include an actuating mechanism 110 and a control unit 120. The actuating mechanism 110 may include a plurality of tightening devices 112, and each of the plurality of tightening devices 112 is used for tightening a corresponding one of the plurality of threaded fasteners 14. The control unit 120 is configured for controlling the plurality of tightening devices 112 to simultaneously tighten the plurality of threaded fasteners 14 at the plurality of fastening points 12 of the battery module 10. The actuating mechanism 110 is configured such that the relative positional relationship of the

plurality of tightening devices 112 is variable to allow the actuating mechanism 110 to switch between at least two configurations, and the control unit 120 is configured for controlling the actuating mechanism 110 to switch between the at least two configurations.

[0035] In the embodiment shown in FIG. 2B, the threaded member fastening system 100 further includes a truss 102 and a mechanical arm 104 mounted on the truss 102. The actuating mechanism 110 may be provided at a distal end of the mechanical arm 104. The actuating mechanism 110 may include a base 114. In the illustrated embodiment, the base 114 may be substantially plate-shaped, and the plurality of tightening devices 112 may be substantially perpendicular to the base 114. The base 114 may be in the form of a rectangular plate. It is conceivable that the base 114 may also be in any other suitable regular or irregular form, such as in the form of an oval plate, or in the form of a block. The tightening device 112 may have a working principle and configuration similar to, for example, a conventional bolt tightening tool, but be further provided with a mounting structure for mounting it to the base 114.

[0036] In the illustrated embodiment, the actuating mechanism 110 may include four tightening devices 112 distributed on the four corners of the rectangular base 114. These four tightening devices 112 can be used, for example, for fastening the battery modules 10a and 10b shown in FIGS. 6A and 6B. The battery modules 10a and 10b each has four fastening points 12a and 12b distributed at the four corners of its rectangular outer periphery, respectively. Accordingly, each of the battery modules 10a and 10b requires four threaded fasteners 14 for tightening, and each of the four tightening devices 112 of the actuating mechanism 110 is used for tightening a corresponding one of the four threaded fasteners 14. It will be appreciated that the above-mentioned battery modules 10a and 10b are only exemplary, and are not intended to limit the configuration of the battery module to which the threaded member fastening system 100 is applied. In addition, the actuating mechanism 110 may have any other suitable number of tightening devices 112, and the number of the tightening devices 112 may be determined according to the number of fastening points of the battery module to be fastened.

[0037] With reference to FIG. 5, each fastening point 12 of the battery module 10 may be in the form of a boss and include a receiving passage 16 (shown as 16a and 16b in FIGS. 6A and 6B) for receiving a corresponding one of the threaded fasteners 14. The threaded fasteners 14 may be members with threads for fastening, such as bolts, studs and screws. The battery pack 20 has a fastening tab 24 adjacent to a case bottom plate 22. A nut 26 may be welded to the

fastening tab 24. In the illustrated embodiment, the nut 26 is welded to a lower side of the fastening tab 24.

[0038] Referring to FIGS. 2A and 2B, the control unit 120 may be coupled to the actuating mechanism 110. The control unit 120 is configured for controlling the plurality of tightening devices 112 of the actuating mechanism 110 to simultaneously tighten the plurality of threaded fasteners 14 at the plurality of fastening points 12 of the battery module 10 at the same speed, stroke and/or torque, so as to simultaneously tighten the plurality of threaded fasteners 14 to the same degree of tightening.

[0039] Referring to FIG. 2B, in the illustrated embodiment, the plurality of tightening devices 112 of the actuating mechanism 110 is movable along an extension plane (XY plane in the figure) of the plate-shaped base 114, so that the relative positional relationship (for example, the distances between the plurality of tightening devices 112) of the plurality of tightening devices 112 is variable (that is, the actuating mechanism 110 can be switched between different configurations), so as to adapt to different fastening-point arrangements of different battery modules. Optionally, each tightening device 112 may be arranged on the base 114 to be movable in a linear direction to move linearly, for example, from position P1 to position P2 (as shown by the dotted line in the figure). It is conceivable that each tightening device 112 may also be arranged on the base 114 to be movable in the +X direction, the -X direction, the +Y direction, and the -Y direction, so as to realize a relatively flexible position change of each tightening device 112 in the XY plane.

[0040] Therefore, for the battery modules 10 with different arrangements of the fastening points 12 (for example, different distances between the plurality of fastening points 12), the actuating mechanism 110 can be switched between different configurations, so that the plurality of tightening devices 112 of the actuating mechanism 110 can be simultaneously aligned with the corresponding plurality of fastening points 12 of the battery module 10, so as to perform the tightening operation simultaneously at the plurality of fastening points 12. Herein, for a specific model of a battery module 10, the following configuration of the actuating mechanism 110 is referred to as a required configuration of the actuating mechanism 110: this configuration allows the plurality of tightening devices 112 of the actuating mechanism 110 to be simultaneously aligned with the corresponding plurality of fastening points 12 of the battery module 10, so as to simultaneously perform the tightening operation at the plurality of fastening points 12.

[0041] Referring to FIGS. 6A and 6B, as previously described, the battery module 10a of FIG. 6A has four fastening points 12a distributed at its four corners. Similarly, the battery module 10b of FIG. 6B has four fastening points 12b distributed at its four corners. The battery module 10a and the battery module 10b have different dimensions, so the relative positional relationships between the fastening points 12a at the corners of the battery module 10a and between the fastening points 12b at the corners of the battery module 10b are different. Specifically, the distances between the fastening points 12a and the distances between the fastening points 12b are different. Accordingly, the required configurations of the actuating mechanism 110 vary for the battery module 10a and the battery module 10b. The actuating mechanism 110 can be switched to the required configuration by moving the four tightening devices 112 relative to each other, for example, by changing the positions of at least three of the four tightening devices 112 in the XY plane.

[0042] Referring to FIG. 2A, the threaded member fastening system 100 may further include an input unit 130 communicating with the control unit 120. The input unit 130 is configured to generate an input signal in response to a user input. The input unit 130 may be, for example, a button, a touch panel, a touch screen, an operation lever, or the like, for the user to operate. For example, in the case where the input unit 130 is a button, the user input may be a pressing action; and in the case where the input unit 130 is a touch panel, the user input may be a touch operation. The input signal generated by the input unit 130 may be a switching signal or an execution signal in response to different user inputs. The control unit 120 may control the actuating mechanism 110 to switch to the required configuration in response to the switching signal from the input unit 130. The control unit 120 may control the plurality of tightening devices 112 to simultaneously tighten the plurality of threaded fasteners 14 in response to the execution signal from the input unit 130.

[0043] Referring to FIGS. 2A and 3, a method for fastening the battery module 10 by means of the threaded member fastening system 100 is described below.

[0044] First, an actuating mechanism 110, a control unit 120 and an input unit 130 are provided. Then, an input signal is generated by the input unit 130 in response to a user input. The user can determine by himself whether the current configuration of the actuating mechanism 110 is the required configuration of the actuating mechanism 110 according to the model of the battery module 10. If the determination result is no, the user can perform an input for instructing switch of the configuration of the actuating mechanism 110 through the input

unit 130, so that the input unit 130 can generate the switching signal, and the control unit 120 can further control the actuating mechanism 110 to switch to the required configuration in response to the switching signal from the input unit 130. After the actuating mechanism 110 has been switched to the required configuration, the user can further perform an input for instructing the execution of tightening through the input unit 130, so that the input unit 130 generates an execution signal, and then the control unit 120 controls the plurality of tightening devices 112 to simultaneously tighten the plurality of threaded fasteners 14 in response to the execution signal from the input unit 130. If the determination result is yes, the user can directly perform an input for instructing the execution of tightening through the input unit 130, so that the plurality of tightening devices 112 can simultaneously tighten the plurality of threaded fasteners 14. The control unit 120 controls the plurality of tightening devices 112 to simultaneously tighten the plurality of threaded fasteners 14 at the same speed, stroke and/or torque, so as to simultaneously tighten the plurality of threaded fasteners 14 to the same degree of tightening. Furthermore, after the actuating mechanism 110 has the required configuration and before the plurality of threaded fasteners 14 at the plurality of fastening points 12 of the battery module 10 are tightened, the plurality of tightening devices 112 may be manually aligned with the plurality of threaded fasteners 14.

[0045] Referring to FIGS. 2B and 5, the process of mounting the battery module by means of the threaded member fastening system 100 is described below.

[0046] When mounting the battery module 10, a heat conductive pad 30 may be firstly laid on the case bottom plate 22 of the battery pack 20 (in the case where the heat conductive pad is required). Then, the battery module 10 is placed on the heat conductive pad 30, and the receiving passage 16 of respective fastening point 12 is aligned with a threaded hole of the corresponding nut 26. At this time, a certain gap exists between the bottom surface of the respective fastening point 12 of the battery module 10 and the upper surface of the fastening tab 24. Then, the plurality of threaded fasteners 14 are passed through the receiving passages 16 of the plurality of fastening points 12, respectively. Then, the plurality of threaded fasteners 14 at the plurality of fastening points 12 of the battery module 10 are simultaneously tightened by the threaded member fastening system 100 through the above-mentioned threaded member fastening method, so as to fix the battery module 10 in the battery pack 20.

[0047] It is conceivable that, by controlling the tightening degree of the plurality of threaded fasteners 14, the gap between the bottom surface of the plurality of fastening points 12 of the

battery module 10 and the upper surface of the fastening tab 24 can be adjusted, and the distance between the bottom of the battery module 10 and the case bottom plate 22 of the battery pack 20 can be further adjusted, so as to adjust the compression amount of the heat conductive pad 30. By simultaneously tightening the plurality of threaded fasteners 14 at the plurality of fastening points 12 of the battery module 10 as described above, it can be avoided that the position of the battery module 10 deviates from the predetermined position, which might otherwise be caused by tightening the bolts one by one. In addition, by simultaneously tightening the plurality of threaded fasteners 14, it can be well ensured that the tightening degree of the plurality of threaded fasteners 14 at the plurality of fastening points 12 is consistent, thereby ensuring that the heat conductive pad 30 has a uniform compression amount, and therefore obtaining a good heat conducting effect.

[0048] FIG. 4A shows a threaded member fastening system 200 for the battery module 10 according to another embodiment of the present disclosure, which shows the main components of the threaded member fastening system 200. The main difference between the threaded member fastening system 200 and the aforementioned threaded member fastening system 100 is that the threaded member fastening system 200 is a fully automatic system and includes a detection unit 240. The main differences between the threaded member fastening system 100 and the threaded member fastening system 200 will be described below, and the similarities therebetween will not be repeated.

[0049] Referring to FIG. 4A to FIG. 5, the threaded member fastening system 200 is used for fastening the battery module 10 simultaneously with a plurality of threaded fasteners 14 at a plurality of fastening points 12 of the battery module 10. The threaded member fastening system 200 mainly includes an actuating mechanism 210, a control unit 220, and a detection unit 240.

[0050] The threaded member fastening system 200 may be integrated, for example, on a mobile industrial robot (not shown). The industrial robot may include a mechanical arm (not shown) and the control unit 220. The actuating mechanism 210 may be provided at a distal end of the mechanical arm. The detection unit 240 may be arranged on the actuating mechanism 210 or may be arranged at other parts of the industrial robot.

[0051] The actuating mechanism 210 may include a plurality of tightening devices (not shown), and each of the plurality of tightening devices is used for tightening a corresponding one of the plurality of threaded fasteners 14. The control unit 220 is configured for controlling

the plurality of tightening devices to simultaneously tighten the plurality of threaded fasteners 14 at the plurality of fastening points 12 of the battery module 10. The actuating mechanism 210 is configured such that the relative positional relationship of the plurality of tightening devices is variable to allow the actuating mechanism 210 to switch between at least two configurations, and the control unit 220 is configured for controlling the actuating mechanism 210 to switch between the at least two configurations.

[0052] The detection unit 240 can communicate with the control unit 220. The detection unit 240 may be configured to collect information related to the positions of the plurality of fastening points 12. The control unit 220 can determine whether the required configuration of the actuating mechanism 210 is identical to a current configuration of the actuating mechanism 210 based on the information collected by the detection unit 240, and the control unit 220 controls the actuating mechanism 210 to switch to the required configuration in response to a determination result being no. Optionally, the detection unit 240 may be a device such as a camera, a three-dimensional scanner, etc., which can acquire information related to the positions of the plurality of fastening points 12 of the battery module 10. It is conceivable that, for the battery modules 10a and 10b shown in FIG. 6A and FIG. 6B, since the fastening points 12a and 12b are disposed on the outer periphery of the battery module 10, the positions of the fastening points 12a and 12b are closely related to the dimensions of the battery modules 10a and 10b, the dimension information of the battery modules 10a and 10b can be obtained through the detection unit 240 and the information related to the positions of the fastening points 12a and 12b of the battery pack can be further obtained. It is conceivable that, the position information of the fastening points 12a and 12b of the battery modules 10a and 10b can also be directly obtained through the detection unit 240, for example, the position information of the fastening points 12a and 12b of the battery modules 10a and 10b can be directly obtained by identifying the fastening points 12a and 12b.

[0053] Referring to FIGS. 4A and 4B, a method for fastening the battery module 10 by means of the threaded member fastening system 200 is described below. First, an industrial robot integrating the actuating mechanism 210, the control unit 220 and the detection unit 240 is provided. Then, the industrial robot collects information related to the positions of the plurality of fastening points 12 through the detection unit 240 by itself, and determines by means of the control unit 220 whether the required configuration of the actuating mechanism 210 is identical to the current configuration of the actuating mechanism 210 based on the information collected by the detection unit 240. In response to the determination result being

no, the industrial robot controls the actuating mechanism 210 by means of the control unit 220 to switch to the required configuration. After the actuating mechanism 210 is switched to the required configuration, the industrial robot controls the plurality of tightening devices by means of the control unit 220 to simultaneously tighten the plurality of threaded fasteners 14. In response to the determination result being yes, the industrial robot directly controls the plurality of tightening devices by means of the control unit 220 to simultaneously tighten the plurality of threaded fasteners 14. Furthermore, after the actuating mechanism 210 has the required configuration and before the plurality of threaded fasteners 14 at the plurality of fastening points 12 of the battery module 10 are tightened, the plurality of tightening devices 112 may be automatically aligned with the plurality of threaded fasteners 14 by the industrial robot.

[0054] It should be understood that the above embodiments only illustrate the optional shape, size and arrangement of each optional component of the threaded member fastening system according to the present disclosure. However, these embodiments are merely intended to illustrate, rather than limit. Other shapes, sizes and arrangements may be adopted without departing from the idea and scope of the present disclosure. Furthermore, not all the activities of the threaded member fastening method according to the present disclosure described above in the general description or in the embodiments are not necessary. Specifically, some of the activities may not be necessary, and one or more additional activities may be performed in addition to the activities described. Further, the sequence in which the activities are listed is not necessarily the sequence in which they are performed.

[0055] The technical contents and technical features of the present disclosure have been disclosed above. However, it can be understood that, those skilled in the art can make various changes and improvements to the above-disclosed concept under the creative concept of the present disclosure, and all these various changes and improvements still fall within the protection scope of the present disclosure. The description of the foregoing embodiments is exemplary rather than restrictive, and the protection scope of the present disclosure is determined by the appended claims.

CLAIMS

1. A threaded member fastening system for a battery module, wherein the threaded member fastening system is used for fastening the battery module simultaneously with a plurality of threaded fasteners at a plurality of fastening points of the battery module, wherein the threaded member fastening system comprises:

an actuating mechanism comprising a plurality of tightening devices, each of the plurality of tightening devices being used for tightening a corresponding one of the plurality of threaded fasteners;

a control unit configured for controlling the plurality of tightening devices to simultaneously tighten the plurality of threaded fasteners;

wherein the actuating mechanism is configured such that the relative positional relationship of the plurality of tightening devices is variable to allow the actuating mechanism to switch between at least two configurations, and the control unit is configured for controlling the actuating mechanism to switch between the at least two configurations.

2. The threaded member fastening system for a battery module according to claim 1, wherein the actuating mechanism comprises a base, and the plurality of tightening devices are provided on the base and are movable relative to the base to allow the actuating mechanism to switch between the at least two configurations.

3. The threaded member fastening system for a battery module according to claim 1 or 2, wherein the threaded member fastening system further comprises a detection unit communicating with the control unit, and the detection unit is configured for collecting information related to the positions of the plurality of fastening points;

wherein the control unit is configured for determining whether a required configuration of the actuating mechanism is identical to a current configuration of the actuating mechanism based on the information collected by the detection unit, and the control unit controls the actuating mechanism to switch to the required configuration in response to a determination result being no.

4. The threaded member fastening system for a battery module according to claim 3, wherein the detection unit is a camera.

5. The threaded member fastening system for a battery module according to claim 3, wherein the detection unit is provided on the actuating mechanism.

6. The threaded member fastening system for a battery module according to claim 1 or 2, wherein the threaded member fastening system further comprises an input unit communicating with the control unit, and the input unit is configured for generating a switching signal in response to a user input;

wherein the control unit is configured for controlling the actuating mechanism to switch to a required configuration based on the switching signal from the input unit.

7. The threaded member fastening system for a battery module according to claim 1 or 2, wherein the control unit is configured for controlling the plurality of tightening devices to simultaneously tighten the plurality of threaded fasteners at the same speed, stroke and/or torque.

8. The threaded member fastening system for a battery module according to claim 1 or 2, wherein the threaded member fastening system further comprises a mechanical arm, and the actuating mechanism is provided at a distal end of the mechanical arm.

9. A threaded member fastening method for a battery module performed by means of a threaded member fastening system according to any one of claims 1-8, comprising:

providing an actuating mechanism and a control unit;

controlling a plurality of tightening devices of the actuating mechanism by the control unit to simultaneously tighten a plurality of threaded fasteners at a plurality of fastening points of the battery module.

10. The threaded member fastening method for a battery module according to claim 9, wherein the control unit controls the plurality of tightening devices to simultaneously tighten the plurality of threaded fasteners at the same speed, stroke, and/or torque.

11. The threaded member fastening method for a battery module according to claim 9 or 10, further comprising: controlling the actuating mechanism by the control unit to switch to a required configuration.

12. The threaded member fastening method for a battery module according to claim 11, further comprising:

providing a detection unit communicating with the control unit;

collecting information related to the positions of the plurality of fastening points by the detection unit;

determining by the control unit whether a required configuration of the actuating mechanism is identical to a current configuration of the actuating mechanism based on the information collected by the detection unit, and controlling the actuating mechanism by the control unit to switch to the required configuration in response to a determination result being no.

13. The threaded member fastening method for a battery module according to claim 11, further comprising:

providing an input unit communicating with the control unit;

generating a switching signal by the input unit in response to a user input;

controlling the actuating mechanism by the control unit to switch to a required configuration based on the switching signal from the input unit.

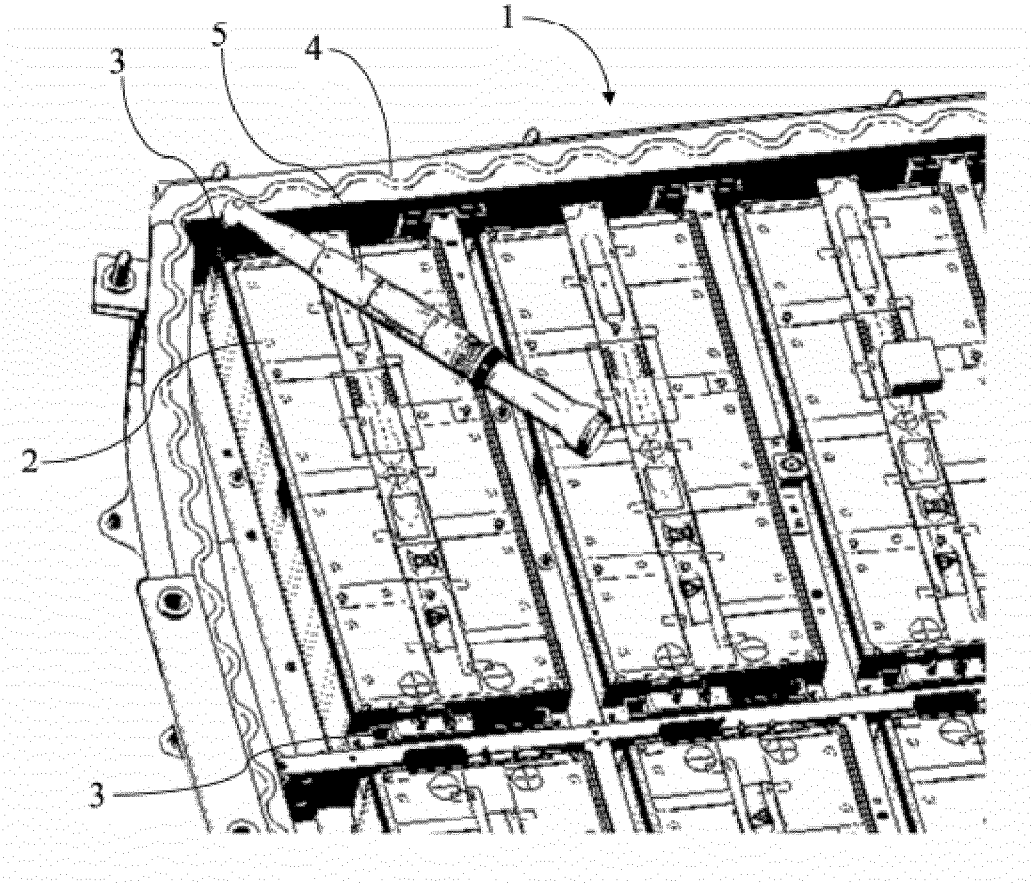


FIG. 1

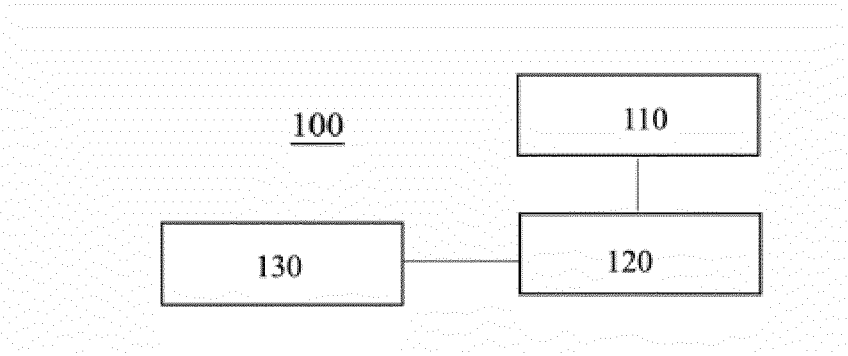


FIG. 2A

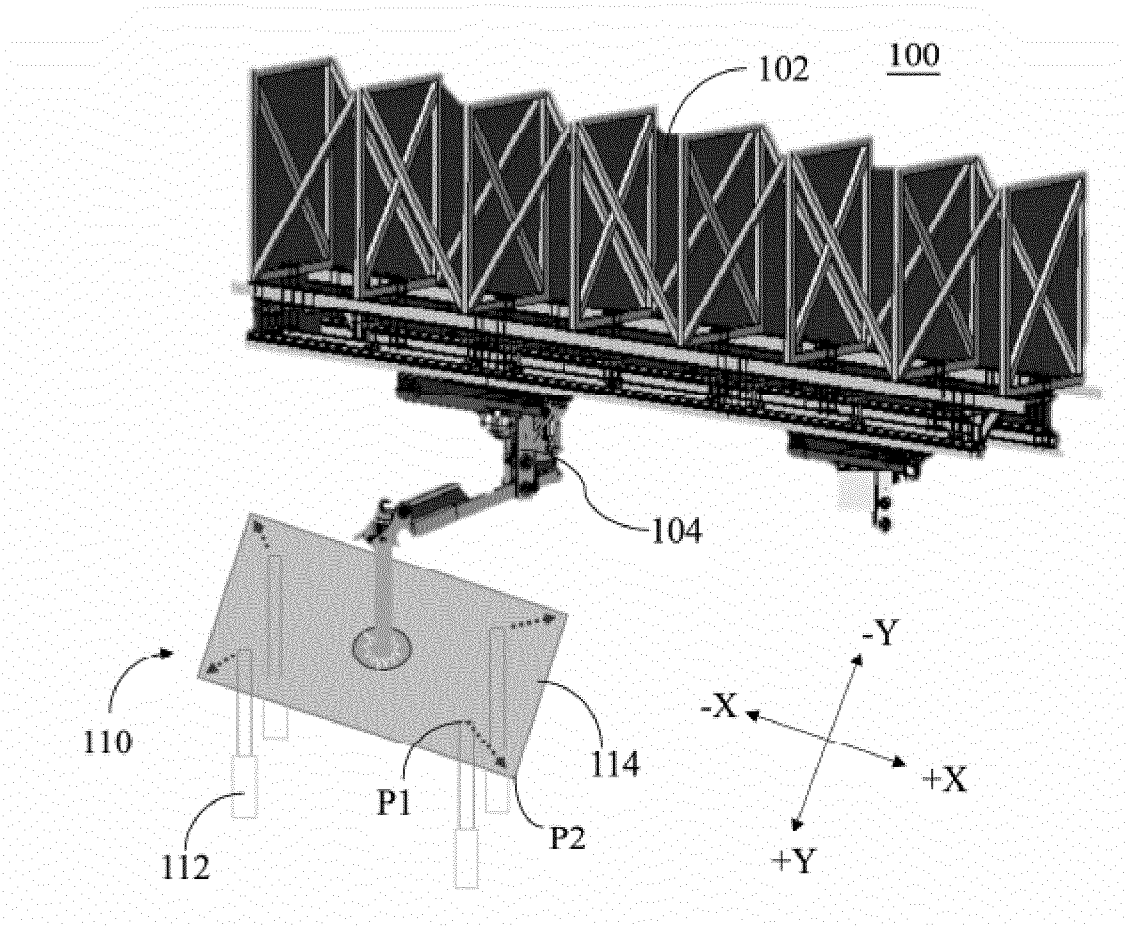


FIG. 2B

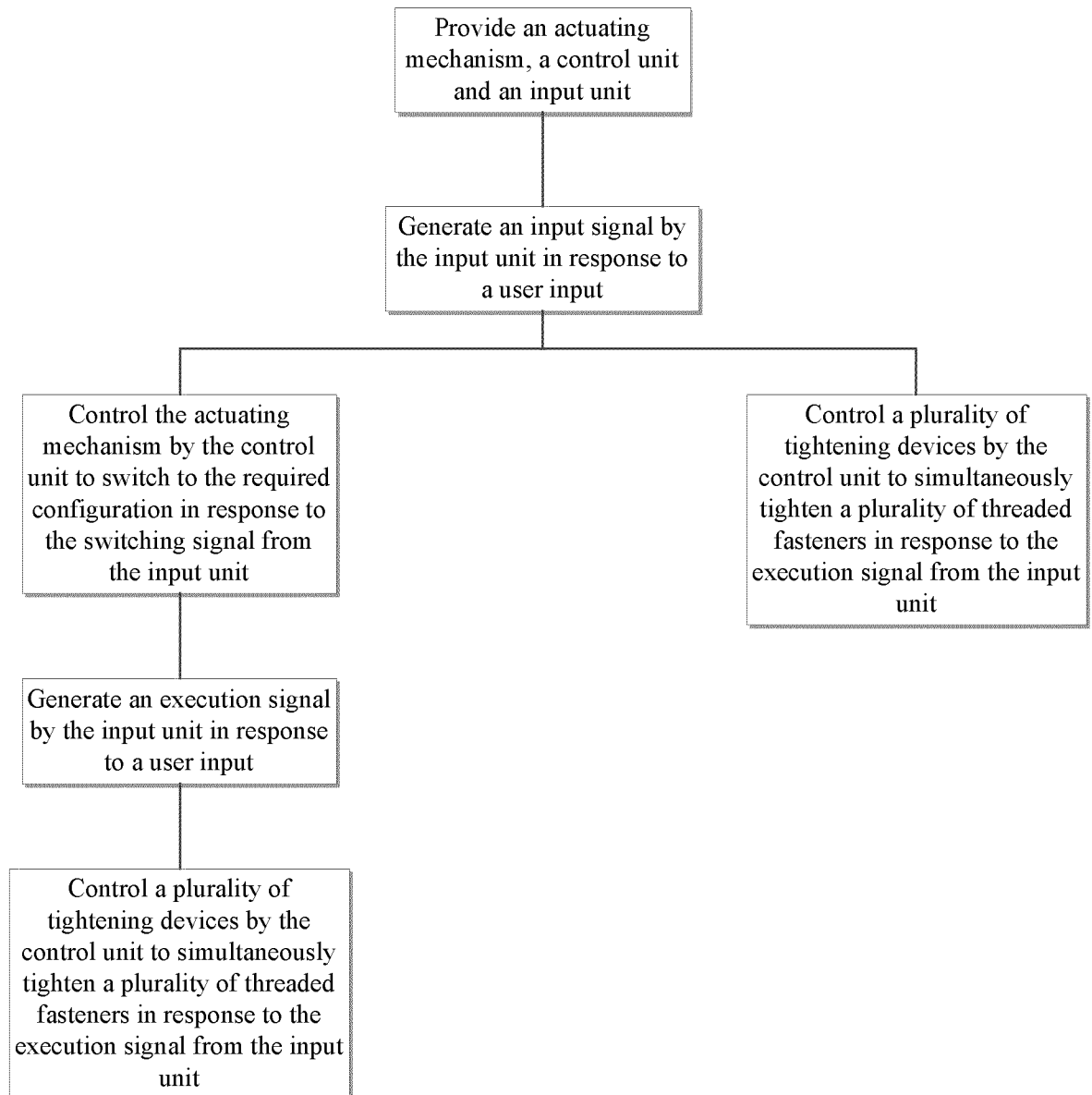
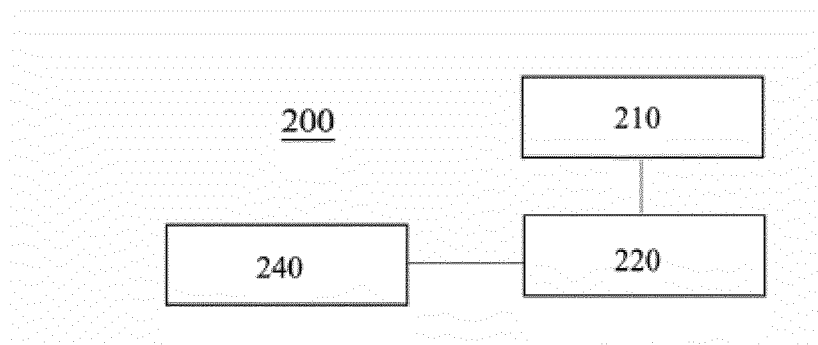
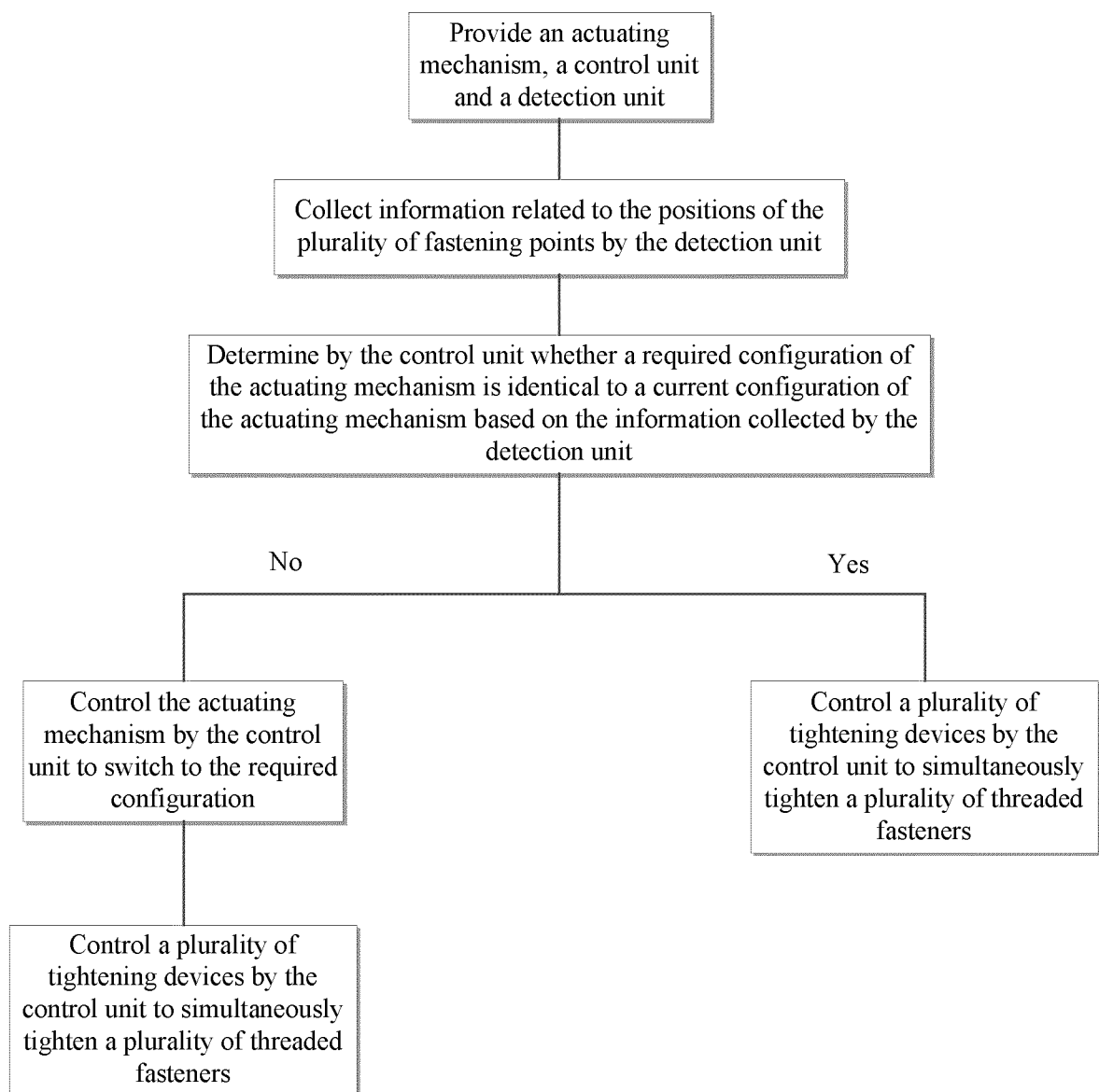


FIG. 3

**FIG. 4A****FIG. 4B**

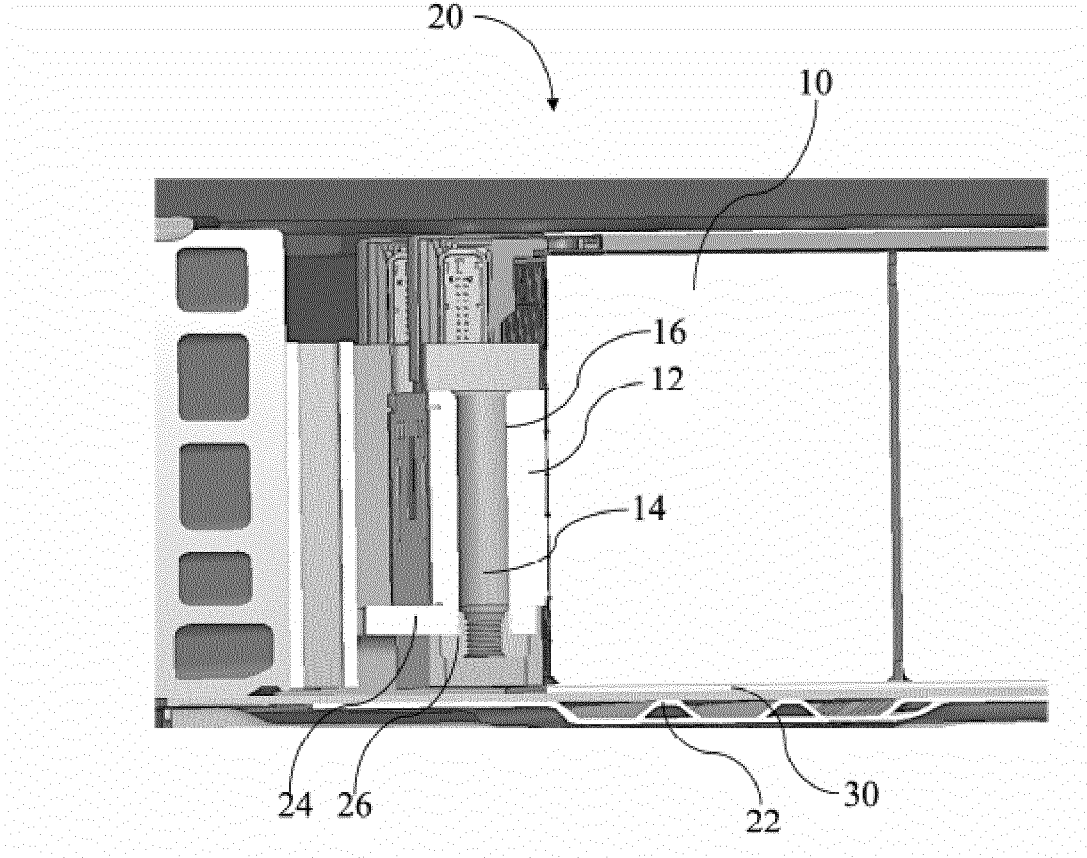


FIG. 5

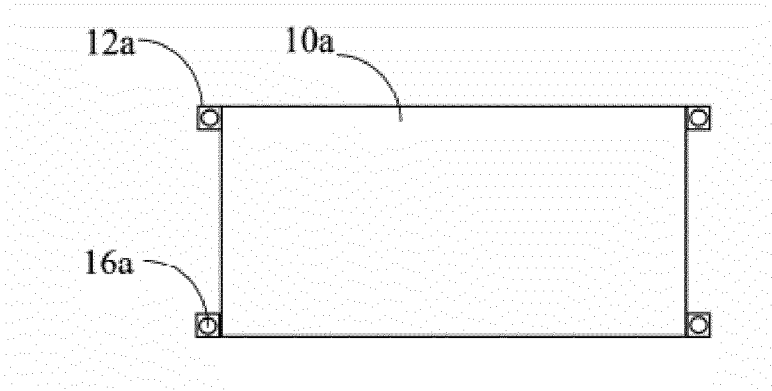


FIG. 6A

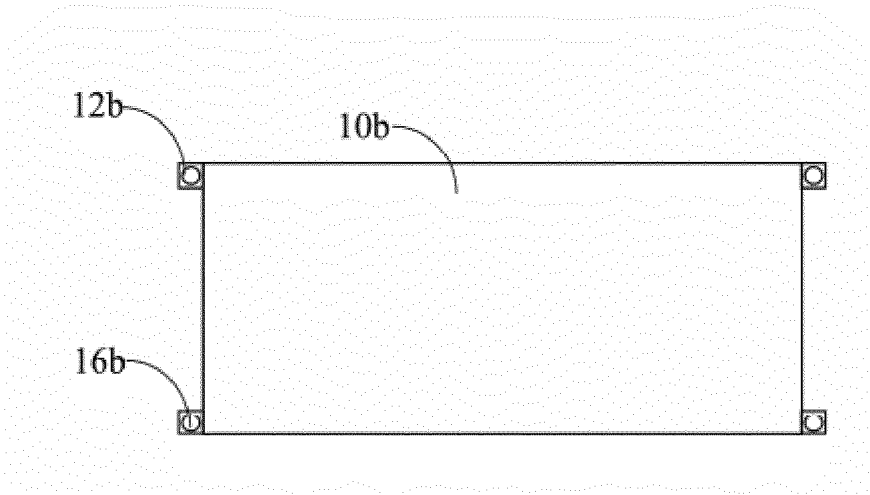


FIG. 6B

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/065062

A. CLASSIFICATION OF SUBJECT MATTER		
INV. H01M50/209 H01M50/249 H01M50/258 H01M50/264 B25B21/00		
ADD.		
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) H01M B25B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2019/156712 A1 (HYTORC DIVISION UNEX CORP [US]) 15 August 2019 (2019-08-15) page 11, line 13 - page 16, line 14 figures 1-5 -----	9-13
X	US 2019/305352 A1 (HSU HSU-CHANG [TW] ET AL) 3 October 2019 (2019-10-03) paragraphs [0007], [0017], [0038] - [0039] figures 1-4 -----	9
A	EP 3 154 105 A1 (SONY CORP [JP]) 12 April 2017 (2017-04-12) paragraphs [0013] - [0028] figures 1, 4 -----	1-13
☐ 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 12 September 2022		Date of mailing of the international search report 20/09/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Mercedes González

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2022/065062

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2019156712 A1	15-08-2019	CN 111819035 A EP 3749487 A1 WO 2019156712 A1	23-10-2020 16-12-2020 15-08-2019
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