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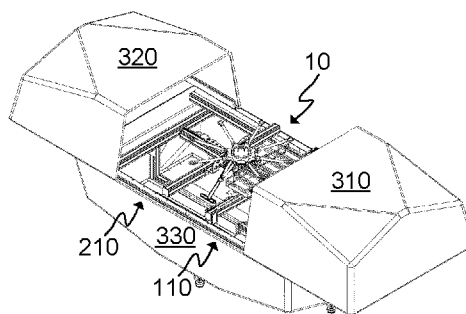


FIG. 5C

(57) Abstract: The invention is a system and a method for swapping a battery housing (400) of a device (10). The system comprises a battery swapping station (100), which comprises a first part (110) and a second part (210). The first part (110) comprises first locking members (120) and the second part (210) comprises second locking members (220), of which at least one set of locking members (120, 220) are moveable. The first part (110) comprises a first actuator member (130) for moving the battery housing (400) and a first replacement battery rack (135), in which is arranged at least one first housing slot (140), from which the battery housing (400) can be moved to the battery rack (500) with the aid of the first actuator member (130). Additionally, the system comprises a battery housing (400), which comprises connecting means (410), and a battery rack (500), which can be arranged in said device (10) and is arranged to receive a battery housing (400), and where the battery rack (500) comprises openings (510) in both ends for receiving said locking members (120, 220) for the duration of the swapping of the battery housing (400), and which battery rack (500) is arranged so that the battery housing (400) can be moved from the battery swapping station (100) to the battery rack (500) and from the battery rack (500) to the battery swapping station (100) from the end of the battery rack (500) with the aid of the actuator member (130, 230).

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SYSTEM AND METHOD FOR SWAPPING A BATTERY HOUSING OF A DEVICE

FIELD OF THE INVENTION

5 The invention generally relates to the swapping of a battery of devices utilizing a battery. The invention in particular relates to systems meant for automatic battery swapping of devices utilizing a battery.

BACKGROUND

10 Several known devices exist which are designed to be autonomically moving or remotely moveable. Examples of such devices are among others unmanned airships, such as camera choppers. Said devices operate by utilizing electrical charge stored in their battery, so the operation of the devices in question is interrupted, if the charging level of the battery falls too low or if the battery charge is completely emptied.

15 Known devices utilizing a battery must typically be brought back to the user and taken to a place where there is a battery charging device, with which more electrical charge can be charged into the battery. Known solutions have the problem that charging usually takes at least a few hours, during which time the device cannot be used. Another alternative is to swap a new charged battery into the device, but this is cumbersome and requires actions from the user.

20 SUMMARY

25 An object of the invention is to provide a system and a method for swapping a device's battery housing, which is arranged to receive a battery. A second object is to at least alleviate problems related to the known solutions and provide a system and a method, by means of which the battery housing of a device utilizing a battery, and advantageously the battery inside it, can be swapped automatically.

30 The system and the method according to the invention are characterized by what is presented in the characterizing parts of the corresponding independent claims. Some embodiments of the invention are presented in the dependent claims.

According to a first aspect, the invention is a system for swapping a battery housing of a device. The battery housing is advantageously arranged for receiving a battery. The system comprises a battery swapping station, which comprises a first part and a second part, which the first part and the second part are arranged on opposite sides of a space, which is arranged for receiving said device in order to swap the battery housing. The first part comprises first locking members and the second part comprises second locking members, of which at least one set of locking members are moveable. At least the first part comprises a first actuator member for moving the battery housing, and a first replacement battery rack, in which replacement battery rack at least one first housing slot has been arranged for a battery housing. From the first housing slot the battery housing is moveable to the battery rack with the aid of the first actuator member.

Additionally, the system comprises said battery housing, which comprises connecting means, which are arranged for transferring electrical charge between the battery and the device. The system also comprises said battery rack, which is arrangeable in said device and is arranged to receive the battery housing. The battery rack comprises opposite first and second ends, and openings in both ends for receiving said locking members for the duration of the swapping of the battery housing. The battery rack is arranged so that the battery housing is moveable from the battery swapping station to the battery rack and from the battery rack to the battery swapping station from the end of the battery rack with the aid of the actuator member.

The system can comprise at least one set of locking means, which are arranged to open in response to arranging at least one locking member into the opening of the battery rack and to close in response to arranging said locking member out of said opening of the battery rack, whereby the battery housing is locked into the battery rack.

The locking means can comprise latches or hooks arranged in the battery rack, and counterparts arranged in the battery housing for attaching to the latches or hooks.

The system can correspondingly be arranged to electronically disconnect the connecting means from the device or connect them to the device in response to arranging at least one locking member into the opening of the battery rack and

to close in response to arranging said locking member out of said opening of the battery rack.

The battery rack can comprise rollers or wheels or gliding surfaces for guiding the moving of the battery housing.

- 5 The second part of the battery swapping station can comprise a second actuator device and a thereto functionally connected second actuator member for moving the battery housing, and where the second part can comprise a second replacement battery rack, in which at least one second housing slot has been arranged for a battery housing, from which second slot the battery housing can
10 be moved to the battery rack with the aid of the second actuator member.

The system can comprise a base, which is arranged between the first and second part and on the surface of which the device can be received in order to swap the battery housing, and which base comprises at least two inclined edge parts, which are arranged to guide the device into the correct spot for swapping
15 the battery housing.

The battery housing can comprise second connecting means in the first and/or second end for transferring electrical charge from the battery swapping station to the battery.

- A battery can advantageously be arranged in the battery housing, and the
20 electric poles of the battery can advantageously be electrically connected at least to the connecting means of the battery housing.

The battery housing can comprise at least one set of second connecting means for transferring electrical charge from the battery swapping station to the battery, arranged in at least one of the following: the first end, the second end.

- 25 A battery can be arranged in the battery housing, and the electric poles of the battery are electrically connected at least to the connecting means of the battery housing, or to the connecting means and second connecting means of the battery housing.

- The device can be any battery-operated device, such as an unmanned aircraft
30 or an electric car or a robot vacuum or a robot lawn mower or an electric boat or any kind of device, which electrically utilizes a battery.

According to a second aspect, the invention is a method for swapping a battery housing of a device. The battery housing is advantageously arranged for receiving a battery. The method comprises

- 5 - receiving said device in a position, which is arranged in a space between a battery swapping station's first and second part for receiving said device in order to swap the battery housing,
- arranging locking members of the first and second part of the battery swapping station in openings arranged in the first and second end of the battery housing arranged in the device,
- 10 - moving the battery housing with the aid of an actuator member from a housing slot of the battery swapping station to a battery rack, and
- arranging the locking members of the first and second part of the battery swapping station out of the openings arranged in the first and second end of the battery housing arranged in the device.
- 15 The method can further comprise
- opening locking means of the battery rack in response to arranging at least one locking member into the opening of the battery rack, and
- closing the locking means of the battery rack in response to arranging said locking member out of said opening of the battery rack, whereby the battery
- 20 housing is locked into the battery rack.

The method can further comprise

- disconnecting the connecting means electrically from the device in response to arranging at least one locking member into the opening of the battery rack, and
- 25 - connecting the connecting means electrically to the device in response to arranging said locking member out of said opening of the battery rack.

The solutions according to the aspects of the inventions provide clear advantages in relation to the prior art, such as the fact that the battery of the device utilizing a battery can be swapped automatically, without actions from a

30 user. This makes possible a quicker swapping of the battery than prior art

charging of the battery takes, whereby the use of the device can be continued more quickly.

The other advantages of the invention become clear to someone skilled in the art based on certain embodiments of the invention presented hereafter.

- 5 The terms “first” and “second” do not mean order, number or importance, but the terms in question are used to separate one feature from another.

Different embodiments of the invention, relating both to structures and operational principles, and its additional objects and advantages can best be understood from the following description of certain embodiments, when it is
10 read while simultaneously reviewing the enclosed drawings.

The embodiments presented in this document should not be construed to set limits to the applicability of the enclosed claims. The verb “comprise” has been used as an open limiter, which does not exclude also features not mentioned herein. Characteristics mentioned in the dependent claims can be freely
15 combined, unless otherwise specifically mentioned.

BRIEF DESCRIPTION OF THE FIGURES

Certain embodiments of the invention have been illustrated in the enclosed drawings, which are described briefly in the following.

Figures 1A-1D show schematically a battery swapping station according to an
20 embodiment of the invention.

Figures 2A-2C show schematically a system according to an embodiment of the invention.

Figures 3A-3C show schematically a battery housing according to an embodiment of the invention.

25 Figures 4A and 4B show schematically a battery rack according to an embodiment of the invention.

Figures 5A-5C show schematically a system according to an embodiment of the invention.

Figure 6 shows a flow chart of a method according to an embodiment of the invention.

DESCRIPTION OF CERTAIN EMBODIMENTS

According to an embodiment of the invention, the system comprises a battery swapping station, a battery housing and a battery rack. The battery housing is advantageously arranged for receiving a battery. The battery can be placed inside the battery housing either manually or by utilizing automatic machines. The battery can for example be a lithium battery, a lead battery, a nickel metal hybrid battery or any other electric battery suitable for using a device. The battery housing can comprise electric connecting means, to which the electric poles of the battery can be connected. The connecting means can advantageously be arranged so that electrical charge can through them or with the aid of them be transferred from the battery to the device and/or from the device to the battery. According to an embodiment of the invention the connecting means comprise a first part, to which the poles of the battery can be connected, and a second part, to which the electric poles of the device can be connected. The first and second part of the connecting means are advantageously electrically connected together.

According to an embodiment of the invention the battery rack can advantageously be arranged to be attached to the device utilizing a battery. This can for example mean attaching the battery rack to the device using attaching means, such as screws or bolts. The battery rack can be arranged to receive a battery housing. According to an embodiment of the invention the battery rack is arranged to receive the battery housing essentially inside it. The battery rack can comprise an opposite first end and second end, through which the battery housing can be arranged in the battery rack, for example through an opening in the end or through openings in the ends, but the battery housing can be arranged in the battery rack also in some other way.

The battery swapping station can advantageously function automatically and thus makes possible the automatic swapping of the battery of a device utilizing a battery for example in a situation, where the battery charge level of the device is almost empty, whereby the battery in question can be replaced with a battery with a higher charge level. The battery swapping station can advantageously comprise necessary control electronics, adjustment system components, such

as a calculation unit and necessary measuring sensors, and actuator devices for performing the battery replacement, and devices and control means for charging the battery.

According to an advantageous embodiment of the invention, the battery swapping station comprises a first part and a second part, which are arranged on opposite sides of a space, which is arranged to receive, or wherein one can place, a device utilizing a battery in order to swap the battery. Additionally, the first part can comprise first locking members and the second part second locking members. Advantageously at least one set of locking members, either those of the first part or of the second part, are moveable. Thus, at least one set of locking members can be moved toward the device, whereby these moveable locking members can be moved when necessary, for example by pushing, to the second locking members on the opposite side of the space. According to an embodiment, the locking members of both parts have been arranged to be moveable.

Additionally, the first part of the battery swapping station can comprise a first actuator member for moving the battery housing from the battery swapping station to the battery rack of the device or from the battery rack of the device to the battery swapping station. The first part can comprise also a first replacement battery rack, in which at least one housing slot has been arranged for a battery housing. From the housing slot the battery housing can advantageously be moved to the battery rack with the aid of the first actuator member.

Figures 1A-1D show schematically a battery swapping station 100 according to an embodiment of the invention. The battery swapping station 100 comprises a first part 110 and a second part 210 and a space 50 between them, which is arranged to receive, or in which one can place, a device in order to swap the battery housing of the device. A base 150 has been arranged between the first 110 and second 210 part, on the surface of which base the device utilizing a battery can be received or placed. The first part 110 of the battery swapping station 100 comprises locking members 120, which are pegs or similar protrusions. In the embodiment according to Figure 1A there are two pegs and they are arranged in the guide plate 160 of the first part 110.

In the embodiment shown in Figure 1A the first part 110 also comprises a replacement battery rack 135, which comprises at least one housing slot 140,

from where the battery housing (not shown in Figures 1A-1D) can be moved from the first part 110 to the device's battery rack (not shown in Figures 1A-1D) or from the battery rack to the housing slot 140 with the aid of the actuator member 130, 230. The replacement battery rack 135 can advantageously

5 comprise charging connecting means 137 in one end of the housing slot 140, whereby, if suitable connecting means have been arranged in the end of the battery housing, these can be connected together electrically, when the battery housing is arranged in the housing slot 140. This makes it possible to start

10 charging the battery received or placed in the battery housing 400 arranged in the housing slot 140, when the battery housing 400 is arranged in the housing slot 140. According to several embodiments of the invention, the charging connecting means 137 are arranged electrically in the charging unit of the battery swapping station 100, which charging unit comprises the necessary electronics and sensors for transferring electrical charge into the battery.

15 In the embodiment in question, the battery housing can be pushed with the aid of an actuator member 130 into the device through an opening in the guide plate 160. The guide plate 160, and thus the therein arranged locking members 120, are arranged to be moveable, so that the locking members 120 can be arranged close to the battery rack of the device, substantially in contact with the battery

20 rack. The guide plate 160 can be attached to the frame 145 of the first part 110, which frame can be moveable for example on rails. The guide plate 160, the locking members 120, the housing slot 140 and the actuator member 130 can be moveable also in the longitudinal direction of the frame 145, i.e. perpendicular to the longitudinal direction of the battery swapping station 100.

25 The battery swapping station 100 can additionally comprise casing parts 310-330. In the embodiment shown in Figures 1A-1D, the battery swapping station 100 comprises a first casing part 310, which is arranged to be moveable and substantially covers the first part 110 of the battery swapping station 100 in an enclosed space. The battery swapping station 100 can comprise a second

30 casing part 320, which is arranged to be moveable and substantially covers the second part 210 of the battery swapping station 100 in an enclosed space. Additionally, the battery swapping station 100 can comprise a bottom part 330, which in the embodiment according to Figures 1A-1D is arranged to be immobile and can comprise e.g. adjustable legs, with which the battery swapping station

35 100 can be adjusted in a desired position.

Figure 1B shows the embodiment according to Figure 1A from a second perspective. The battery swapping station 100 comprises a second part 210, which comprises locking members 220. The second part 210 can additionally comprise a guide plate 260, where the locking members 220 can be arranged, a frame 245, which can be moveable, and an actuator member 230, which is arranged so that it can be used to push the battery housing from the battery rack of the device to the housing slot 140 of the first part 110. From Figure 1B it can be noted that the edge part 155 of the base 150 can be arranged to be inclined, so that its surface sinks toward the centre of the base 150, whereby for example when receiving an unmanned aircraft, such as a camera chopper, the device is guided by gliding toward the centre of the base 150, settling in the correct area for swapping the battery.

By arranging the actuator members 130, 230, such as the beams or shafts meant for pushing the battery housing, in both parts of the battery swapping station 100, as is shown for example in Figures 1A-1B, a solution is provided, where e.g. the battery housing can always be moved by pushing, whereby it is not necessary to arrange complicated gripping means, such as hooks or the like, in the actuator members 130, 230.

Figure 1C shows the battery swapping station 100 according to the embodiment shown in Figures 1A and 1B from the side.

Figure 1D shows the battery swapping station 100 according to the embodiment shown in Figures 1A and 1B from above. From Figure 1D it can be noted that the replacement battery rack 135 in the first part 110 of the battery swapping station 100 can have several housing slots 10, such as for example six of them.

According to several embodiments of the invention, the system can comprise a control unit (not shown in the figures). The control unit can be arranged in the battery swapping station 100, for example in the first 110 or second 210 part, or alternatively in both said parts 110, 210, or outside the battery swapping station 100. The control unit can comprise a calculation unit, such as a microprocessor, and memory. Additionally, the control unit can advantageously be arranged to be in contact with several sensors, such as a distance sensor, which identifies if the device is arranged in the correct place, and/or sensors performing electrical measurements, such as voltage, current or electrical power measuring sensors.

The control unit can advantageously be arranged to at least control the operation of the system for swapping a battery housing 400.

Figures 2A-2C show schematically a system according to an embodiment of the invention. The system particularly comprises a battery swapping station 100, a
5 battery rack 500 which can be arranged in a device, and a battery housing 400, which is arranged to receive a battery. The battery rack 500 can be arranged attached to the device, for example by means of screws or bolts, or in some other corresponding manner. Figure 2A shows the system from a perspective, Figure 2B from above and Figure 2C from the side. All Figures 2A-2C show the
10 same situation from different directions. The reference numbers used in Figures 2A-2C correspond to the reference numbers used in Figures 1A-1D, and additionally Figures 2A-2C show the battery housing 400.

According to certain embodiments of the invention the battery housing 400 is arranged to receive another type of electricity storage than an electric battery.
15 The battery housing 400 can be arranged to receive a fuel cell, whereby the system can be arranged to swap a device's fuel cell instead of an electric battery.

From Figures 2A-2C can be seen that the battery rack 500 can comprise a bottom, above which the battery housing 400 can be arranged. Additionally, the battery rack 500 can comprise longitudinal pipes or beams, to the ends of which
20 end parts of the battery rack 500 have been attached, or they are manufactured as one piece. From Figures 2A and 2B can especially be observed that the end parts of the battery rack 500 have openings, through which the locking members 120, 220 of the battery swapping station 100 are arranged to be set. According to certain embodiments of the invention, the battery rack 500, and thus the
25 device to which it is attached, can with the aid of the locking members 120, 220 be carried during the swapping of the battery housing 400. For someone skilled in the art it is obvious that in the case of heavy devices, such as an electric car, using locking members 120, 220 for carrying the device requires especially strong locking members and other thereto related structures. According to some
30 embodiments of the invention, the locking members 120, 220 do not carry the battery rack 500 during the swapping of the battery housing 400.

According to several embodiments of the invention, the replacement battery rack 135 can be moved in a perpendicular direction to the longitudinal direction of the battery swapping station 100. Thus the actuator member 130, 230 can remain

substantially in its place and the replacement battery rack 135 can be moved so that a desired battery housing 400 moves to the actuator member 130, 230 in order to arrange the battery housing 400 into the battery rack, or alternatively an empty housing slot 140 of the replacement battery rack 135 can be arranged to the actuator member, whereby a battery housing 400 can be moved from the battery rack to the empty housing slot 140 in question of the replacement battery rack 135. Figures 2A and 2B show charging connecting means 137 arranged in the rear end of the housing slots 140 of the replacement battery rack 135, which charging connecting means can typically be electrical couplings, which are fitted to receive a corresponding coupling means or coupling arranged in the battery housing 400.

From Figure 2B can be seen that the actuator member 130 of the first part 110 of the battery swapping station 100, i.e. the first actuator member 130, and the actuator member 230 of the second part 210, i.e. the second actuator member 230, are arranged in contact with the battery housing 400. With the aid of the actuator members 130, 230, the battery housing 400 can be moved from the replacement battery rack 135, more precisely from the housing slot 140, toward the opposite part of the battery swapping station. In this case the battery housing 400 can be moved from the first part 110 toward the second part 210, but also the other way. According to an embodiment of the invention, only one actuator member 130, 230 is used for moving the battery housing 400, so that the actuator member 130, 230, with the aid of which the battery housing 400 can be moved in the desired direction by pushing, is in use. In other words, the first actuator member 130 is used, when the battery housing 400 is pushed from the first part 110 toward the second part 210, and the second actuator member 230 when the battery housing 400 is pushed from the second part 210 toward the first part 110. It should be noted that the first actuator member 130 can be arranged to push the battery housing 400 from a housing slot 140 in the first part 110 to the battery rack 500 of the device or from the battery rack 500 to a housing slot 210 in the second part 210, if one is arranged in the battery swapping station 100. The second actuator member 230 can be arranged to push the battery housing 400 from a housing slot in the second part 210 to the battery rack 500 of the device or from the battery rack 500 to a housing slot 140 in the first part 110. According to several embodiments of the invention, the battery housing 400 can be arranged into the device's battery rack or out of it through both ends of

the battery rack. Said both ends are arranged on corresponding sides to the first 110 and second 210 part of the battery swapping station 100.

According to the embodiments of the invention shown in Figures 2A-2C, there are in the second end or end part of the battery rack 500, in addition to openings
5 arranged for the locking members 120, 220, battery housing openings for moving a battery housing 400 through the end parts. According to certain embodiments of the invention, there are battery housing openings in both ends
10 of the battery rack 500. This is especially advantageous in embodiments, where the first 110 and second 210 part of the battery swapping station 100 comprise replacement battery racks 135. Thus, the battery housing 400 can be moved from either part 110, 210 to the battery rack 500 and correspondingly out of the battery rack 500 to either part 110, 210.

Figures 3A-3C show schematically a battery housing 400 according to an embodiment of the invention, seen from three different directions. The battery
15 housing 400 is arranged to receive a battery, the electric poles of which can be connected to the connecting means 410 of the battery housing 400 in order to transfer electrical charge from the battery to the device or alternatively from the battery swapping station 100 to the battery, when the battery housing 400 is arranged in a housing slot 140 of the replacement battery rack 135.

20 The battery housing 400 can comprise a frame 405, inside which the battery can be arranged. Additionally, the battery housing 400 can comprise guide means 430, such as rollers or wheels or a gliding surface, with the aid of which the battery housing 400 can be guided and moved to the battery rack 500 or the battery swapping station 100. According to an embodiment of the invention,
25 connecting means 410 of the battery housing have been arranged in one end of the battery housing 400. According to another embodiment of the invention, connecting means 410 of the battery housing have been arranged in both ends of the battery housing 400, as is shown in Figures 3A-3C. At least one or two connecting means 410 can have been connected to the electric poles of the
30 battery. By arranging the connecting means 410 in both ends of the battery housing 400, what is achieved is that the battery housing 400 does not need to be turned, when it is moved between the battery swapping station 100 and the battery rack, or the device, because one set of connecting means 410 can be used for transferring electrical charge from the battery to the device and the

second set of connecting means 410 for transferring electrical charge from the battery swapping station to the battery.

Additionally, especially in Figure 3B can be seen a counterpart 435 of the locking means 540 according to an embodiment of the invention, such as a peg or an opening arranged for a latch. The counterpart 435 can advantageously be arranged to receive a latch or hook of the locking means 540. In Figures 3A-3C it is arranged in the end of the axis of the guide means 430, but it can also be arranged in another part of the battery housing 400. The latch or hook can according to an embodiment of the invention be arranged, as is shown in Figures 4A and 4B, in the battery rack 500.

According to an embodiment of the invention, the battery housing 400 can comprise second connecting means in the first and/or second end for transferring electrical charge from the battery swapping station 100 to the battery.

Figures 4A and 4B show schematically a battery rack 500 according to an embodiment of the invention from two different perspectives. The battery rack 500 can be arranged attached to a device which utilizes a battery or operates with a battery. The battery rack 500 is also arranged to receive a battery housing 400 according to an embodiment of the invention.

From Figure 4A can be noted that the battery rack 500 can comprise a battery housing opening 525 in at least one end or end part 520 of the battery rack 500. The battery housing 400 according to an embodiment of the invention can be moved through the battery housing opening 525 in question into the battery rack 500 or out of the battery rack 500. Additionally, the battery rack 500 can comprise pipes 550 or beams 550, which are arranged in the longitudinal direction of the battery rack 500. The battery housing 400 according to an embodiment of the invention, which comprises guide means 430, is arranged to be moveable along the pipes 550 or beams 550. The pipes 550 or beams 550 can advantageously be connected to the end parts 520 for example with bolts, rivets or by welding.

In Figure 4B can be noted that locking means 540 can be arranged in the battery rack 500. According to an embodiment of the invention, the locking means 540 are arranged to open in response to arranging at least one locking member 120, 220 into the opening 510 of the battery rack 500 and to close in response to

arranging said locking member 120, 220 out of said opening 510 of the battery rack 500, whereby the battery housing 400 is locked into the battery rack 500. The locking means 540 shown in Figure 4B comprise a mechanism arranged in the vicinity of an opening 510, which mechanism is arranged to change the position of the locking means 540, when the locking member 120, 220 of the battery swapping station 100 is arranged through the opening 510.

In the embodiment shown in Figure 4B, the locking means 540 comprise a hook or a latch, and said mechanism arranged to change its position. Additionally, the system comprises a counterpart 435 for said hook or latch, arranged in the battery housing 400. This can mean that when the locking member is arranged in the opening of the battery rack, the latch or hook of the locking means opens, i.e. detaches from the counterpart 435 arranged in the battery rack, and on the other hand connects to the counterpart 435, when the locking member is removed from the opening. For someone skilled in the art, it is clear that the locking means 540, which are arranged to operate in response to the operation of the locking member 120, 220, can be implemented in many different ways. The battery housing can thus be removed from the battery rack or moved into the battery rack, when the locking member is arranged in the opening of the battery rack. According to an embodiment of the invention, the locking means 540 are arranged in the battery housing 400 or in both the battery rack 500 or the battery housing 400.

According to an embodiment of the invention, the system can comprise locking means in the vicinity of more than one, for example two or four, openings 510. Thus, the battery housing 400 can be arranged to be locked in the battery rack 500, for example by all of its corners.

According to several embodiments of the invention, the connecting means 410 of the battery housing 400 connect to the connecting means 530 of the battery rack 500 at the same time as the battery housing 400 is arranged into the battery rack 500 with the aid of the actuator member 130. Correspondingly, the connecting means 410 of the battery housing 400 connect to the charging connecting means 137 of the housing slot 140 in the replacement battery rack 135 at the same time as the battery housing 400 is arranged into the battery swapping station 100 with the aid of the second actuator member 230.

According to an embodiment of the invention, there can be battery housing openings 525 in both ends of the battery rack 500. In this case, the electrical connecting means 410, 530 meant for transfer of electrical charge between the battery housing 400 and the battery rack 500 must be arranged in a way that
5 differs from the way shown in Figures 3A-3C and 4A-4B, for example in the side edge or upper edge of the housing 400 and rack 500, whereby for example the locking means 540 can be arranged so that an electric connection between the housing 400 and rack 500 is formed when the locking members 120, 220 are arranged out of the opening 510 or openings 510 of the battery rack 500.

10 According to an embodiment of the invention, the system is arranged to correspondingly disconnect the connecting means 410 of the battery housing 400 from the device 10 or connect to the device 10 in response to arranging at least one locking member 120, 220 into the opening 510 of the battery rack 500 and to close in response to arranging said locking member 120, 220 out of said
15 opening 510 of the battery rack 500. Thus, the battery in the battery housing 400 is detached or electrically disconnected from the device 10, when the locking member 120, 220 is arranged in the opening 510 of the battery rack 500. This makes possible the moving of the battery housing 400 and on the other hand that when the battery housing 400 is in place and the locking member 120, 220
20 is removed from the opening 510 of the battery rack 500, the battery housing 400 can electrically connect to the device 10 in response to movement of the locking member 120, 220, whereby electrical charge can be transferred from the battery to the device 10 or vice versa.

According to an embodiment of the invention, the battery rack 500 can comprise
25 guide means, such as rollers or wheels or gliding surfaces, for guiding the moving of the battery housing 400. The guide means can be arranged between the housing slot 140 of the first part 110 of the battery swapping station 100 and the locking members 120, so that when the locking members 120 are arranged in the opening 510 of the battery rack 500, the battery housing 400 can be
30 moved from the replacement battery rack 135 to the battery rack 500 of the device 10.

Figures 5A-5C show a system according to an embodiment of the invention, which system comprises a battery swapping station 100, a battery housing 400 and a battery rack arranged attached to a device 10, in this case a remote-
35 controlled unmanned helicopter 10. Part of the features shown in Figures 5A-5C

correspond to those in Figures 1A-1D and will not be described here again to avoid repetition.

In Figures 5A-5C the device 10 is a remote-controlled, unmanned helicopter, which has been received or arranged in the space 50. The legs of the device 10 are arranged against the base 150. The legs of the device 10 can comprise or can be provided with wheels or rollers, whereby with the aid of the base 150 according to an embodiment of the invention, which base can be arranged to have one or several, such as two, inclined edge parts 155, the device 10 can glide toward the centre or centre part of the base, settling in a suitable spot for swapping the battery housing 400.

According to an embodiment, the second part 210 of the battery swapping station 100 can comprise a second actuator device and a thereto functionally connected second actuator member 230 for moving the battery housing 400. Additionally, the second part can comprise a replacement battery rack, in which at least one housing slot for a battery housing has been arranged. From said housing slot, the battery housing can be moved to the battery rack with the aid of the second actuator member 230, for example in a corresponding way as from the housing slot 140 of the first part 110 with the aid of the first actuator member 130.

According to an embodiment of the invention, a battery has been arranged in the battery housing 400, and the electric poles of the battery are electrically connected at least to the connecting means 410 of the battery housing 400.

According to an embodiment of the invention, the battery housing comprises at least one set of second connecting means for transferring electrical charge from the battery swapping station to the battery, arranged in at least one of the following: the first end, the second end.

According to an embodiment of the invention, a battery has been arranged in the battery housing, and the electric poles of the battery are electrically connected at least to the connecting means of the battery housing, or to the connecting means and second connecting means of the battery housing.

According to an embodiment of the invention, the device is any battery-operated device. The device can for example be an unmanned aircraft or an electric car or a robot vacuum or a robot lawn mower or an electric boat. According to certain

embodiments of the invention, the device 10 is an autonomically moving or remote-controlled device 10 taking or receiving from a battery the electrical power needed for a device to move or be moved, such as a camera chopper, or a remote-controlled airplane or car or boat or helicopter, or a robot vacuum or lawn mower.

Figure 6 shows a flowchart of a method meant for swapping a battery housing 400 of a device 10 according to an embodiment of the invention, which battery housing is arranged for receiving a battery. The method comprises a starting phase 700, where among others the necessary devices and systems are acquired, which are configured into operating condition, whereby the system is ready to receive a device 10 in the space 50 for swapping a battery housing 400.

The method comprises receiving 710 a device, especially a device utilizing a battery or a device operating with a battery, in the space 50, which is arranged substantially between the first 110 and second 210 part of the battery swapping station 100 for receiving said device 10 in order to swap the battery housing 400. Additionally, the method comprises arranging 720 locking members 120, 220 of the first 110 and second 210 part of the battery swapping station 100 in openings 510 arranged in the first and second end of the battery rack 500 arranged in the device 10. Additionally, the method includes moving 730 the battery housing 400 with the aid of an actuator member 130, 230 from the housing slot 140 of the battery swapping station 100 to the battery rack 500. The method additionally comprises arranging 740 locking members 120, 220 of the first 110 and second 210 part of the battery swapping station 100 out of the openings 510 arranged in the first and second end of the battery rack 500 arranged in the device 10.

The execution of the method can be stopped in point 799. According to several embodiments of the invention, the method can be executed once, repeatedly, as needed, such as when the device 10 is received in the space 50, or at certain intervals or continuously.

According to an embodiment of the invention, the method for swapping a battery housing 400 can comprise that the locking means 540 of the battery rack 500 are opened in response to arranging at least one locking member 120, 220 into the opening 510 of the battery rack 500 and that the locking means 540 of the battery rack 500 are closed in response to arranging said locking member 120,

220 out of said opening 510 of the battery rack 500, whereby the battery housing 400 is locked into the battery rack 500.

According to an embodiment of the invention, the method for swapping a battery housing 400 can comprise that the connecting means 410 are electrically
5 disconnected from the device or connected to the device in response to arranging at least one locking member into the opening of the battery rack and that the connecting means are electrically connected to the device in response to arranging said locking member out of said opening of the battery rack.

According to several embodiments of the invention, at least the frame of the
10 battery housing 400 and/or battery rack 500 is manufactured from metal, such as aluminium or steel.

Some embodiments of the invention have been shown above. For someone skilled in the art it is however clear that the solution according to the invention can also be made in other ways than what has been presented above. Features
15 can for example be replaced by equivalent features. The above-presented embodiments should not be interpreted as restrictive to the claims.

CLAIMS

1. A system for swapping a battery housing (400) of a device (10), which the battery housing (400) is arranged for receiving a battery, which the system comprises
- 5 - a battery swapping station (100), which comprises a first part (110) and a second part (210), which the first (110) and the second (210) part are arranged on opposite sides of a space (50), which is arranged for receiving said device (10) in order to swap the battery housing (400), and which the first part (110) comprises first locking members (120) and the second part (210) comprises
- 10 second locking members (220), of which at least one set of locking members (120, 220) are moveable, and wherein at least the first part (110) comprises a first actuator member (130) for moving the battery housing (400) and a first replacement battery rack (135), in which the replacement battery rack (135) is arranged at least one first housing slot (140) for the battery housing (400), from
- 15 which the first housing slot (140) the battery housing (400) is moveable to a battery rack (500) with the aid of the first actuator member (130),
- said battery housing (400), which comprises connecting means (410), which are arranged for transferring electrical charge between the battery and the device (10), and
- 20 - said battery rack (500), which is arrangeable in said device (10) and is arranged for receiving the battery housing (400), and wherein the battery rack (500) comprises opposite first and second ends, and openings (510) in both of said ends for receiving said locking members (120, 220) for the duration of the swapping of the battery housing (400), and which the battery rack (500) is
- 25 arranged so that the battery housing (400) is moveable from the battery swapping station (100) to the battery rack (500) and from the battery rack (500) to the battery swapping station (100) from one of the ends of the battery rack (500) with the aid of the actuator member (130, 230).
2. The system according to claim 1, comprising at least one set of locking
- 30 means (540), which are arranged to open in response to arranging at least one locking member (120, 220) into the opening (510) of the battery rack (500) and to close in response to arranging said locking member (120, 220) out of said opening (510) of the battery rack (500), whereby the battery housing (400) is locked into the battery rack (500).

3. The system according to claim 2, where the locking means (540) comprise latches or hooks arranged in the battery rack (500), and counterparts (435) arranged in the battery housing (400) for attaching to the latches or hooks.
4. The system according to claim 2 or 3 arranged to correspondingly
5 disconnect the connecting means (410) from the device (10) or connect to the device (10) in response to arranging the at least one locking member (120, 220) into the opening (510) of the battery rack (500) and to close in response to arranging said locking member (120, 220) out of said opening (510) of the battery rack (500).
- 10 5. The system according to any of the preceding claims, wherein the battery rack (500) comprises rollers or wheels or gliding surfaces for guiding the moving of the battery housing.
6. The system according to any of the preceding claims, wherein the second
15 part (210) comprises a second actuator device and thereto functionally connected second actuator member (230) for moving the battery housing (400), and wherein the second part (210) comprises a second replacement battery rack, in which at least one second housing slot has been arranged for the battery housing (400), from which second slot the battery housing (400) is moveable to the battery rack (500) with the aid of the second actuator member (230).
- 20 7. The system according to any of the preceding claims, comprising a base (150), which is arranged between the first (110) and the second (210) part and on the surface of which the device (10) is receivable in order to swap the battery housing (400), and which the base (150) comprises at least two inclined edge
25 parts (155), which are arranged to guide the device (10) into the correct spot for swapping the battery housing (400).
8. The system according to any of the preceding claims, wherein the battery housing (400) comprises second connecting means in the first and/or second end for transferring electrical charge from the battery swapping station (100) to the battery.
- 30 9. The system according to any of the preceding claims, wherein the battery has been arranged in the battery housing (400), and the electric poles of the battery are electrically connected at least to the connecting means (410) of the battery housing (400).

10. The system according to any of the preceding claims, wherein the battery housing (400) comprises at least one set of second connecting means for transferring electrical charge from the battery swapping station (100) to the battery, the second connecting means being arranged in at least one of the
5 following: the first end, the second end.

11. The system according to any of the preceding claims, wherein the battery has been arranged in the battery housing (400), and the electric poles of the battery are electrically connected at least to the connecting means (410) of the battery housing (400), or to the connecting means (410) and the second
10 connecting means of the battery housing.

12. The system according to any of the preceding claims, wherein the device (10) is a battery-operate device, such as an unmanned aircraft or an electric car or a robot vacuum or a robot lawn mower or an electric boat or any kind of device, which electrically utilizes the battery.

13. A method for swapping a battery housing (400) of a device, which the battery housing (400) is arranged for receiving a battery, which the method comprises

- receiving (710) said device (10) in a position, which is arranged in the space (50) between a first (110) and a second (210) part of a battery swapping station (100) for receiving said device (10) in order to swap the battery housing (400),
20

- arranging locking members (120, 220) of the first (110) and the second (210) part of the battery swapping station (100) in openings (510) arranged in a first and second end of a battery rack (500) arranged in the device (10),

- moving (730) the battery housing (400) with the aid of an actuator member (130) from a housing slot (140) of the battery swapping station (100) to the battery rack (500),
25

- arranging (740) the locking members (120, 220) of the first (110) and second (210) part of the battery swapping station (100) out of the openings (510) arranged in the first and second end of the battery rack (500) arranged in the
30 device (10).

14. The method according to claim 13, comprising

- opening locking means (540) of the battery rack (500) in response to arranging at least one locking member (120, 220) into the opening (510) of the battery rack (500), and

- 5 - closing the locking means (540) of the battery rack (500) in response to arranging said locking member (120, 220) out of said opening (510) of the battery rack (500), whereby the battery housing (400) is locked into the battery rack (500).

15. The method according to claim 13 or 14, which comprises

- 10 - disconnecting connecting means (410) electrically from the device (10) in response to arranging at least one locking member (120, 220) into the opening (510) of the battery rack (500), and

- connecting the connecting means (410) electrically to the device (10) in response to arranging said locking member (120, 220) out of said opening (510) of the battery rack (500).

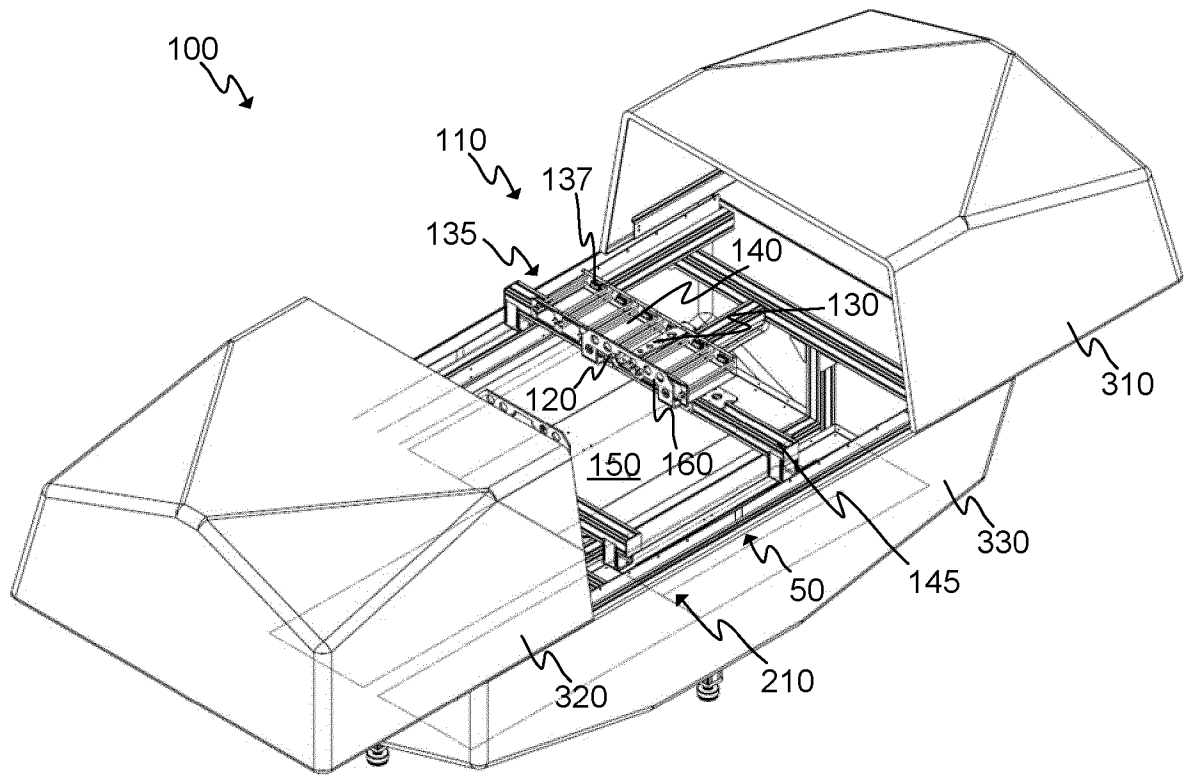


FIG. 1A

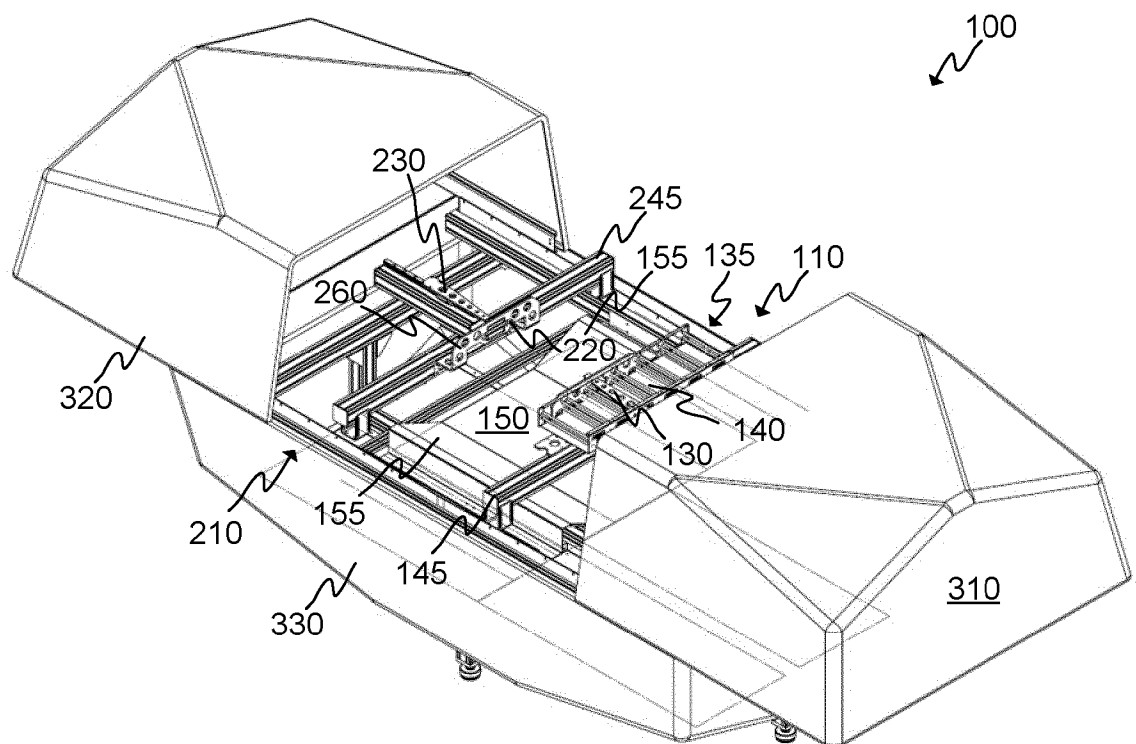


FIG. 1B

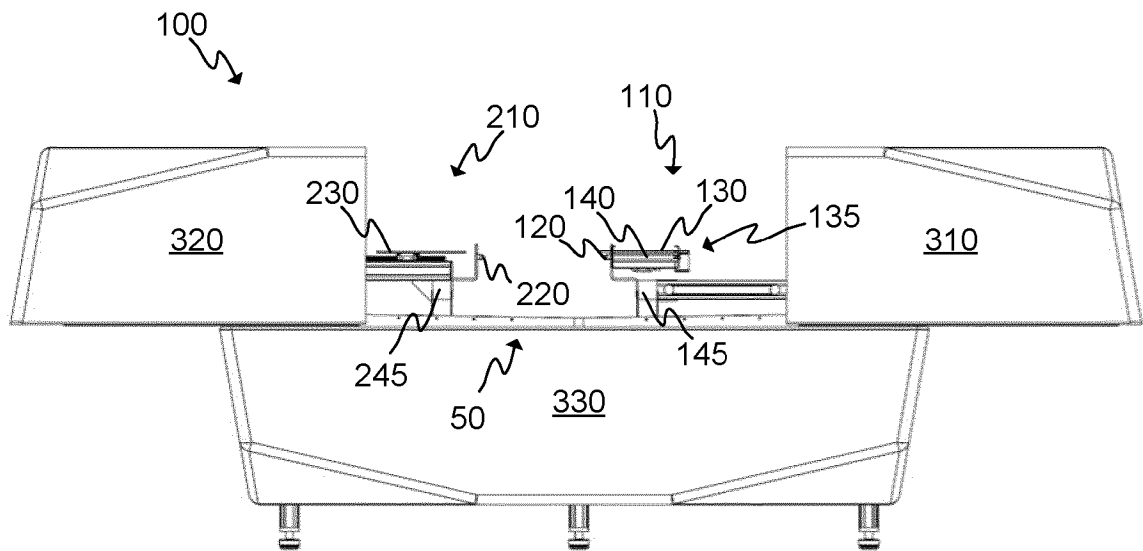


FIG. 1C

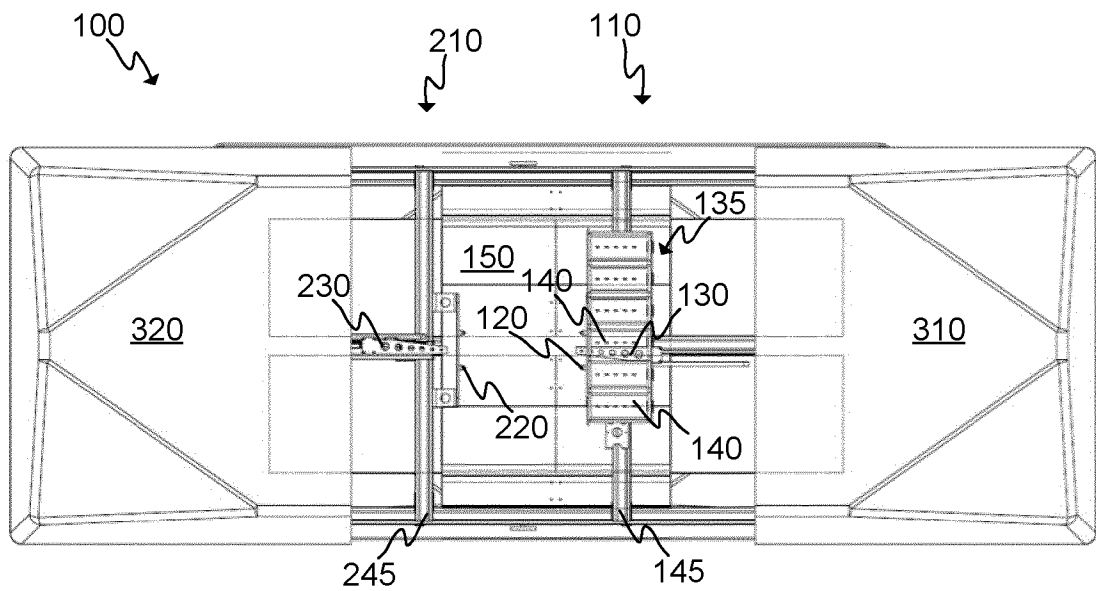


FIG. 1D

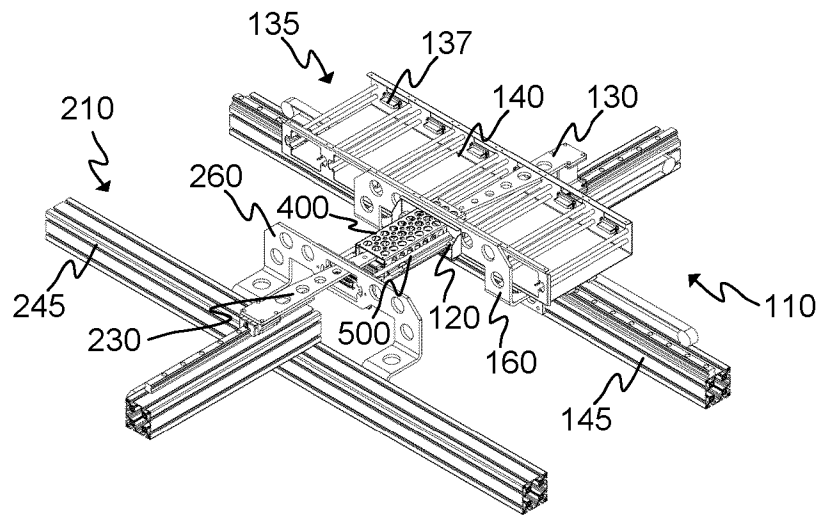


FIG. 2A

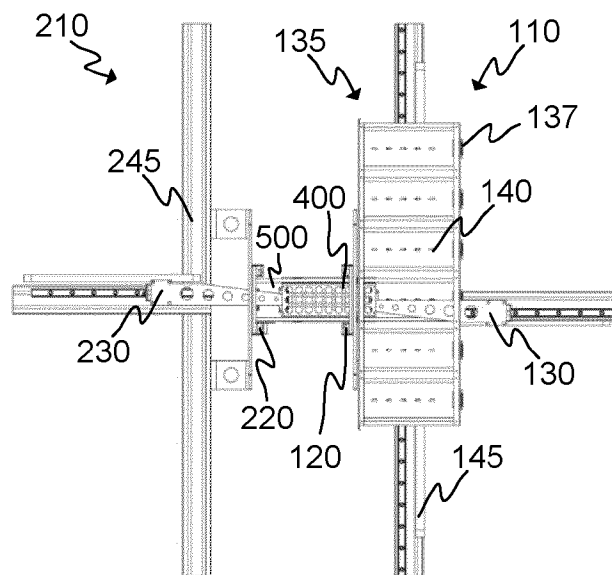


FIG. 2B

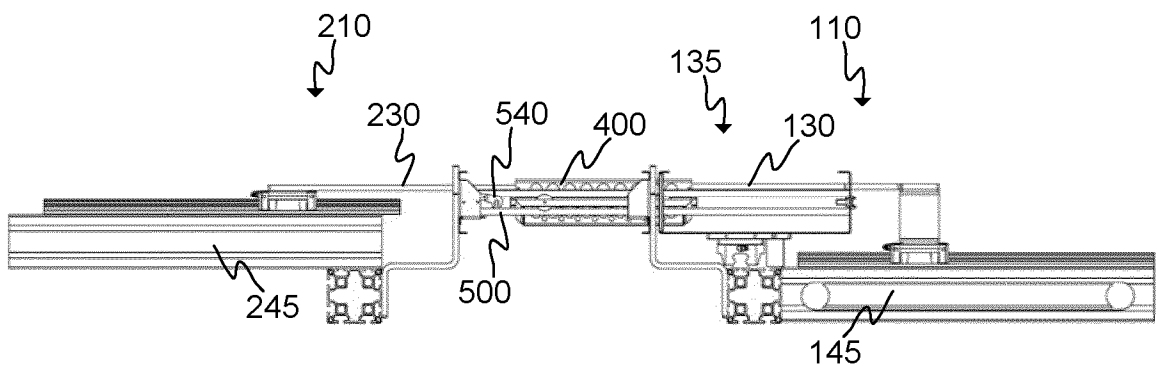


FIG. 2C

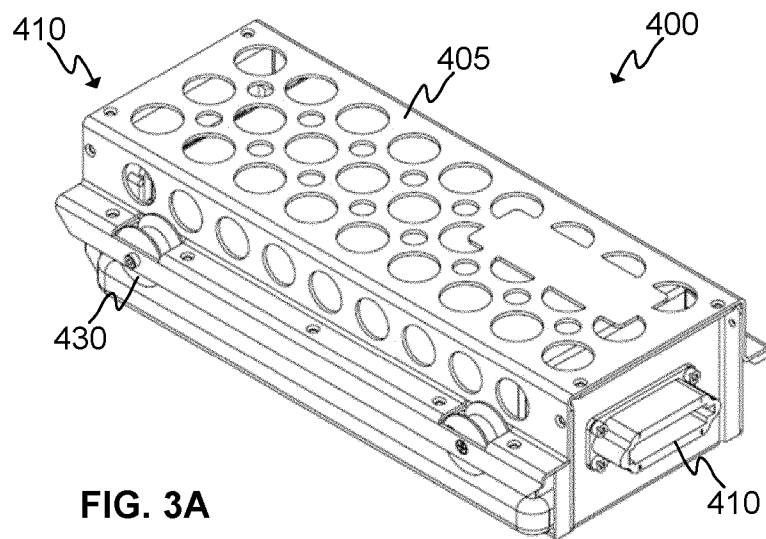


FIG. 3A

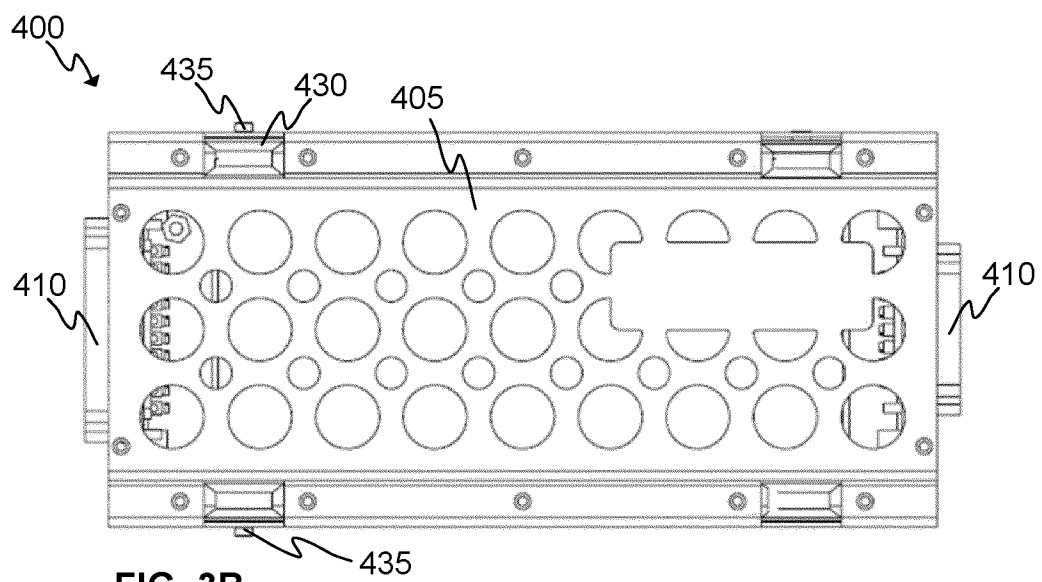


FIG. 3B

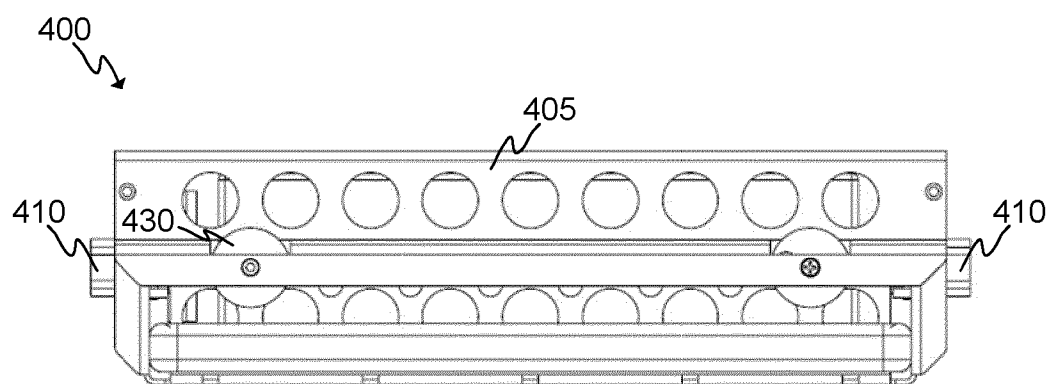


FIG. 3C

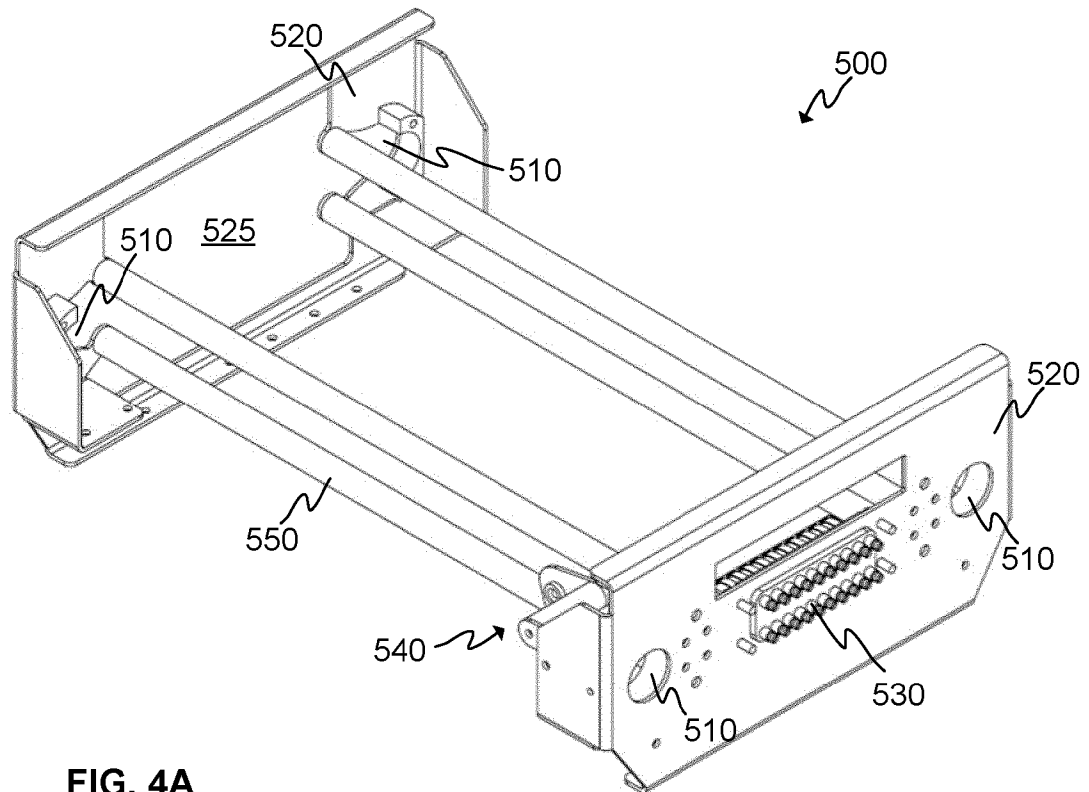


FIG. 4A

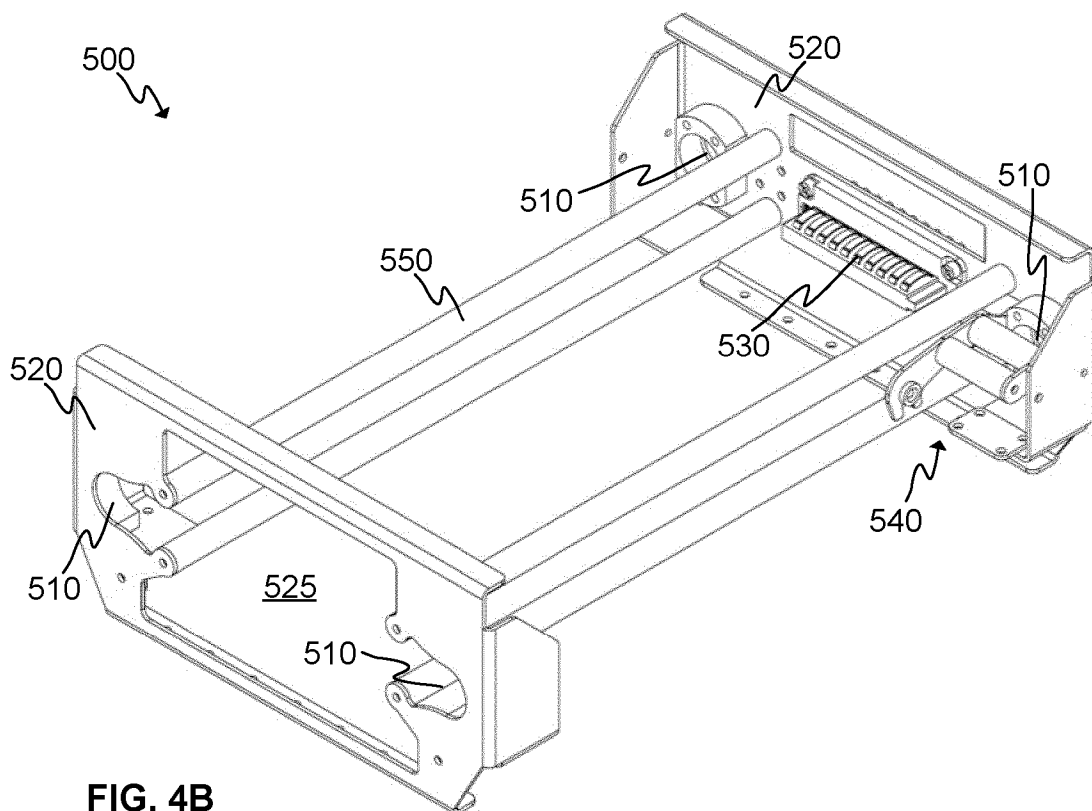


FIG. 4B

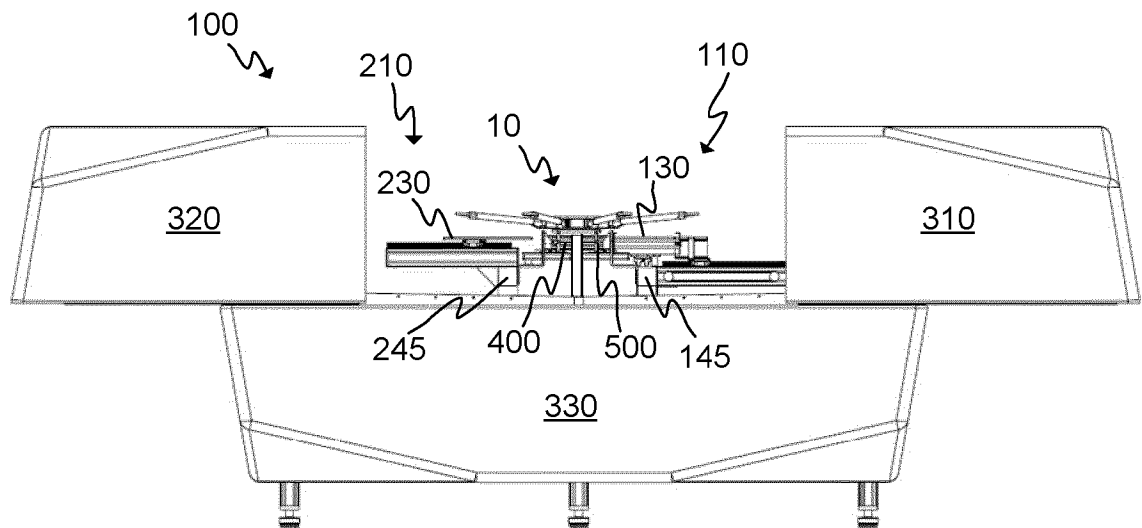


FIG. 5A

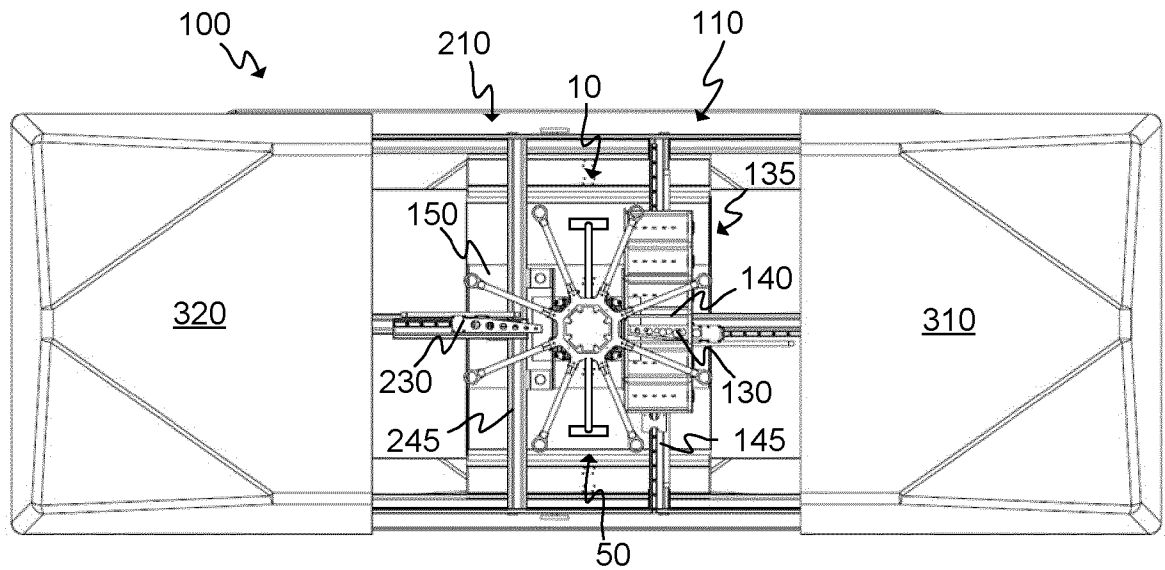


FIG. 5B

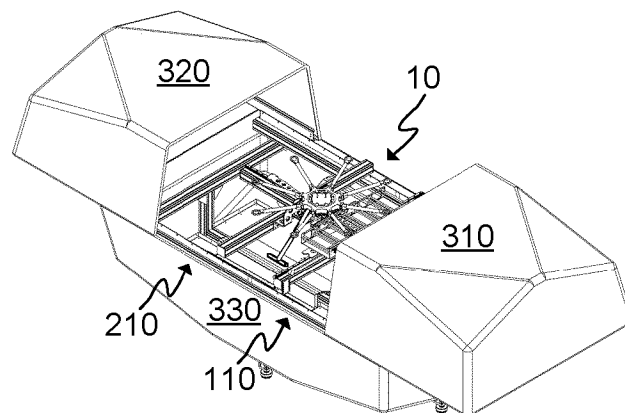


FIG. 5C

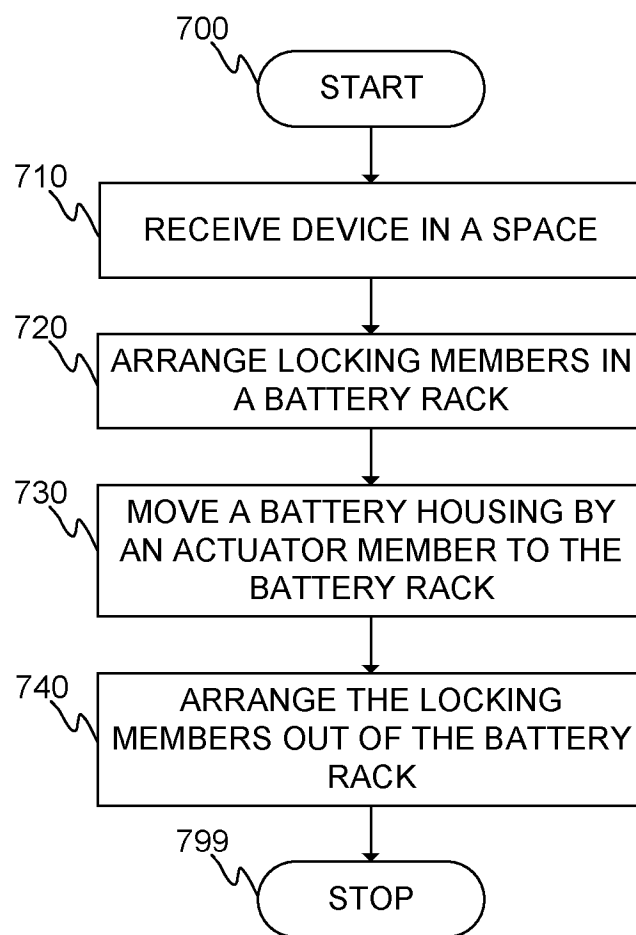


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2019/050268

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60L53/80 B60S5/06 B60L53/30 B60L53/35
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)

B60L B60S

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	URE N KEMAL ET AL: "An Automated Battery Management System to Enable Persistent Missions With Multiple Aerial Vehicles", IEEE / ASME TRANSACTIONS ON MECHATRONICS, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 20, no. 1, 1 February 2015 (2015-02-01), pages 275-286, XP011560405, ISSN: 1083-4435, DOI: 10.1109/TMECH.2013.2294805 [retrieved on 2014-10-03]	1,5-7, 12,13
Y	abstract page 277, column 1, line 7 - line 32 page 279, column 2, line 33 - line 36 page 280, column 1, line 8 - line 14 page 281, column 1, line 1 - line 33 figures 1, 7-12 ----- -/--	2-4, 8-11,14, 15



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

1 August 2019

Date of mailing of the international search report

08/08/2019

Name and mailing address of the ISA/

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Authorized officer

Lutz, Tobias

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2019/050268

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 927 938 A (HAMMERSLAG JULIUS G [US]) 27 July 1999 (1999-07-27) title figures 10-12	1-15
Y	----- KOJI A O SUZUKI ET AL: "Automatic Battery Replacement System for UAVs: Analysis and Design", JOURNAL OF INTELLIGENT AND ROBOTIC SYSTEMS ; THEORY AND APPLICATIONS - (INCORPORATING MECHATRONIC SYSTEMS ENGINEERING), KLUWER ACADEMIC PUBLISHERS, DO, vol. 65, no. 1 - 4, 9 September 2011 (2011-09-09), pages 563-586, XP019989902, ISSN: 1573-0409, DOI: 10.1007/S10846-011-9616-Y page 571, column 1, line 1 - line 4 page 571, column 2, line 6 - line 25 page 572 page 574, column 1, line 13 - line 15 figures 5-7 -----	2-4, 8-11,14, 15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/FI2019/050268

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5927938 A	27-07-1999	US 5927938 A	27-07-1999
		US 5951229 A	14-09-1999
