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INT CL **H01M, H02J**
Other: **Online: WPI, EPODOC**

(54) Title of the Invention: **Battery docking system and battery module**
Abstract Title: **Battery docking system and battery module**

(57) A docking system 5 for receiving electrical energy from a rechargeable battery 3 is disclosed. The docking system 5 comprises means for mechanically securing the battery 3 to enable connection of electrical terminals of the docking system (13, fig 2) with electrical terminals of the battery (15, fig 4), and an authentication system configured to communicate with a connected battery to authenticate whether or not it is valid. An isolation means is configured to isolate the docking system 5 to prevent energy being received from a connected battery 3 through the electrical terminals (13, fig 2; 15, fig 4) if the battery is determined as invalid. The docking station 5 may comprise a microprocessor 31, memory 33 and a pseudo random number generator 35, which communicate with the microprocessor unit 51 of the battery 3. An alarm may be triggered if a non-authentic, e.g. incompatible or non-genuine, battery is detected. The docking station and a rechargeable battery for connection to the docking system are also claimed.

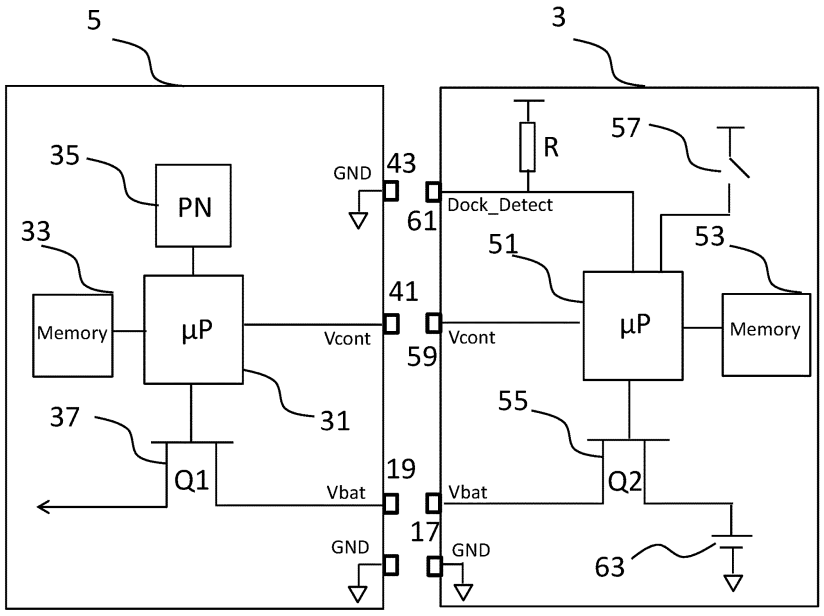

Fig. 5

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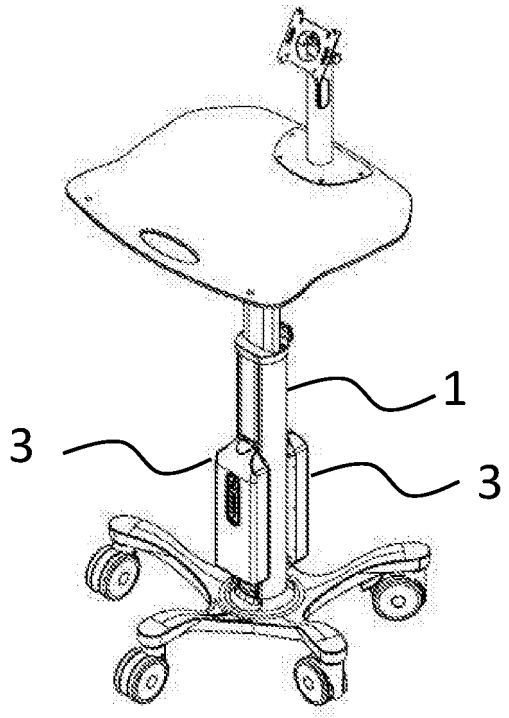

Fig. 1

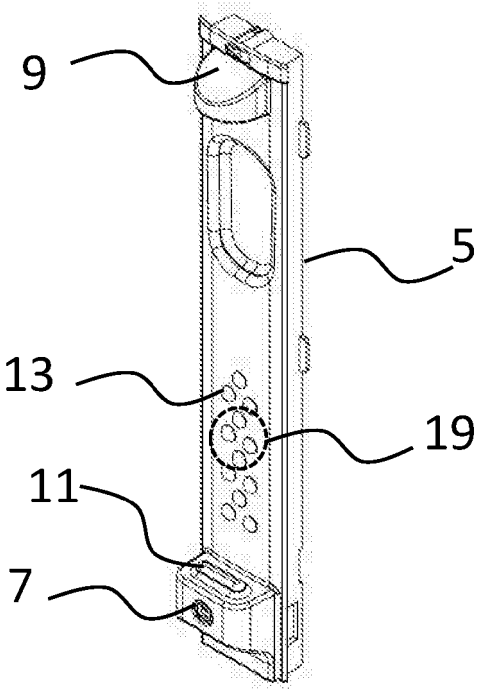

Fig. 2

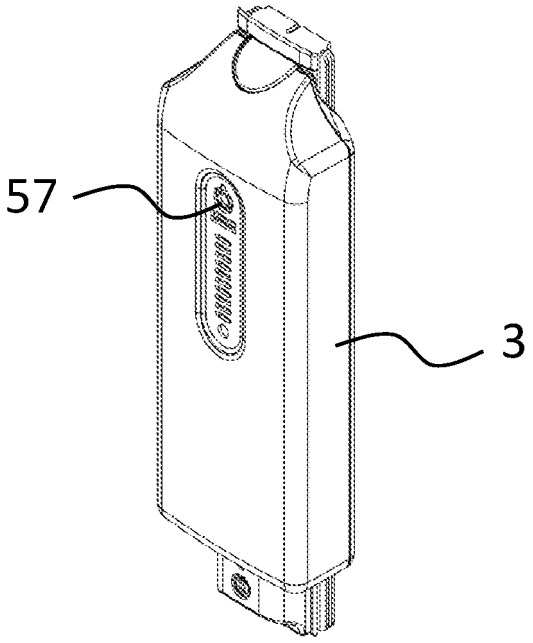

Fig. 3

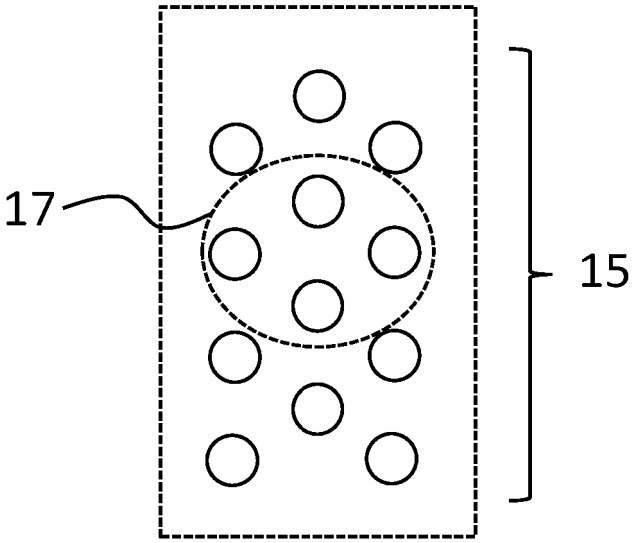
17
15

Fig. 4

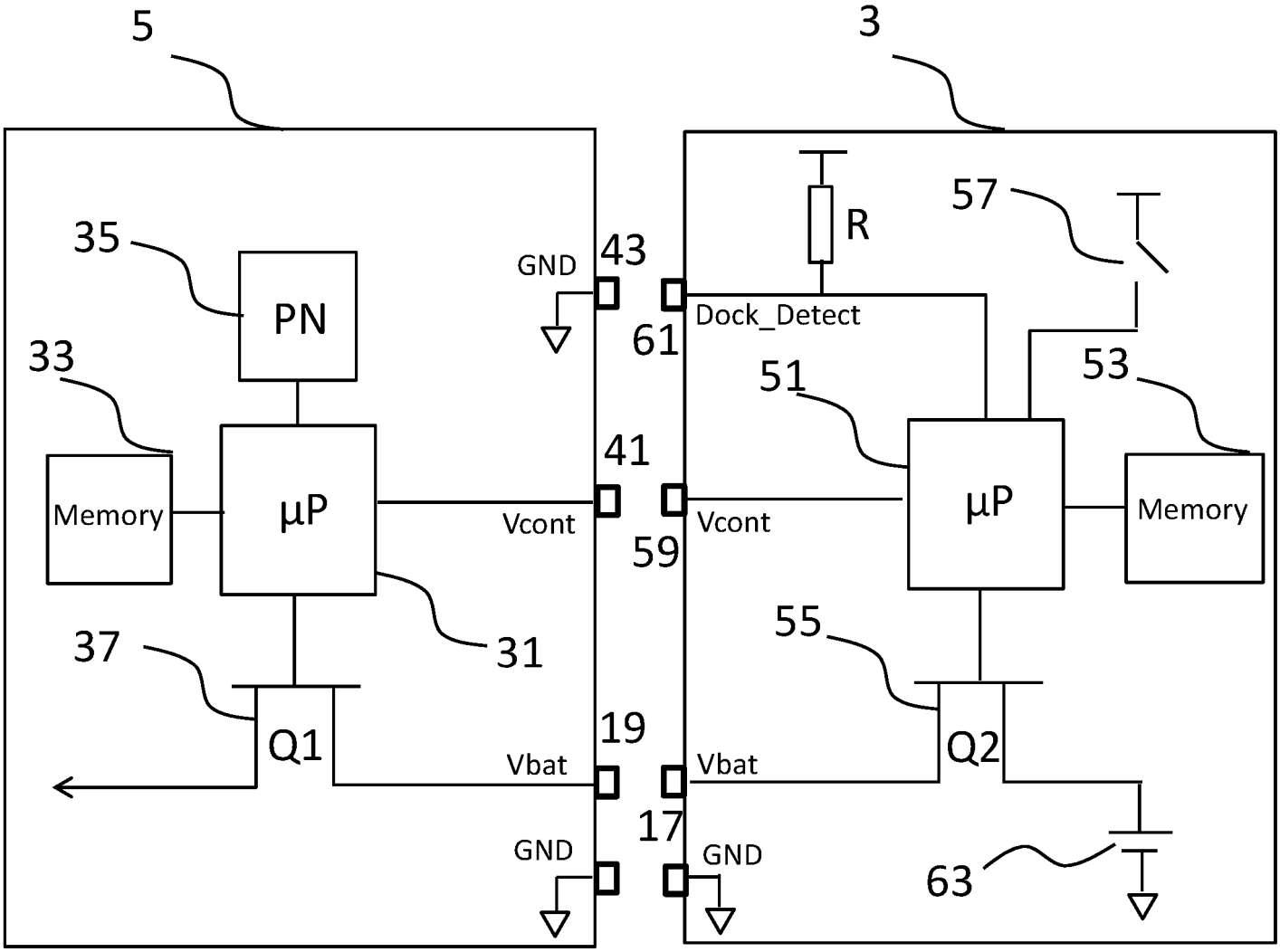
5
3
35
PN
33
Memory
µP
37
Q1
GND
43
61
Vcont
41
59
31
Vbat
19
GND
17
R
Dock_Detect
57
51
53
µP
Memory
Vcont
55
Q2
Vbat
63
GND

Fig. 5

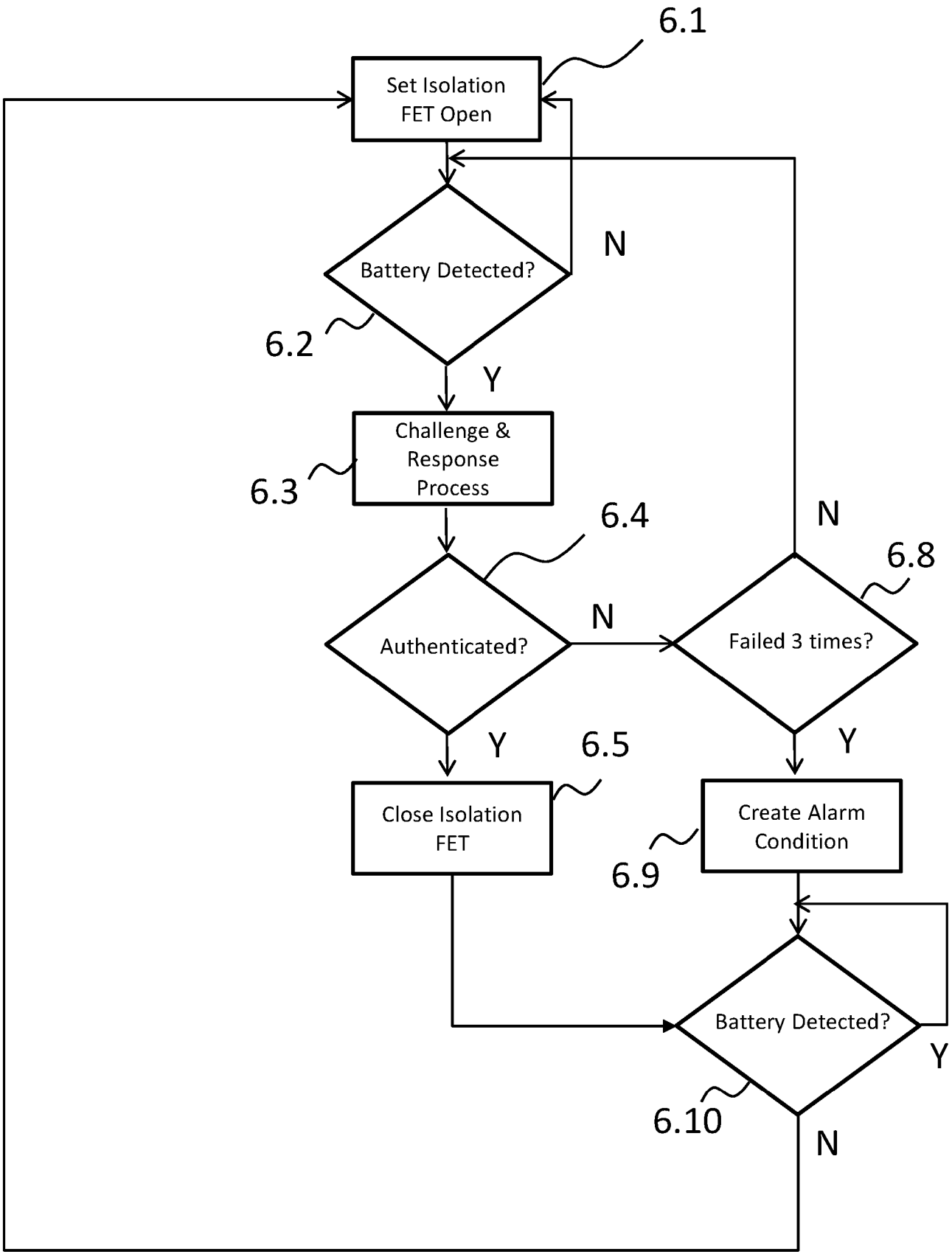
6.1
Set Isolation FET Open
Battery Detected?
N
6.2
Y
Challenge & Response Process
6.3
6.4
N
6.8
Authenticated?
N
Failed 3 times?
Y
Y
6.5
Close Isolation FET
Create Alarm Condition
6.9
Battery Detected?
Y
6.10
N

Fig. 6

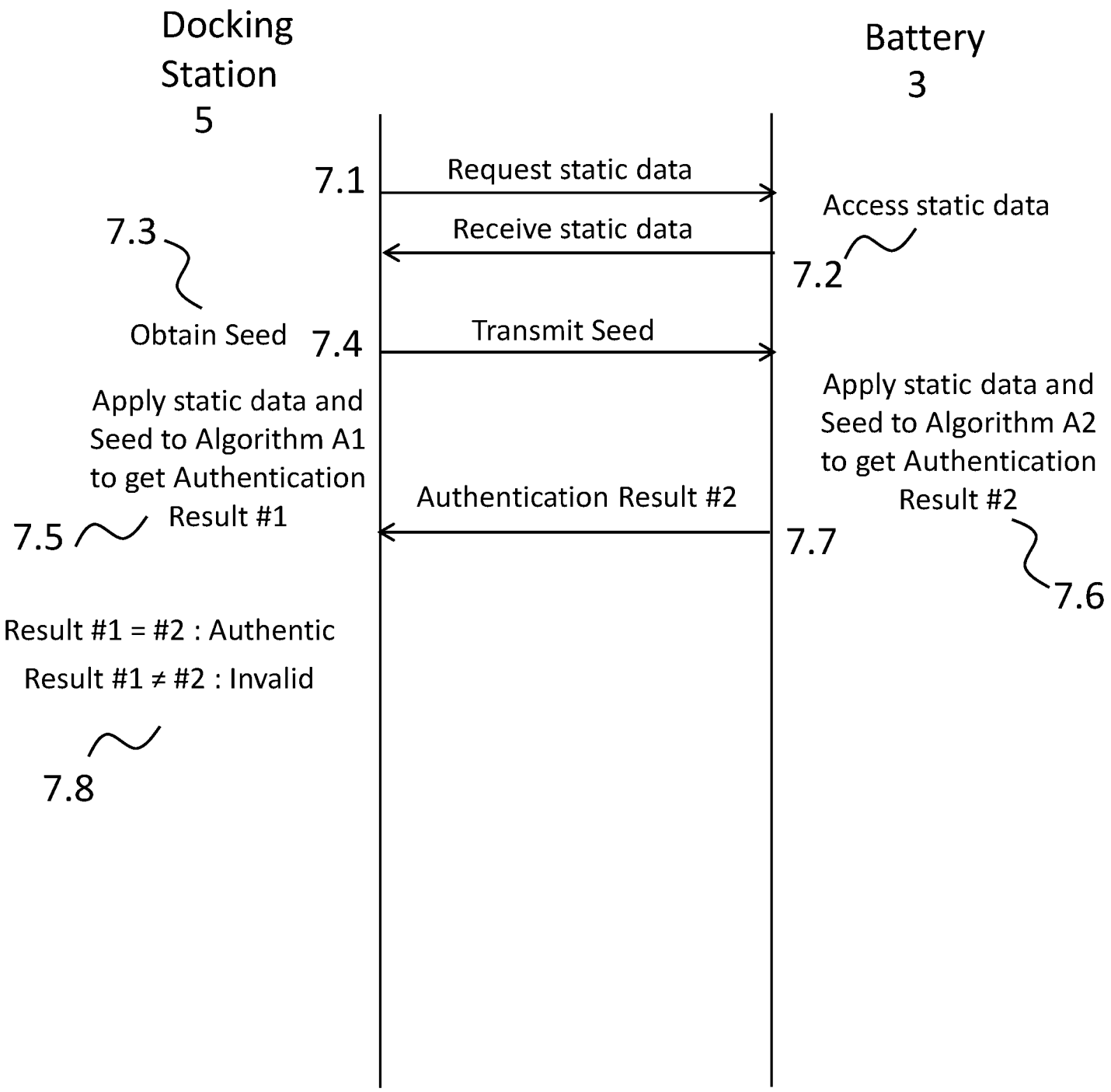
Docking Station 5
Battery 3
7.1
Request static data
Access static data
Receive static data
7.2
7.3
Obtain Seed
7.4
Transmit Seed
Apply static data and Seed to Algorithm A1 to get Authentication Result #1
Apply static data and Seed to Algorithm A2 to get Authentication Result #2
Authentication Result #2
7.5
7.7
7.6
Result #1 = #2 : Authentic
Result #1 ≠ #2 : Invalid
7.8

Fig. 7

Battery Docking System and Battery Module

Field of the Invention

This invention relates to a docking system for receiving electrical energy from a connected rechargeable battery module. The invention also relates to a battery module for use with the docking station.

Background of the Invention

Electrical batteries are used in many applications. One important application is in the medical field. For example, it is known to provide a wheeled trolley with a platform on which to support a display for entertainment or for other medical equipment supported on the platform. The trolley includes a docking station for receiving one or more rechargeable batteries which provide portable power for equipment supported thereon. In the context of this specification, a docking station can also be a battery charger.

Batteries have a high value. They also present a potential hazard if an incorrect or incompatible battery is connected to a docking station or charger, for example due to different voltages or poor mechanical construction. One or both of the docking station and the battery can be damaged and, in extreme cases, the battery may explode.

Summary of the Invention

A first aspect of the invention provides a docking system for receiving electrical energy from a rechargeable battery, the docking system comprising: means for mechanically securing a battery to electrical terminals of the docking system; authentication means configured to communicate with a connected battery to authenticate whether or not it is valid; and an isolation means configured to isolate the system to prevent energy being received from a connected battery through the electrical terminals if the battery is determined as invalid.

The authentication means may be configured to acquire static data from the battery, to send a challenge signal to the battery, to receive a challenge response from the battery and to determine based on the challenge response and the static data whether or not the battery is valid.

The isolation means may be further configured to prevent energy being delivered to the electrical terminals in order to charge the connected battery unless the battery is determined as valid.

The docking system may comprise a control module configured to initiate the authentication means performing its acquisition, sending and receiving steps in response to an electrical control signal being received from the battery indicative of the battery being correctly secured. The electrical control signal from the battery may be received through one or more predetermined terminals, different from terminal(s) through which electrical energy is received or delivered from/to the connected battery. The control module may be further configured to stop the authentication means performing its acquisition, sending and receiving steps if the electrical control signal stops being received from the battery prior to the determination.

The electrical control signal may be received in response to user action on a button or switch provided on the connected battery.

The authentication means may be configured to generate a pseudorandom (PN) number and to apply said PN number to the received static data using a predetermined algorithm A1, to send the PN number as the challenge signal and to determine based on the challenge response whether or not there is a valid match.

The static data may comprise two separate sets of data received from a connected battery. The static data may comprise data representing a manufacturing date and a serial number of the battery.

The PN number may be generated using a linear feedback shift register that updates automatically after a period of time to generate a new PN number.

The isolation means may be a solid state switch, e.g. a FET, which is opened to electrically isolate the system from the connected battery and closed when a valid battery is detected.

After the battery is determined as valid, the authentication means may further be configured to send subsequent challenge signals whilst the battery remains connected to the system, and to determine based on the challenge response from the battery whether or not the battery continues to be valid, and wherein the isolation means is configured to prevent energy being received from the battery if an invalid condition is detected subsequently.

The docking system may further comprise an audible alarm which is configured to sound in the event that an invalid battery is detected.

The docking system may further comprise storage means comprising computer-readable code which, when executed, is configured to store a log of events pertaining to the validation or non-validation state of a connected battery.

The computer-readable code, when executed, may be configured to store in the log details of the time of the validation or non-validation condition and the static data received from the associated battery.

A second aspect of the invention provides a docking station comprising means for connecting to a battery and receiving electrical energy from one or more terminals of the battery for delivery to a load, the docking station further comprising an isolation means for isolating the load from the connected battery until a control signal is received from the battery indicative of (a) the battery being connected and the user operating a button or switch on the connected battery, and (b) subsequent to (a) the battery is authenticated using an authentication algorithm which takes as input data stored on the battery.

A third aspect provides a rechargeable battery for connection to the docking system according to any preceding claim, the battery comprising electrical terminals including a power terminal and one or more control terminals for connection to corresponding terminals of the docking station, wherein the battery is configured to respond to an authentication signal initiated by the docking station to which it is connected with data for enabling validation to be performed at said docking station.

The battery may further comprise a memory configured to store a set of static data, to send the static data to the docking station when connected thereto, to receive a challenge signal from the docking station, automatically to generate a challenge response using the challenge signal, and to send the challenge response to the docking system.

The battery may be configured to generate the challenge response using the challenge signal and a predetermined algorithm A2 which takes as inputs data in the challenge signal and the stored static data.

In a validated system, the predetermined algorithm A2 is preferably the same as an algorithm A1 stored at the docking station.

One or more electrical terminals may be first control terminal(s) for being connected to corresponding control terminal(s) of the docking station, the battery further comprising a button

or switch that, when operated by user action, generates a control signal which is output to the first control terminal(s).

One or more electrical terminals may be second control terminal(s) for being connected to corresponding control terminal(s) of the docking station, the battery further comprising a control means configured to isolate the battery from delivering or receiving electrical energy through its power terminal until a predetermined connection condition is met.

In the context of this specification, the term docking system is intended to cover stand-alone battery chargers.

Brief Description of the Drawings

The invention will now be described, by way of non-limiting example, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a medical trolley having a plurality of battery modules connected thereto via docking station(s);
Figure 2 is a perspective view of the docking station hidden from view in Figure 1;
Figure 3 is a perspective view of a battery module connected to the docking station of Figure 2;
Figure 4 is a schematic plan view of metallic terminals of the battery module shown in Figure 3, from the reverse side;
Figure 5 is a circuit schematic diagram showing functional elements of both the docking station shown in Figure 2 and the battery module shown in Figure 3;
Figure 6 is a flow diagram showing process steps performed by an isolation routine; and
Figure 7 is a process timing diagram showing stages of an authentication routine forming part of the isolation routine shown in Figure 6.

Detailed Description of Preferred Embodiments

Figure 1 shows a medical trolley 1 on which electronic medical equipment (or entertainment equipment for use in a medical environment) may be mounted and powered by a battery pack 3. In this case, first and second battery packs 3 are shown mounted on the stem of the trolley 1; one battery pack 3 is connected to a docking station 5 (shown more clearly in Figure 2) to provide power to the electronic equipment and the other is a replacement battery supported on the opposite side for manual replacement into the docking station when required. Alternatively, two such docking stations 5 may be provided so that batteries can be 'hot swapped' automatically when the charge on one battery is depleted.

Figure 2 shows an example docking station 5 which comprises an elongate unit having, at a lower end, a lower dock support 7 on which one end of the battery pack 3 is located in use and, at an upper end, a dock connector 9 into which the other end of the battery pack is releasably secured into position. In order to connect a battery pack 3 to the docking station 5, the lower end of the battery pack 3 is first located over a protruding part 11 of the lower dock support 7 and then the upper part is rotated towards the dock connector 9 where it is secured it in place.

Figure 3 shows the battery pack 3 when secured to the docking station 5.

When a battery pack 3 is connected to the docking station 5, subject to an authentication process (to be explained later), electrical energy from a battery cell inside the battery pack is discharged through the docking station into internal circuitry of the trolley 1 which provides the necessary connections to the supported electronic equipment.

The docking station 5 has a plurality of dome-like electrical terminals 13. Each is configured to connect with a corresponding terminal 15 provided on the battery, for which see the schematic of Figure 4 which is the rear face of battery pack 3. In this example, four terminals 17 are used for the charging and discharge of electrical energy from the battery cell. These terminals are referred to as Vbat and the docking station has a corresponding set 19, for which see Figure 2. Other terminals are used for different purposes, some of which will be explained below. The terminals 15 of the battery module 3 are preferably planar in form and recessed from the outer casing so that terminals cannot be accidentally shorted if placed on a flat metallic surface.

To avoid damage to either the docking station 5 or the battery pack 3, the battery is required to be authenticated to the docking station. Prior to authentication, the docking station 5 isolates its Vbat terminals 19 to prevent the receiving or delivering of electrical energy for the purposes of charging the battery module 3 and the discharging of energy from the battery to electrical equipment on the trolley 1, i.e. the load. Only when a connected battery pack 3 is authenticated is the isolation removed and charging and discharge permitted. The primary purpose of this is to avoid incompatible batteries (or batteries that have not gone through the necessary quality control) from damaging the docking station 5 or from becoming hazardous.

Referring to Figure 5, functional circuit components of both the docking station 5 and battery pack 3 are shown.

The docking station 5 comprises a microprocessor 31, which is connected to a memory module 33 and a pseudo random number (PN) generator 35. The microprocessor 31 is also connected to a solid state switch Q1 37 which in this case is a field effect transistor (FET).

The switch Q1 37 provides the isolation means; specifically, one end is connected to the Vbat terminals 19 and the other to the load of the docking station 5. The switch 37 is opened and closed by the microprocessor 31. The microprocessor 31 has a control input and output which is connected to a control pin 41 (Vcont) of the terminals 13.

The microprocessor 31 runs under program control (the program being stored on the memory module 33) to control operation of each of the other components connected to it, particularly authentication and isolation control. For this purpose, RAM (not shown) is also provided for the temporary storage of data. The microprocessor 31 can take any suitable form.

The authentication program includes an authentication algorithm A1 which takes as input static data from a connected battery and a seed which, in this case, is in the form of a pseudo random number generated by the PN generator 35. The static data can be any fixed data stored in the battery.

The battery pack 3 comprises a microprocessor 51, which is connected to a memory module 53, a user-operable switch 57, a solid state switch Q2 55 and to a dock_detect terminal 61 of the terminals 15. The microprocessor 51 has a control input and output which is connected to a control pin 59 (Vcont) of the terminals 15. The microprocessor 51 runs under program control (the program being stored in the memory module 53) to control operation of each of the other components connected to it. One program relates to a dock detect routine. Another program relates to the authentication process, and runs in cooperation with the authentication program on the docking station 5. For this purpose, the authentication program on the battery also uses an authentication algorithm A2.

The battery cell of the battery pack 3 is indicated by reference numeral 63.

Dock Detect Routine

When the battery 3 is disconnected from the docking station 5, the Dock_Detect terminal 61 is held at a high (non-zero) voltage by the resistor R. Responsive to this high voltage the microprocessor 51 closes switch Q2 55 and hence the battery cell is isolated by Q2 from the Vbat terminal 17. This provides a first advantageous safety feature to prevent accidental

discharge from the Vbat terminal 17. When the battery pack 3 is connected to the docking station 5, the docking station pin 43 pulls the signal at terminal 61 low; the microprocessor 51 responds to this by opening Q2 55 to permit charging and discharging to Vbat 17.

Authentication

Referring to Figure 6, an overview of the authentication process performed by the docking station's authentication program will now be described.

In an initial step 6.1, the isolation FET Q1 37 is opened (if not already open). In step 6.2 it is determined whether a battery is detected, i.e. connected to the docking station 5. In step 6.3 a challenge and response process takes place, which will be described later on with reference to Figure 7. In step 6.4 it is determined wither the battery is authenticated. If so, then in step 6.5 Q1 is closed and hence Vbat 19 can receive and deliver electrical energy from / to the battery cell 63 and the load can receive energy.

As part of the challenge and response process in step 6.3 a PN seed is generated using the PN generator 35. The PN generator 35 is a 16-bit linear feedback shift register (LFSR) which changes its value every 100 seconds. In step 6.6, if the seed changes, the process returns to step 6.2 and the authentication process repeats. If the battery pack is disconnected in the meantime, the process returns to step 6.1 and Q1 37 is opened (step 6.7).

In the event of non-authentication in step 6.4, the authentication process in this case repeats three times (step 6.8) after which an alarm condition is set, resulting in e.g. a visual or audible alarm being initiated in step 6.9. Whilst the alarm condition is set, the process continues to monitor the connection state of the battery in step 6.10 and if disconnected the process returns to step 6.1.

The challenge and response process 6.3 is indicated in Figure 7. In a first step 7.1 the docking station 5 requests static data from the battery pack 3. The static data can be any static data stored in the battery pack 3; in this case, we use two sets.

In step 7.2 the battery pack 3 sends the static data to the docking station 5 using the connected Vcont terminals 59, 41.

In step 7.3 the docking station 5 obtains a PN seed from PN module 35. The PN seed is transmitted to the battery 3 in step 7.4.

In step 7.5 the docking station 5 uses its authentication algorithm A1 to compute an authentication result #1 using the static data and the PN seed.

In step 7.6 the battery 3 uses its authentication algorithm A2 likewise to compute an authentication result #2 using its static data and the PN seed received from the docking station 5. In step 7.7, authentication result #2 is sent back to the docking station 5.

In step 7.8, the docking station 5 compares the authentications results #1 and #2 and authenticates the battery 3 if there is a match. Otherwise, there is no authentication.

Note that step 7.4 can be performed before or after step 7.1.

Thus, the authentication algorithms A1 and A2 represent a shared secret and in this case authentication will only result if the algorithms are the same. The algorithm is arranged such that even in a single number change in one parameter will cause a significant deviation on the results #1 and #2.

For example, below are three sets of results each with sequential seed numbers. The second set only changes the first set of static data by one, and the third set only changes the second set of static data by one.

	Set #1			Set #2			Set #3		
vSeed	Stat.1	Stat.2	Result	Stat.1	Stat.2	Result	Stat.1	Stat.2	Result
100	1234	3465	56174	1235	3465	59153	1234	3466	40943
101	1234	3465	46813	1235	3465	52771	1234	3466	16350
102	1234	3465	28090	1235	3465	40007	1234	3466	32701

The code to generate these keys is about 150bytes & computes the result in under a second. The PN generator 35 can generate the 16-bit seed pseudo randomly with a simple free running counter in the main loop.

A battery pack that is not authentic may have different static data or a different algorithm A2. Either or both the static data or algorithm may be protected further from being copied by means of encryption.

Battery Connection Detection

The docking station 5 may use one of various methods for detecting that a battery pack 3 is connected to it. These may be electrical or mechanical or a combination of both.

In one embodiment, the docking station 5 (specifically the microprocessor 31) requires a battery_detect signal to be received from the battery pack 3 in order to commence authentication. The battery pack 3 is configured to generate this signal in response to the switch or button 57 on the battery pack being operated by user action for a predetermined time period. The switch or button 57 is preferably capacitive to reduce accidental activation. If pressed for the predetermined time period, the battery_detect signal is issued by the microprocessor 51 to the docking station 5 and authentication commences. The user can then release the button at this time. The battery pack 3 has a light emitter on the front to indicate to the user when the button can be released. If released before the time has elapsed, the battery cannot be authenticated.

In another embodiment, which makes use of the aforementioned dock detect routine performed by the battery pack 3, the microprocessor 51 only issues the battery_detect signal to the docking station 5 if both the dock detect terminal 61 is pulled low and, subsequent to this event, the switch or button 57 is operated for the predetermined time period.

Log and Management System

The docking station 5 may comprise an internal log which stores data relating to various events, including any of the following:

- the details of batteries connected thereto,
- time of connection;
- authentication result.

The list is not exhaustive.

The internal log can be uploaded either manually or periodically to a centralised management server, e.g. of a hospital, to maintain a global log of docking stations and the tracking of batteries, whether genuine or otherwise.

In another embodiment, the battery pack 3 could contain its own internal authentication system similar or the same as that provided in the docking station 5. More specifically, the battery pack 3 would comprise the means to communicate with the docking station 5 to determine whether or not the docking station 5 is valid or not valid, and to isolate itself against power being received or delivered from or to the docking station 5 if not valid. The general circuit setup and methodology would be appreciated by the skilled person from the above. Thus,

two-way authentication can be provided. This can be performed sequentially in any order or simultaneously.

For the avoidance of doubt, whilst the term docking station has used been throughout, this is intended to cover stand-alone chargers which can contain the same circuitry and functionality described and shown in, e.g. Figure 5. The term docking station as used in the claims is intended as such to cover stand alone-chargers and indeed any device to which a rechargeable battery pack can mechanically and electrically connect.

In summary, there is described a novel docking station and battery pack which together provide a means of preventing damage to either or both modules due to the use of incompatible batteries or batteries that have not gone through the appropriate quality control procedures. In some embodiments, this is provided by an authentication routine that prevents the discharge of energy from the battery cell to the dock unless the battery is authenticated; in other embodiments, one or more conditions must be met even before authentication commences, e.g. the battery pack must detect that it is connected to the docking station and that the user is depressing a power-on switch for a predetermined time period.

Battery Pack Updating & Logging

The program stored on the battery pack 3 can be updated through the electrical terminals without the need to open the battery pack. Otherwise, any firmware update would require the sealed unit to be opened and the plastics to be replaced and resealed.

The microprocessor 51 can be induced externally into a bootloader condition which permits external access to the microprocessor 51 and updating of new program code. In the present embodiment, the command set of the SM bus, which is conventionally used to communicate battery functions, is expanded to perform additional functions one of which is to induce the bootloader and upload new firmware via the SM bus.

Another feature provided by extending the SM bus command set is to gain direct access to the on-board memory 53 (or additional/alternative memory) enabling logging information to be written or read directly to the memory, again via the SM bus which is in effect an I2C bus. This connection usually connects to the SM bus port of the LTC Battery Management IC within the docking station 5; however in this case within the docking station is to use an I2C multiplexer to take-over the SM bus lines for the programming. However, for logging, we monitor the SM bus and use the space between commands to read and write to the memory logs.

The logging information allows the history of the battery pack 3 to be maintained within, e.g. for examination at a later date, or through back-end software, where the data may also be collected remotely.

It will be appreciated that the above described embodiments are purely illustrative and are not limiting on the scope of the invention. Other variations and modifications will be apparent to persons skilled in the art upon reading the present application.

Moreover, the disclosure of the present application should be understood to include any novel features or any novel combination of features either explicitly or implicitly disclosed herein or any generalization thereof and during the prosecution of the present application or of any application derived therefrom, new claims may be formulated to cover any such features and/or combination of such features.

Claims

1. A docking system for receiving electrical energy from a rechargeable battery, the docking system comprising:

means for mechanically securing a battery to electrical terminals of the docking system;

authentication means configured to communicate with a connected battery to authenticate whether or not it is valid; and

an isolation means configured to isolate the system to prevent energy being received from a connected battery through the electrical terminals if the battery is determined as invalid.

2. A docking system according to claim 1, wherein the authentication means is configured to acquire static data from the battery, to send a challenge signal to the battery, to receive a challenge response from the battery and to determine based on the challenge response and the static data whether or not the battery is valid.

3. A docking system according to claim 1 or claim 2, wherein the isolation means is further configured to prevent energy being delivered to the electrical terminals in order to charge the connected battery unless the battery is determined as valid.

4. A docking system according to any preceding claim, further comprising a control module configured to initiate the authentication means performing authentication in response to an electrical control signal being received from the battery indicative of the battery being correctly secured.

5. A docking system according to claim 4, wherein the electrical control signal from the battery is received through one or more predetermined terminals, different from power terminal(s) through which electrical energy is received or delivered from/to the connected battery.

6. A docking system according to claim 4 or claim 5, wherein the control module is further configured to stop the authentication means performing authenticationif the electrical control signal stops being received from the battery prior to the determination.

7. A docking system according to any one of claims 4 to 6, wherein the electrical control signal is received in response to user action on a button or switch provided on the connected battery.

8. A docking system according to any preceding claim, wherein the authentication means is configured to generate a pseudorandom (PN) number and to apply said PN number to received static data using a predetermined algorithm (A1), to send the PN number as a challenge signal and to determine based on a challenge response whether or not there is a valid match.

9. A docking system according to claim 2 or any claim dependent thereon, wherein the static data comprises two separate sets of data received from a connected battery.

10. A docking station according to claim 8 or any claim dependent thereon, wherein the PN number is generated using a linear feedback shift register that updates automatically after a period of time to generate a new PN number.

11. A docking system according to any preceding claim, wherein the isolation means is a solid state switch, e.g. a FET, that is opened to electrically isolate the system from the connected battery, and closed when a valid battery is detected.

12. A docking system according to any preceding claim, wherein, after the battery is determined as valid, the authentication means is further configured to send subsequent challenge signals whilst the battery remains connected to the system, and to determine based on the challenge response from the battery whether or not the battery continues to be valid, and wherein the isolation means is configured to prevent energy being received from the battery if an invalid condition is detected subsequently.

13. A docking system according to any preceding claim, further comprising an audible alarm which is configured to sound in the event that an invalid battery is detected.

14. A docking system according to any preceding claim, further comprising storage means comprising computer-readable code which, when executed, is configured to store a log of events pertaining to the validation or non-validation state of a connected battery.

15. A docking system according to claim 14, wherein the computer-readable code, when executed, is configured to store in the log details of the time of the validation or non-validation condition and the static data received from the associated battery.

16. A docking station comprising means for connecting to a battery and receiving electrical energy from one or more terminals of the battery for delivery to a load, the docking station further comprising an isolation means for isolating the load from the connected battery until a control signal is received from the battery indicative of (a) the battery being mechanically connected and the user operating a button or switch on the connected battery, and (b) subsequent to (a) the battery is authenticated using an authentication algorithm which takes as input data stored on the battery.

17. A rechargeable battery for connection to the docking system according to any preceding claim, the battery comprising electrical terminals including a power terminal and one or more control terminals for connection to corresponding terminals of the docking station, wherein the battery is configured to respond to an authentication signal initiated by the docking station to which it is connected with data for enabling validation to be performed at said docking station.

18. A rechargeable battery according to claim 17, further comprising a memory configured to store a set of static data, to send the static data to the docking station when connected thereto, to receive a challenge signal from the docking station, automatically to generate a challenge response using the challenge signal, and to send the challenge response to the docking system.

19. A rechargeable battery according to claim 18, wherein the battery is configured to generate the challenge response using the challenge signal and a predetermined algorithm (A2) which takes as inputs data in the challenge signal and the stored static data.

20. A rechargeable battery according to claim 19, wherein the predetermined algorithm (A2) is the same as an algorithm (A1) stored at the docking station.

21. A rechargeable battery according to any of claims 17 to 19 when dependent on claim 4, or claim 16, wherein one or more electrical terminals is or are first control terminal(s) for being connected to corresponding control terminal(s) of the docking station, the battery further comprising a button or switch that, when operated by user action, generates a control signal which is output to the first control terminal(s).

22. A rechargeable battery according to any one of claims 17 to 21, wherein one or more electrical terminals is or are second control terminal(s) for being connected to corresponding control terminal(s) of the docking station, the battery further comprising a control means configured to isolate the battery from delivering or receiving electrical energy through its power terminal until a predetermined connection condition is met.

23. A rechargeable battery according to any one of claims 17 to 21, further comprising authentication means configured in response to being connected to a docking station to communicate with the docking station to authenticate whether or not the docking station is valid and to isolate itself from delivering or receiving power to or from the docking station if invalid.

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Application No:	GB1501237.0	**Examiner:**	Dr Steven Chadwell
Claims searched:	1-16	**Date of search:**	29 September 2016

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 & 16 at least	GB 2400759 A (SANYO) see whole document
X	1 & 16 at least	EP 1892791 A1 (MATSUSHITA) see whole document
X	1 & 16 at least	US 2012/0235628 A1 (OKABAYASHI et al) see whole document, especially the abstract, figures and paragraphs [0010]-[0025] and [0090]-[0155]
X	1 & 16 at least	US 2006/0087286 A1 (PHILLIPS et al) see whole document, especially paragraphs [0067]-[0075] and figures 7 and 8
X	1 & 16 at least	US 5350993 A (TOYA et al) see whole document, especially the abstract and figures
X	1 & 16 at least	JP 2012129015 A (JVC) see figures 1, 2 and 6-12 in particular, and also the EPODOC abstract and WPI Abstract Accession No. 2012-H62843
X	1 & 16 at least	JP 2009015744 A (MATSUSHITA) see especially figure 1, paragraphs [0036]-[0037], and also the EPODOC abstract and WPI Abstract Accession No. 2009-E12231
X	1 & 16 at least	JP 2006114423 A (SONY) see especially figure 4 and also the EPODOC abstract and WPI Abstract Accession No. 2006-313167
X	1 & 16 at least	JP 2005285567 A (CASIO) see figures 1 and 16 in partcicular, and also the EPODOC abstract and WPI Abstract Accession No. 2005-752552

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

Worldwide search of patent documents classified in the following areas of the IPC

H01M; H02J

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
H01M	0010/44	01/01/2006
H01M	0002/34	01/01/2006
H01M	0010/46	01/01/2006
H02J	0007/00	01/01/2006