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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) **METHOD OF REPLACING A BATTERY AND AN ELEVATOR SYSTEM**

(57) The invention relates to an elevator system (1) comprising power supply devices (2) providing operational devices (4, 10, 17, 19) of the elevator system (1) with power, an elevator control controlling (8) the operation of the elevator system (1), and a first battery (9) which is charged by the power supply devices (2). To improve the safety in an elevator system where one or more batteries are utilized the elevator control (8) is arranged to interrupt charging of the first battery (9) and to discharge the first battery (9) in response to a discharge request.

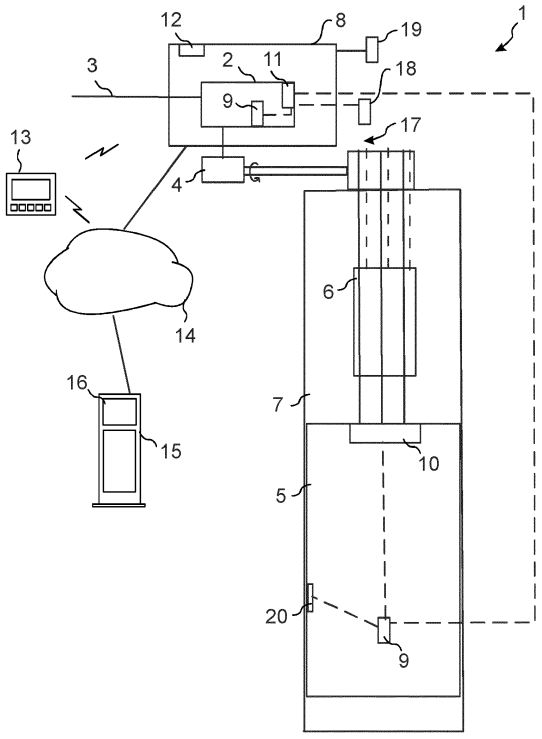

FIG. 3

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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] This invention relates to a solution for improving the safety of maintenance of an elevator system comprising a battery.

DESCRIPTION OF PRIOR ART

[0002] Known elevator systems contain one or more batteries associated with different elevator functions. One or more batteries may be included in the power supply devices as backup for breaks in the electric supply, for instance. Also, the emergency lighting and emergency communication from the elevator car may be provided with one or more batteries.

[0003] Battery technologies have developed significantly in recent years. Due to this the energy density of batteries has increased on relatively high levels. This has caused a need for new solutions in order to be able to safely handle batteries during maintenance.

[0004] Traditionally, lead acid batteries and sealed acid batteries have been used in elevator systems. Due to their battery chemistry, only low amount of battery supervision was required. Therefore, with the new batteries having high energy density and different failure modes, new practices, including new maintenance and installation operations, will be developed to ensure elevator safety.

SUMMARY OF THE INVENTION

[0005] An object of the present invention is to solve the above-mentioned drawback and to provide a solution which improves the safety in an elevator system where one or more batteries are utilized. This object is achieved with the solution defined in the independent method claim 1 and with the elevator system as defined in the independent claim 12.

[0006] The risk of injuries to personnel or to equipment can be minimized when the elevator system is arranged to discharge energy from the battery, in particular from a high-energy battery, in response to a discharge request. In this way, once service personnel start maintenance work involving the battery, the maintenance work can be done under more safe conditions than previously.

[0007] Preferred embodiments of the invention are disclosed in the dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

[0008] In the following the present invention will be described in closer detail by way of example and with reference to the attached drawings, in which

Figure 1 is a flow diagram of a first embodiment of a method,

Figure 2 is a flow diagram of a second embodiment of a method, and

Figure 3 illustrates an elevator system.

DESCRIPTION OF AT LEAST ONE EMBODIMENT

[0009] Figure 1 illustrates a first embodiment of a method of replacing a battery in an elevator system, which may be implemented in the elevator system 1 illustrated in Figure 3, for instance.

[0010] The elevator system 1 is provided with power supply devices 2 connected to an electric network 3 for supplying power to operational devices 4, 10, 17, 19 of the elevator system. In Figure 3 it is by way of example assumed that the power supply devices 2 include a drive, such as a frequency converter, supplying electricity to the electrical motor 4 of a hoisting machinery 17 which moves an elevator car 5 and a counterweight 6 in an elevator shaft 7.

[0011] The power supply devices 2 may be located in several different locations. In Figure 3 it is by way of example assumed that the power supply devices 2 are located in an elevator control 8 controlling the operation of the elevator system 1. The elevator control 8 may be located in a control cabinet in a machine room, for instance. Alternatively, in case of an elevator system without a machine room, the elevator control may be disposed in a landing at one of the floors of the building, for instance. In that case the elevator control may be located next to a landing door, for instance. Alternatively or additionally, the elevator control may be located in shaft 7, close to the hoisting machinery 17.

[0012] The elevator system 1 illustrated in Figure 1 is provided with one or more batteries 9. In the illustrated example two batteries 9 are illustrated by way of example. One battery is included in the power supply devices 2, such as in connection with the drive. At such a location the battery 9 can operate as a backup power supply during power outage of the mains from the electric network 3. With power supplied from this elevator drive battery, the elevator car 5 may be relocated to a landing to release elevator passengers. The battery 9 can also be a backup power supply for one or more hoisting machinery 17 brakes. Further, in the example illustrated in Figure 3 the elevator car 5 has a backup power supply in the form of a battery 9 to secure operation of selected functions, such as emergency lighting 10 and an emergency communication device 20. Irrespectively of the number or locations of the batteries 9, these batteries are charged by a monitoring unit 11 including a battery charger and a switch, which is included in the power supply devices 2 in the illustrated example.

[0013] In particular when the battery or batteries 9 are high energy density batteries, such as Li-Ion (Lithium-Ion) batteries, it is necessary to provide special attention to safety during maintenance work including handling

and replacement of these batteries. To facilitate this, the battery replacement method of Figure 1 is initiated in step A by triggering a discharge request to the elevator control 8. This discharge request may be triggered in several alternative ways, as illustrated in Figure 3.

[0014] The elevator control 8 may be provided with a manual input 12 which is used to trigger the discharge request. In that case the manual input 12 may be a keyboard with buttons, or alternative as a connector socket to which a maintenance person may connect a counterpart socked of a portable keyboard. In any case, by pressing a correct button or button combination, the discharging request may be triggered to the elevator control 8.

[0015] A second alternative is that the maintenance person is provided with a mobile communication device 13 which transmits the discharging request wirelessly directly to the elevator control 8, or alternatively, wirelessly to a communication system 14, which forwards the discharging request wirelessly or via a wired connection to the elevator control 8.

[0016] A third alternative is that the discharging request is triggered remotely at a remote service center 15 or in a cloud, from where the discharge request is forwarded via a communication system 14 to the elevator control 8.

[0017] It is also possible that the discharge request is triggered at the same time a maintenance module is performed. Maintenance module refers to a service module containing service operations. Such a module 16 may be implemented by software only or by a combination of software and hardware, for instance. Maintenance modules will be scheduled in advance in a service center or in a cloud. Each maintenance module contains selected maintenance operations to be performed in elevator site by service personnel. When a maintenance module includes battery replacing operation, discharge request may be triggered such that the battery will be discharged shortly before the maintenance personnel arrives to the site of the elevator system. Alternatively, the service person may access a user interface to schedule a date and time when maintenance is planned, in which case elevator control 8 may trigger the discharge request at the scheduled time.

[0018] Once the discharge request has been triggered, discharging of the first battery 9, which refers to a battery currently used in the elevator system 1, is initiated in step B of Figure 1. Several alternatives for discharging the first battery exists. In an elevator system the used discharging alternative may be fixed, in such a way that the same discharging alternative is always used. Alternatively, it is possible that the discharge load is selected separately by the elevator control or maintenance personnel each time discharging is needed. In that case the elevator status may determine the most appropriate discharging alternative for that specific moment.

[0019] A first alternative is that the discharging is carried out by connecting the battery 9 to an operational device of the elevator system which during operation of the elevator system consumes the charged energy from the battery 9. Examples of such operational devices include a line filter of the drive which is included in the power supply devices 2, lighting devices 10 in the elevator car the electric motor 4 of the hoisting machinery 17 and a braking resistor 19.

[0020] A second alternative is that the elevator system is provided with a dedicated discharging equipment 18 and that the battery is discharged by connecting it to this discharging equipment. Such a discharging equipment may include a resistor which consumes the energy charged in the battery 9 and dissipates it as heat to surroundings, for instance.

[0021] A third alternative is that the discharging is done to the mains network, in other words to the electric network 3. In Figure 3 the monitoring unit 11 may be provided with a battery charger and also with a switch controlling the charging and discharging under control of the elevator control 8. In that case the elevator control 8 interrupts charging of the first battery 9 and discharges the first battery 9 by changing a state of the switch of the monitoring unit 11 such that the first battery 9 is disconnected from the power supply devices 2 and connected to one of the operational devices of the elevator system 1 or to the dedicated discharging equipment 18 which consumes energy from the battery.

[0022] Once the first battery 9 is discharged, the first battery can be removed from the elevator system 1 in step C of Figure 1. Finally, a second new battery may be installed in the elevator system 1 as a replacement to the removed first battery.

[0023] Figure 2 illustrates a second method of replacing a battery in an elevator system, which also may be implemented in the elevator system 1 illustrated in Figure 3, for instance. The embodiment of Figure 2 is very similar to the one explained in connection with Figure 1. Therefore, in the following, the embodiment of Figure 2 will be mainly explained by pointing out the differences as compared to the embodiment of Figure 1.

[0024] In Figure 2 an additional method step E is included where it is checked whether or not the charging level of the first battery has reached a predetermined level. Consequently, discharging of the first battery 9 continues until the charging of the first battery reaches a predetermined level or limit. In Figure 3 the monitoring unit 11 monitors the state of the first battery and interrupts the discharging when the charging level reaches the predetermined level.

[0025] The predetermined level at which discharging should be interrupted varies depending on the battery type. Typically discharging should be interrupted when the charging level reaches 50% to 30% of the full charge. In case of a high energy density battery such as a Li-Ion battery, discharging should be interrupted when the battery has a charging level SoC (State of Charge) mentioned in the United Nations Recommendations on the Transport of Dangerous Goods UN3480 or UN3481. The current version for year 2020 of UN3480 and UN3481 mention a current SoC limit of 30%, though this limit may

change in later versions of these regulations. Consequently, charging of such a battery may be interrupted at 30% of the full charge, for instance. Alternatively or additionally, elevator control may be configured such that the discharge level is adjustable and can be changed manually and / or remotely.

[0026] Additionally, in Figure 2 an additional method step F is included. At this stage the maintenance person, after triggering discharging of the first battery 9, remains waiting for an indication verifying that the battery has actually been discharged. Such an indication may be provided by the elevator control 8 via the manual input 12, for instance, once the monitoring unit 11 has determined that the first battery has been discharged to a correct level.

[0027] It is to be understood that the above description and the accompanying figures are only intended to illustrate the present invention. It will be obvious to a person skilled in the art that the invention can be varied and modified without departing from the scope of the invention.

Claims

1. A method of replacing a battery in an elevator system, **characterized in that** the method comprises:

   triggering (A) a discharge request to an elevator control (8),
   discharging (B) a first battery (9) in the elevator system in response to the discharge request,
   removing (C) the discharged first battery (9) from the elevator system,
   installing (D) a second battery as a replacement for the removed first battery.

2. The method according to claim 1, wherein discharging (E) of the first battery (9) is continued until the charging level of the first battery reaches a predetermined level.

3. The method according to claim 1 or 2, wherein discharging (E) of the first battery (9) is continued until the charging level of the first battery reaches a predetermined level which is less than 50% of full charge, preferably 30% or less of the full charge.

4. The method according to one of claims 1 to 3, wherein the discharging is carried out by connecting the first battery (9) to an operational device of the elevator system (1) which during operation of the elevator system consumes the charged energy from the first battery (9).

5. The method according to one of claims 1 to 4, wherein the discharging is carried out by connecting the first battery (9) for discharging to a line filter (2), to a hoisting machinery (17), to a braking resistor (19) or to a mains network.

6. The method according to one of claims 1 to 3, wherein the discharging is carried out by connecting the first battery (9) to a dedicated discharging equipment (18).

7. The method according to one of claims 1 to 6, wherein the discharge request is triggered from a manual input (12) of the elevator control (8).

8. The method according to one of claims 1 to 6, wherein the discharge request is triggered by a mobile device (13) transmitting the discharge request via a wireless connection to the elevator control (8).

9. The method according to one of claims 1 to 6, wherein the discharge request is triggered at a remote service center (15) which forwards the discharge request via a communication network (14) to the elevator control (8).

10. The method according to one of claims 1 to 9, wherein the discharge request is triggered by a maintenance module of the elevator system.

11. The method according to one of the previous claims, wherein
    an indication (F) that the first battery (9) has been discharged is awaited after triggering the discharge request, and
    the first battery is removed (C) after said indication.

12. An elevator system (1) comprising:

    power supply devices (2) providing operational devices (4, 10, 17, 19) of the elevator system (1) with power,
    an elevator control controlling (8) the operation of the elevator system (1), and
    a first battery (9) which is charged by the power supply devices (2), **characterized in that**
    the elevator control (8) is arranged to interrupt charging of the first battery (9) and to discharge the first battery (9) in response to a discharge request.

13. The elevator system of claim 12, wherein
    the elevator system (1) comprises a switch (11) controlling charging and discharging of the first battery (9) under control of the elevator control (8), and
    the elevator control (8) interrupts charging of the first battery (9) and discharges the first battery (9) by changing a state of the switch (11) such that the first battery (9) is disconnected from the power supply devices (2) and connected for discharging to one of the operational devices (4, 10 17, 19) of the elevator

system (1), to a dedicated discharging equipment (18) which consumes energy from the first battery (9) or to a mains network.

14. The elevator system of claim 12 or 13, wherein the elevator system (1) comprises a monitoring unit (11) monitoring the state of the first battery (9), and which comprises a switch interrupting discharging of the first battery (9) when the charging level of the first battery (9) reaches a predetermined level.

15. The elevator system according to one of claims 12 to 14, wherein the elevator system comprises a monitoring unit (11) monitoring the state of the first battery (9) and the elevator control (8) provides an indication that the first battery (9) has been discharged when the charging level of the first battery (9) reaches a predetermined level.

16. The elevator system according to one of claims 12 to 15, wherein the first battery (9) is one of a backup power supply of a hoisting motor, a backup power supply of one or more hoisting machinery (17) brakes, a backup power supply of an emergency communication device (20) or a power supply of emergency lighting (10).

Amended claims in accordance with Rule 137(2) EPC.

1. A method of replacing a battery in an elevator system, **characterized in that** the method comprises:

triggering (A) a discharge request to an elevator control (8),
discharging (B) a first battery (9) in the elevator system in response to the discharge request,
removing (C) the discharged first battery (9) from the elevator system,
installing (D) a second battery as a replacement for the removed first battery.

2. The method according to claim 1, wherein discharging (E) of the first battery (9) is continued until the charging level of the first battery reaches a predetermined level.

3. The method according to claim 1 or 2, wherein discharging (E) of the first battery (9) is continued until the charging level of the first battery reaches a predetermined level which is less than 50% of full charge, preferably 30% or less of the full charge.

4. The method according to one of claims 1 to 3, wherein the discharging is carried out by connecting the first battery (9) to an operational device of the elevator system (1) which during operation of the elevator system consumes the charged energy from the first battery (9).

5. The method according to one of claims 1 to 4, wherein the discharging is carried out by connecting the first battery (9) for discharging to a line filter (2), to a hoisting machinery (17), to a braking resistor (19) or to a mains network.

6. The method according to one of claims 1 to 3, wherein the discharging is carried out by connecting the first battery (9) to a dedicated discharging equipment (18).

7. The method according to one of claims 1 to 6, wherein the discharge request is triggered from a manual input (12) of the elevator control (8).

8. The method according to one of claims 1 to 6, wherein the discharge request is triggered by a mobile device (13) transmitting the discharge request via a wireless connection to the elevator control (8).

9. The method according to one of claims 1 to 6, wherein the discharge request is triggered at a remote service center (15) which forwards the discharge request via a communication network (14) to the elevator control (8).

10. The method according to one of claims 1 to 9, wherein the discharge request is triggered by a maintenance module of the elevator system.

11. The method according to one of the previous claims, wherein

an indication (F) that the first battery (9) has been discharged is awaited after triggering the discharge request, and
the first battery is removed (C) after said indication.

12. An elevator system (1) comprising:

power supply devices (2) providing operational devices (4, 10, 17, 19) of the elevator system (1) with power,
a first battery (9) which is charged by the power supply devices (2),
an elevator control controlling (8) the operation of the elevator system (1), the elevator control (8) is arranged to interrupt charging of the first battery (9) and to discharge the first battery (9) in response to a discharge request **characterized in that** the elevator system comprises a monitoring unit (11) monitoring the state of the first battery (9) and the elevator control (8) provides an indication that the first battery (9) has been discharged when the charging level of the first battery (9) reaches a predetermined level.

13. The elevator system of claim 12, wherein

the elevator system (1) comprises a switch (11) controlling charging and discharging of the first battery (9) under control of the elevator control (8), and
the elevator control (8) interrupts charging of the first battery (9) and discharges the first battery (9) by changing a state of the switch (11) such that the first battery (9) is disconnected from the power supply devices (2) and connected for discharging to one of the operational devices (4, 10 17, 19) of the elevator system (1), to a dedicated discharging equipment (18) which consumes energy from the first battery (9) or to a mains network.

14. The elevator system of claim 12 or 13, wherein the elevator system (1) comprises a monitoring unit (11) monitoring the state of the first battery (9), and which comprises a switch interrupting discharging of the first battery (9) when the charging level of the first battery (9) reaches a predetermined level.

15. The elevator system according to one of claims 12 to 14d, wherein the first battery (9) is one of a backup power supply of a hoisting motor, a backup power supply of one or more hoisting machinery (17) brakes, a backup power supply of an emergency communication device (20) or a power supply of emergency lighting (10).

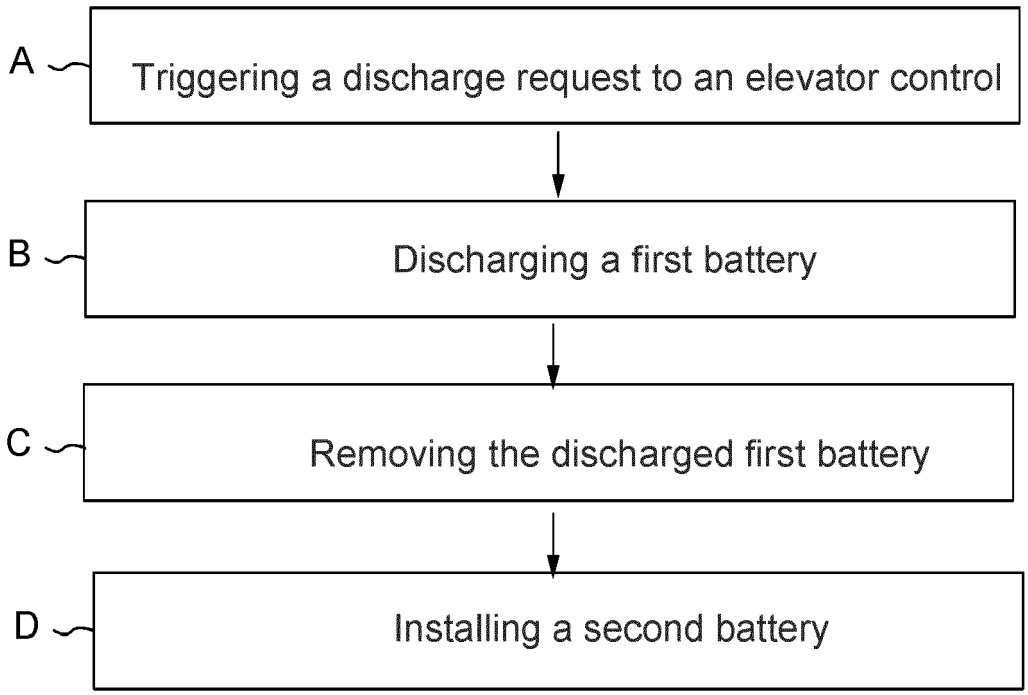
A
Triggering a discharge request to an elevator control
B
Discharging a first battery
C
Removing the discharged first battery
D
Installing a second battery

FIG. 1

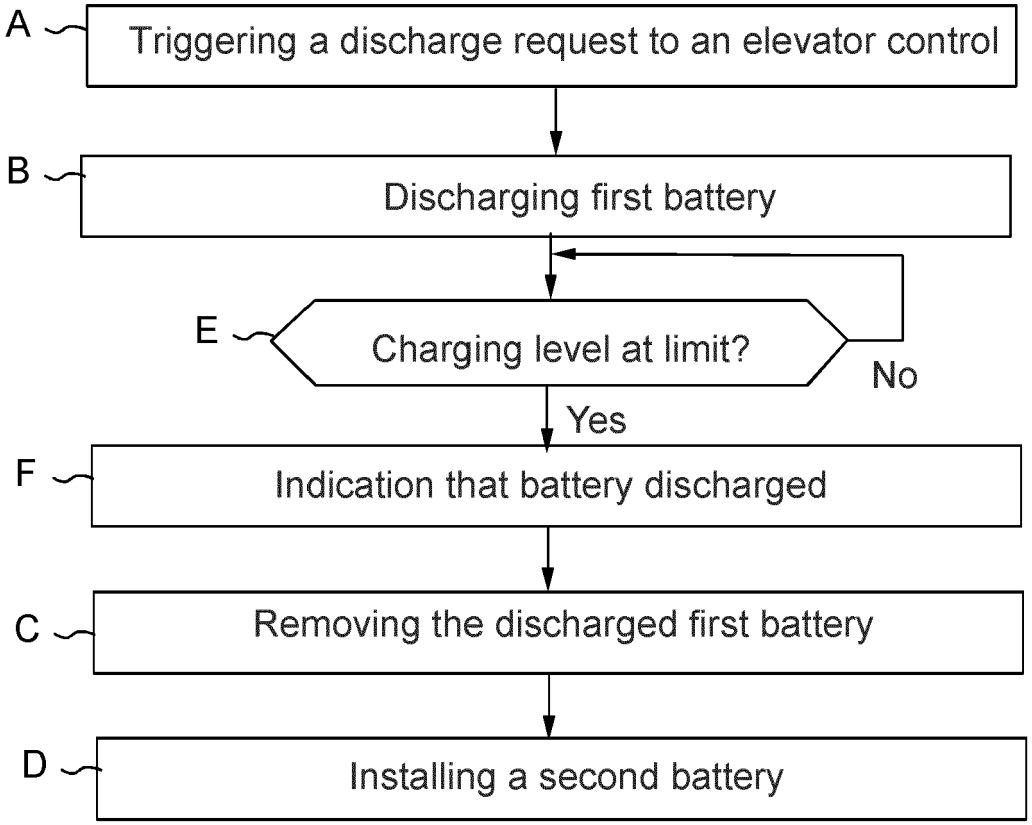
A
Triggering a discharge request to an elevator control
B
Discharging first battery
E
Charging level at limit?
No
Yes
F
Indication that battery discharged
C
Removing the discharged first battery
D
Installing a second battery

FIG. 2

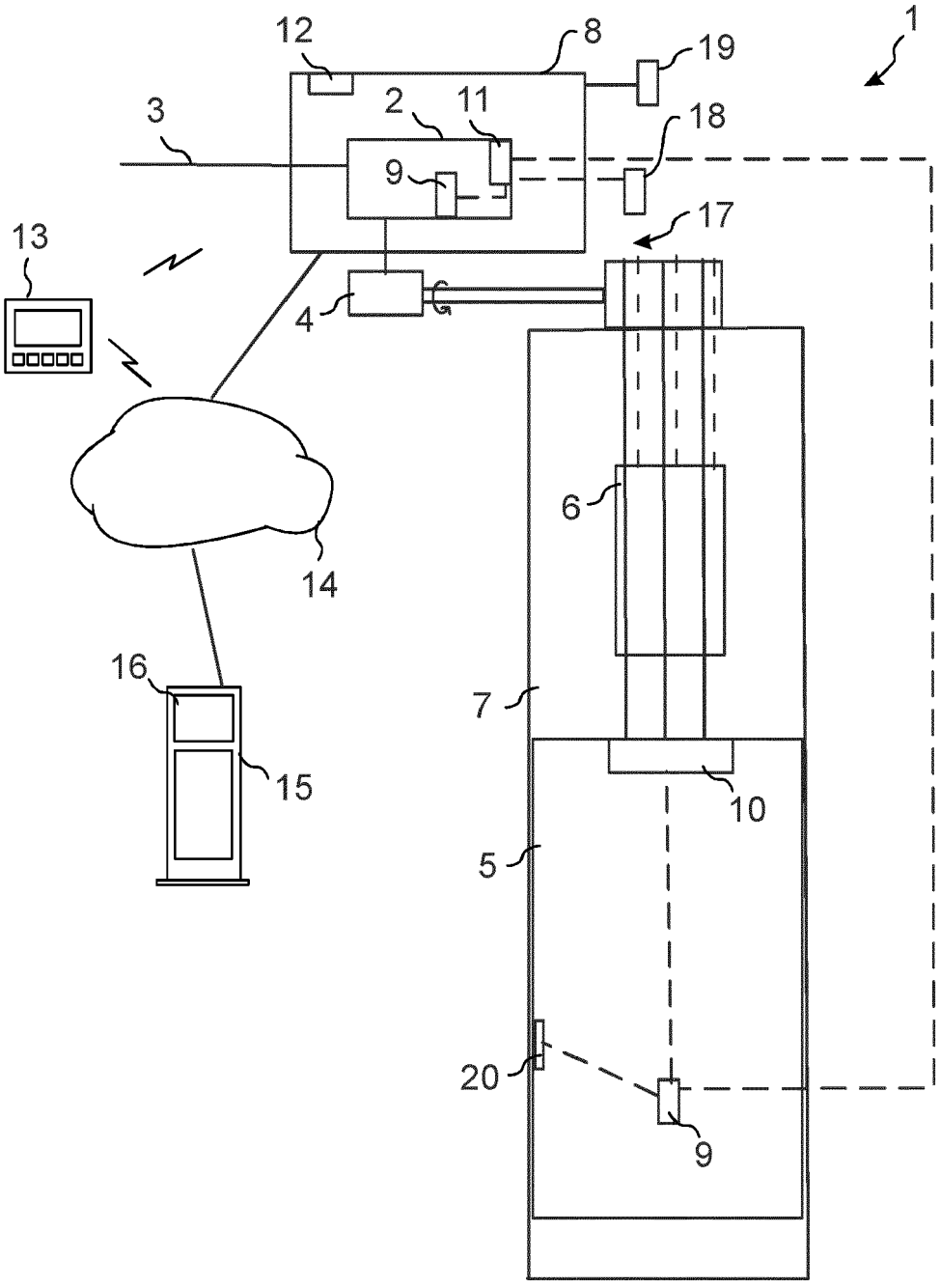

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 20 18 2406

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2002/053490 A1 (BANNO HIROKAZU [JP] ET AL) 9 May 2002 (2002-05-09) * pages 1-6, paragraphs 0007-0019,0046-0076; figures 1-8 * -----	12-16 1-7	INV. B66B5/00 B66B7/00 ADD.
Y	Apcs/cargo: "APCS/Cargo Lithium Battery Guidance Document Transport of Lithium Metal and Lithium Ion Batteries Revised for the 2015 Regulations", , 27 November 2014 (2014-11-27), XP055525153, Retrieved from the Internet: URL:https://www.costha.com/uploads/PDF/1418409745_lithium-battery-guidance-document-2015-en.pdf [retrieved on 2018-11-20]	1-7	B66B19/00 B66B1/46
A	* pages 1-7 * -----	8-16	
A	US 2017/260026 A1 (DOMINGUEZ FRANCK [FR] ET AL) 14 September 2017 (2017-09-14) * the whole document * -----	1-16	

TECHNICAL FIELDS SEARCHED (IPC)
B66B H01M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 November 2020	Lohse, Georg

CATEGORY OF CITED DOCUMENTS

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