

Description

. Field of the invention

[0001] . The present invention relates to a fault detection method for a lift system, a fault detection device, a fault detection kit, and a lift system.

. Background art

[0002] . The lift systems of the known type usually comprise a car movable between a plurality of floors, wherein the car comprises at least one car door and each floor comprises at least one floor door.

[0003] . The car is usually provided inside with a button panel with buttons to control the movement of the car to a floor, and a car alarm button configured to signal an alarm when a user is trapped in the car. In some lift systems, by pressing the car alarm button the user can contact a maintenance operations center directly to signal the fault and request prompt action. In other lift systems, the car alarm button generates an audible signal which alerts people outside the lift system so that they can contact the maintenance operations center by telephone.

[0004] . In the lift systems of the known type, it is thus possible to signal a malfunction only when a user is present, i.e., trapped in the car through the car alarm button, or when the user attempting to use the lift system notices a malfunction thus being able to contact the maintenance operations center by telephone or by pressing an alarm button provided on a button panel in the car or on the roof of the car during a maintenance operation.

[0005] . The average time between the occurrence of the fault and its solution is between 4 and 6 hours as the market standard, being a severe inconvenience to the trapped users and to the users of the building or facility equipped with a lift system who are forced to walk to their destination floor.

[0006] . A need is strongly felt in the industry to reduce intervention time by restoring the use of the lift system in a short time.

[0007] . Furthermore, a need is felt in the industry to find solutions to reduce the fault detection and solution time adapted to be implemented in both modern systems, which meet the most recent safety regulations adopted at the European and international level, and less modern systems.

[0008] . Therefore, the problem underlying the present invention is to devise a fault detection method for a lift system, a fault detection device, a fault detection kit, and a lift system, which have structural and functional features to satisfy the aforementioned requirements and, at the same time, solve the drawbacks mentioned with reference to the prior art and satisfy the aforesaid felt needs.

. Solution

[0009] . It is the object of the present invention to pro-

vide a fault detection method for a lift system, a fault detection device, a fault detection kit, and a lift system.

[0010] . This and other objects and advantages are achieved by a fault detection method for a lift system according to claim **1**, a fault detection device according to claim **8** adapted to implement said method, a fault detection kit according to claim **10**, and a lift system according to claim **12**.

[0011] . Some advantageous embodiments are the object of the dependent claims.

[0012] . The analysis of this solution indicated how to reduce the time to detect a fault in a lift system and how to reduce the time for maintenance staff to intervene.

[0013] . Furthermore, by virtue of the suggested solutions, it is possible to signal a fault in a lift system automatically without the need for a user to be present to detect the fault while using the system or attempting to use it.

[0014] . Still further, the suggested solutions allow the detection of a system failure before the users utilize the system, thus making it possible to reduce the likelihood of a lift system failure occurring when a user is inside the car.

[0015] . Furthermore, the suggested solutions make it possible to implement a fault detection device which can be easily integrated into previously installed lift systems, both the most modern and the older ones, making it possible to increase their safety levels in a cost-effective and minimally invasive manner.

[0016] . Still further, by virtue of the suggested solutions, it is possible to ensure greater readiness of maintenance staff.

[0017] . Still further, by virtue of the suggested solutions, it is possible to analyze the lift movement parameters, which makes it possible to help maintenance staff to identify the causes of the failure and to accelerate its solution, in a preventive manner.

[0018] . Still further, by virtue of the suggested solutions, false positive alarms can be avoided by providing an electrical connection between the fault detection device and at least two floor buttons of the car button panel.

[0019] . Still further, with the suggested solutions, by virtue of the fault detection method, it is possible to detect a fault in the lift system in an automatic manner, and to check the operating status of the lift system remotely without intervening on the switchboard, i.e., completely independently therefrom.

. Drawings

[0020] . Further features and advantages of the fault detection method of a lift system for a lift system, the fault detection device, the fault detection kit, and the lift system will be apparent from the following description of the preferred examples of implementation thereof, given by way of a non-limiting example, with reference to the accompanying figures in which:

- figure 1 shows a block diagram of the failure detection method of a lift system according to the present invention;
- figure 2 shows a fault detection device according to the present invention, which can be connected to a lift car to monitor the movement of the car in the shaft and the movement of at least one car door;
- figure 3 shows a fault detection kit according to the present invention;
- figure 4 diagrammatically shows a lift system according to the present invention configured to implement the method according to the present invention.

. Description of some preferred embodiments

[0021] . According to a general embodiment, a fault detection method is provided for a lift system 100, said lift system 100 comprising a car 101 movable in a travel shaft between a plurality of floors. According to an embodiment, said car 101 is provided with at least one car door 102, each floor of said plurality of floors being provided with at least one floor door.

[0022] . Said method comprising the steps of:

- . x - detecting at least one car movement parameter of said car 101 over time;
- . a1 - analyzing changes of the at least one car movement parameter in a detected second threshold time T2;
- . b1 - when the at least one car movement parameter analyzed in step a1 has not changed in said second threshold time interval T2, sending a second signal to move the car to a second floor position;
- . a2 - following step b1, analyzing changes of the at least one detected car movement parameter in a third threshold time interval T3, said third threshold time interval T3 being successive to said second threshold time interval T2;
- . b2 - when the at least one car movement parameter analyzed in step a2 has not changed for said third threshold time T3, sending a fault signal to signal a fault.

[0023] . According to a manner of operation, said fault signal is sent to a cloud server 200.

[0024] . According to a manner of operation, said fault signal is sent to a list of people in charge of maintenance.

[0025] . According to a manner of operation, an activation of step x, and thus an implementation of the method of the present invention, is provided in an operating time interval. According to an embodiment, the operation time interval can be set according to time slots in which the lift system is usually less used. According to an embodiment, the operation time interval can be set to activate periodically.

[0026] . According to a manner of operation, said at least one movement parameter is a parameter detectable on at least one component of a lift system which can be

either directly or indirectly correlated with a movement of the car 101.

[0027] . According to a manner of operation, said at least one movement parameter comprises at least either a car acceleration, a car pressure or a car position. Indeed, car movements can be determined by detecting accelerations in one direction of car travel higher than a given threshold. It also is possible to determine the movement of the car by detecting the pressure inside the shaft or in the car and evaluating the changes thereof. Similarly, the displacement of the car can be determined by monitoring the position of the car and evaluating changes in the position over time.

[0028] . According to a manner of operation, said method, before step a1, comprises the following steps:

- . a0 - analyzing changes of the at least one car movement parameter in a first threshold time interval T1;
- . b0 - when the at least one car movement parameter analyzed in step a0 has not changed in said first threshold time T1 sending a first signal to move the car 101 to a first floor position; otherwise, repeating step a0.

[0029] . According to a manner of operation, said second floor position is a control position of said car 101, in which said control position is unreachable for an unauthorized user, i.e., in which the car is not configured to stop in normal conditions of use. In this manner, if step a0 and step b0 before step a1 are not provided, it is possible to determine the failure to move the car 101 by sending a single signal to move said car 101.

[0030] . According to a manner of operation, the repetition of step a1 or step a0 is provided, when step a0 is provided, when the at least one car movement parameter analyzed in step a1 has changed in said second threshold time interval T2.

[0031] . According to a manner of operation, the repetition of step a1 or step a0 is provided when step a0 is provided when the at least one car movement parameter analyzed in step a2 has not changed for said third threshold time interval T3.

[0032] . By virtue of the present method, it is possible to automatically command a movement to the car 101 from a current position, in which it is stopped, to a second floor position, in which it is stopped for a second threshold time interval T2 with no passengers inside, and thus automatically check the operating status of the lift system 101.

[0033] . By virtue of step b1, when the previous steps a0 and b0 are provided, it is possible to prevent the failed movement of the car 101 after sending said first signal to move the car 101 to the second floor position from being mistakenly recognized as a failure if the car 101 is already in the second floor position after the first threshold time interval T1 and after the second threshold time interval T2. Therefore, step b1 serves as the control step, and only after verification in step a2 of the movement to

a different position, the second floor position, is the possible sending an alarm signal through step b2.

[0034] . By virtue of this solution, it is thus possible to detect a fault in the lift system by monitoring the failed operation of the system during the time intervals in which the system is not being utilized by the users, thus reducing the likelihood that a failure event will occur trapping a user inside the car.

[0035] . Therefore, the present method of fault detection is a procedure for monitoring the operating status of the lift system which can drastically reduce the fault detection time and the maintenance intervention time.

[0036] . According to a manner of operation, either after or at the same time as step b2, said method comprises the step of:

. b4 - sending a stop signal, through a gateway/modem, to an operational center and/or car button panel and/or lift system.

[0037] . According to a manner of operation, either after or at the same time as step b2, said method comprises the step of:

. b5 - sending from said cloud server 200 a failure message to a list of people in charge of maintenance. In this manner, it is possible to alert the maintenance staff in a timely manner by means of a call and/or message on a mobile communication device, such as a cell phone, and request immediate action.

[0038] . According to a manner of operation, said method comprises a step of configuring, wherein said second threshold time interval T2, and said third threshold time interval T3 is set and stored. According to a manner of operation, said first threshold time interval T1, and/or said operation time interval, and/or said second floor position, and/or said second floor position is set and stored in said setting step.

[0039] . According to a mode of operation, said first threshold time interval T1 is greater than said second threshold time interval T2. According to a mode of operation, said second threshold time interval T2 is greater than said third threshold time interval T3.

[0040] . According to a manner of operation, said first threshold time interval T1 is comprised between 1 minute and 60 minutes. According to a manner of operation, said second threshold time interval T2 is comprised between 2 seconds and 60 minutes. According to a manner of operation, said second threshold time interval T2 is comprised between 5 seconds and 1 minute. According to a manner of operation, said third threshold time interval T3 is comprised between 2 seconds and 60 minutes. According to a manner of operation, said third threshold time interval T3 is comprised between 5 seconds and 1 minute.

[0041] . According to a manner of operation, said method comprises the steps of:

- . c1 - detecting at least one vibrational parameter of the lift system 100 over time;
- . c2 - analyzing changes in a predetermined time

interval T4 of the at least one lift system vibrational parameter detected over time by generating a lift system vibrational characteristic associated with said at least one vibrational parameter detected in the predetermined time interval T4;

. c3 - sending said lift system vibrational characteristic in the predetermined time T4 to a cloud server (200).

[0042] . According to a manner of operation, said predetermined time interval T4 is set in said step of configuration.

[0043] . According to a manner of operation, said at least one vibrational parameter of the lift system comprises car vibrations of said car 101 to be detected during the movement of said car 101. According to a method of operation, said car vibrations are detected on said car 101, preferably on the roof of said car 101.

[0044] . According to a manner of operation, said at least one vibrational parameter of the lift system comprises car door vibrations of said at least one car door 101 to be detected during the movement of said car door 101. According to a manner of operation, the car door vibrations are measured on said car 101.

[0045] . According to a manner of operation, said at least one vibrational parameter of the lift system comprises accelerations and/or guide vibrations to be detected on said car 101 when said car 101 is stopped. According to a manner of operation, said at least one vibrational parameter of the lift system comprises accelerations and/or driving vibrations to be detected on at least one guide 111 arranged in said shaft along which said car 101 runs when said car 101 is stopped.

[0046] . By virtue of step c1, it is possible to detect the vibrations and/or accelerations stressing the car during its movements over time, the vibrations and/or accelerations stressing the at least one car door, the vibrations and/or accelerations to which the at least one guide along which the car runs is subjected, when the car is stopped, allowing the stresses and/or accelerations to which the building is subjected to be detected accordingly.

[0047] . Vibrational parameter characteristic means statistical processing of the vibrations and/or accelerations to which the cab and/or cab door and/or cab guide is subjected which were detected over time and analyzed for the predetermined time interval T4.

[0048] . By virtue of step c2, it is possible to process the vibrational characteristic of the vibrational parameter detected at a specific preset time interval, i.e., the predetermined time interval T4, allowing information to be gathered on the operating status of the car, the car door, and the travel comfort of the lift users.

[0049] . In particular, by virtue of the detected vibrational parameters related to the car and car door, it is possible to obtain a quick evaluation of the user experience of the people using the lift system and the quality of the operation of the car doors.

[0050] . According to a manner of operation, according

to an embodiment, said method comprises the steps of:

- . c4 - comparing said lift system vibrational characteristic in the predetermined time interval T4 with a system standard vibrational characteristic or with a previous system vibrational characteristic associated with said at least one vibrational parameter detected in a previous predetermined time interval T4';
- . c5 - when said lift system vibrational characteristic in the predetermined time interval T4 exceeds or differs from said system standard vibrational characteristic, or said previous system vibrational characteristic, beyond a vibration alarm threshold, sending an alarm signal to a cloud server.

[0051] . According to an embodiment, said standard system vibrational characteristic is set in said step of configuration. Standard system vibrational characteristic means statistical processing of the vibrations to which the car and/or car door and/or car guide are subjected under normal conditions of lift use.

[0052] . According to an embodiment, the predetermined time interval T4 is either one hour or a predetermined number of hours, e.g., 12 hours or 24 hours, and said previous predetermined time interval T4 is respectively related to the previous hour, or a predetermined number of previous hours, such as the previous 12 hours or the previous 24 hours. For example, by comparing the vibrational characteristic of the car movement, and/or the car door and/or the car guide with the previous processed vibrational characteristic, e.g., related to the previous day, it is possible to detect the vibrational changes which occur day by day making it possible to monitor the wear and tear of the system and to detect the presence of damages even imperceptible to a user.

[0053] . By virtue of step c3 and c4, it is possible to detect vibrational abnormalities during the movements of the car and/or car door and/or car guides and to detect possible causes of lift system failure in advance by virtue of step c5 by which an alarm signal is signaled in a timely manner, e.g., to the cloud server and/or a predetermined list of people. In this manner, it is possible to allow the maintenance staff to intervene before failures occur, saving maintenance costs, avoiding the occurrence of costly failures, and increasing user safety.

[0054] . According to a manner of operation, said method comprises the step of associating said at least one vibrational parameter detected in step c1 with said car movement parameter detected in step x. In this manner, for example, when the detected motion parameter is the position of the car, which is followed by an analysis of its changes over time, it is possible to gather precise information on which car positions are most critical on vibrational and acceleration level, as well as possible positions in which prompt maintenance is needed.

[0055] . According to a manner of operation, following said step c5, said method comprises the step of:

- . c6 - sending a stop signal to a car control unit and/or to

a switchboard of said lift system.

[0056] . According to a manner of operation, following said step c5, said method comprises the step of:

- . c7 - sending from said cloud server an intervention message to a list of people in charge of maintenance.

[0057] . According to a manner of operation, said steps c6 and/or c7 are parallel and/or simultaneous with step b5.

[0058] . According to a manner of operation, either in parallel with step b5 or step b2, said method comprises the following step of:

- . b51 - sending, from said cloud server 200, said lift system vibrational characteristic in the predefined time interval T4 to said list of people in charge of maintenance.

[0059] . By virtue of step b51, the people in charge of maintenance are not only informed of the failure of the lift system but also have the opportunity to analyze the vibrational characteristics of the lift system associated with one or more of the vibrational parameters to promptly evaluate the causes of the failure.

[0060] . The present invention further relates to a fault detection device 1 for a lift system 100. In particular, the present device 1 is configured to implement the previously described fault detection method.

[0061] . According to an embodiment, said lift system 100 comprising a car 101 movable along a shaft between a plurality of floors, said car 101 being provided with at least one car 102 and each floor of said plurality of floors being provided with at least one floor door.

[0062] . Said device 1 comprises sensor module 2 configured to detect at least one movement parameter of said car 101 over time.

[0063] . Said device comprises a processing unit 4 configured to analyze changes of the at least one movement parameter detected by said sensor module 2 over time. According to an embodiment, said processing unit 4 is integrated into said sensor module 2.

[0064] . Said device 1 comprises a signal transmission module 5 configured to send a fault signal to signal a fault in the lift system 100. According to an embodiment, the signal transmission module 5 is a wireless transmission module. According to an embodiment, said signal transmission module 5 is configured to communicate with a cloud server 200 and/or a maintenance person list. According to an embodiment, said signal transmission module 5 is integrated into said sensor module 2.

[0065] . Said device 1 comprises a signal converter module 6 connected to said sensor module 2 and/or said processing unit 4.

[0066] . Said device 1 is constrainable to said car 101.

[0067] . Said device 1 is connectable to an energy power source through a power connection or cable 13.

[0068] . Said signal converter module 6 is electrically connectable by means of a second electrical connection 8 to a second floor second button 104 of a car button panel 105 of said car 101. Electrical connection means an electrical connection cable or a connection port for said electrical connection cable. In other words, said sig-

nal converter module 6 is configured to be connected either directly or indirectly to a button panel of a car so that said device 1 can control a car movement autonomously.

[0069] . In this manner, when the analyzed motion parameter has not changed for a second threshold time interval T2, said device 1 is configured to send to the second floor button 104 a second signal to move the car to a second floor position, and when the analyzed current car position $s(t)$ has not changed for a third threshold time interval T3, said device 1 is configured to send, e.g., to said cloud server 200, said failure signal to signal a failure of the lift system 100.

[0070] . According to an embodiment, said signal converter module 6 is electrically connectible by means of a first electrical connection 7 to a first floor first button 103 of a car button panel 105 in parallel with said second electrical connection 104.

[0071] . In this manner, when the at least one analyzed movement parameter has not changed for a first threshold time interval T1 before said second threshold time interval T2, said device 1 is configured to send to said first floor first button 103 a first signal to move the car (101) to a first floor position.

[0072] . According to a manner of operation, said at least one car movement parameter is at least either a car acceleration, a car pressure and/or a shaft pressure and a car position. According to an embodiment, said sensor module 2 comprises at least one of either an accelerometer 9 configured to detect said car acceleration, a pressure sensor 10 configured to detect said shaft pressure and/or car pressure, a position sensor 3 to detect over time said car position of said 101 between said plurality of floors by communicating with a reference position indicating device 106 arranged at a reference floor of said plurality of floors.

[0073] . According to an embodiment, said accelerometer 9 is configured to detect car accelerations and/or car vibrations when said car 101 is in motion along said shaft.

[0074] . According to an embodiment, said accelerometer 9 is configured to detect car door vibrations when said at least one car door 102 is moving relative to said car door 101.

[0075] . According to an embodiment, said at least one accelerometer 9 is configured to detect shaft vibrations when said car 101 and said at least one car door 102 are stopped relative to said shaft. According to an embodiment said at least one accelerometer 9 comprises at least one MEMS accelerometer sampled between 1Hz and 150 HZ, preferably 100 Hz. According to an embodiment said at least one accelerometer 9 comprises at least one MEMS accelerometer sampled between 100 Hz and 1 kHz, preferably 200 Hz.

[0076] . According to an embodiment, said position sensor 3 is a magnetometer and said reference position signaling device 106 is a magnet fixed to a floor door of said reference floor of said plurality of floors, preferably a ground floor, to detect the current car position of said

car 101 relative to said magnet 106.

[0077] . According to an embodiment, said sensor module 2 comprises a temperature sensor configured to detect the temperature in said shaft and/or in said cab.

5 According to an embodiment, said temperature sensor is integrated into said pressure sensor 10.

[0078] . According to an embodiment, said signal converter module 6 is electrically connectible to an alarm button 107 of said car button panel 105 by means of a third electrical connection 11 and/or a car roof alarm button so that when said alarm button 107 is activated, said sensor module 3 is configured to send an alarm signal to said cloud server 200.

[0079] . According to an embodiment, said signal converter module 6 is electrically connectible by means of a fourth electrical connection 12 to a maintenance button 108 of said car button panel 105 and/or a car roof maintenance button such that when said maintenance button 108 is activated, said sensor module 3 is configured to send a performed maintenance signal to said cloud server 200.

[0080] . According to an embodiment, said processing unit 4 is configured to measure the running comfort of the users by evaluating the lifting and acceleration speed.

25 **[0081]** . According to an embodiment, said processing unit 4 is configured to count the number of trips of said car 101. According to an embodiment, said processing unit 4 is configured to determine the average time of each car trip. According to an embodiment, said processing unit 4 is configured to calculate the total distance of trips recorded in a time interval of interest. According to an embodiment, said processing unit 4 is configured to determine a peak time of traffic/use of the lift system. According to an embodiment, said processing unit 4 is configured to detect the temperature and humidity of a shaft. According to an embodiment, said processing unit 4 is configured to control a number of opening and closing cycles of at least one car door.

[0082] . According to an embodiment, said device 1 is configured to evaluate a damage sustained by a structure or building comprising the car travel shaft following and during an earthquake.

[0083] . According to an embodiment, said device 1 is configured to provide a statistical analysis of a drift of said building. According to an embodiment, said device 1 is configured to provide a statistical analysis of the basic building accelerations. According to an embodiment, said device 1 is configured to provide a statistical analysis related to exceeding thresholds of disturbance to people, and exceeding thresholds of non-structural damage to the building.

[0084] . According to an embodiment, said device 1 comprises a memory unit to store the parameters of the step of the configuration of the described method, and the values of the detected and analyzed car motion and/or system vibrational parameters.

[0085] . The present invention further relates to a fault detection kit 20 for a lift system 100.

[0086] . Said kit 20 comprises at least one fault detection device 1 according to at least one of the previously described embodiments. Said fault detection device 1 is connectible to said car 101, preferably on a roof of said car 101 near said at least one car door 102.

[0087] . According to an embodiment, said kit 20 comprises at least one reference position signaling device 106 of a reference floor of said plurality of floors, preferably a ground floor, which can be installed at a floor door of said reference floor.

[0088] . According to an embodiment, said at least one reference position signaling device 106 is a magnet.

[0089] . According to an embodiment, said fault detection kit 20 comprises at least one motor accelerometer 109 installable at a motor 112 of said lift system 100 to detect vibrations of said motor 112.

[0090] . Said fault detection kit 20 comprises at least one guide sensor 110 associable with at least one guide 111 along which said 101 is running, wherein said at least one guide sensor 110 comprises at least one guide inclinometer and/or at least one guide accelerometer.

[0091] . The present invention further relates to a lift system 100.

[0092] . Said lift system 100 comprises at least one car 101 movable in a shaft between a plurality of floors, said car 101 being provided with at least one car 102 and each floor of said plurality of floors being provided with at least one floor door, wherein said car 101 comprises a car button panel 105 comprising at least a second floor second button 104.

[0093] . Said lift system 100 comprises at least one fault detection device 1 according to one of the previously described embodiments.

[0094] . Said at least one fault detection device 1 is fixed to said car 101 and electrically connected to at least said second floor button 104.

[0095] . According to an embodiment, said system comprises at least one guide 111 and said car 101 runs along said at least one guide 111, said guide being mounted inside the travel shaft in which car 101 is movable.

[0096] . According to an embodiment, said at least one guide is at least two guides parallel and facing opposite parts of the travel shaft. Said guides are configured to drive the up and down travel of the car through a rope actuation or hydrodynamic cylinders.

[0097] . According to an embodiment, said system comprises at least one guide sensor 110 which can be associated with said at least one guide 111 along which said car 101 runs. Said at least one guide sensor 110 comprises at least one guide inclinometer, preferably a triaxial MEMS inclinometer, and/or at least one guide accelerometer, preferably a triaxial MEMS accelerometer. According to an embodiment, said at least one guide sensor 110 is mounted on a board PCB connected to a data bus, preferably of the CAN or WI-FI type, which also comprises a power cable, connected to a control unit. According to an embodiment, said at least one guide sensor

111 comprises a microprocessor fitted on said board PCB. According to an embodiment, said guide accelerometer comprises a high-frequency accelerometer and a low-frequency guide accelerometer. According to an embodiment, said low-frequency accelerometer has a sampling frequency between 1 Hz and 150 Hz for structural monitoring. According to an embodiment, said high-frequency accelerometer has a sampling frequency between 1Hz and 1KHz, preferably 200 Hz, for monitoring vibrations transmitted to the guides 111. According to an embodiment, said fault detection device 1 is in data communication with the control unit to which the driving sensors are connected.

LIST OF REFERENCES

[0098]

1	fault detection device
2	sensor module
3	position sensor
4	processing unit
5	wireless transmission module
6	signal converter module
7	first electrical connection
8	second electrical connection
9	accelerometer
10	pressure sensor
11	third electrical connection
12	fourth electrical connection
13	power cable
20	fault detection kit
100	lift system
101	car
102	car door
103	first floor first button
104	second floor second button
105	car button panel
106	reference position indicating device
107	alarm button
108	maintenance button
109	motor accelerometer
110	guide sensor
111	guide
112	motor
200	cloud server

Claims

1. A fault detection method for a lift system (100), said lift system (100) comprising a car (101) movable along a travel shaft between a plurality of floors, said car (101) being provided with at least one car door (102) and each floor of said plurality of floors being

provided with at least one floor door, said method comprising the steps of:

x - detecting at least one car movement parameter of said car (101) over time; 5
 a1 - analyzing changes of the at least one car movement parameter in a second threshold time interval (T2);
 b1 - when the at least one car movement parameter analyzed in step a1 is unchanged in said second threshold time interval (T2), sending a second signal to move the car to a second floor position; 10
 a2 - following step b1, analyzing changes of the at least one car movement parameter in a third threshold time interval (T3), said third threshold time interval (T3) being successive to said second threshold time interval (T2); 15
 b2 - when the at least one car movement parameter analyzed in step a2 is unchanged for said third threshold time interval (T3), sending a fault signal to signal a fault of said lift system (100). 20

2. A fault detection method according to the preceding claim, comprising, before step a1, the following steps: 25

a0 - analyzing changes of the at least one car movement parameter in a first threshold time interval (T1); 30
 b0 - when the at least one car movement parameter analyzed in step a0 is unchanged in said first threshold time interval (T1), sending a first signal to move the car (101) to a first floor position; otherwise, repeating step a0; 35

wherein said second threshold time interval (T2) is successive to said first threshold time interval (T1); 40

and wherein said first floor position is different from said second floor position;
 or
 wherein said second floor position is a control position of said car (101), wherein said control position is unreachable by an unauthorized user; 45
 and/or wherein said at least one movement parameter comprises at least either a car acceleration, a car pressure or a car position; and/or 50
 wherein said fault signal is sent to a cloud server (200); and/or where said fault signal is sent to a list of people in charge of maintenance.

3. A fault detection method according to any one of the preceding claims, further comprising the steps of: 55

c1 - detecting at least one vibrational parameter

of the lift system (100) over time;
 c2 - analyzing variations in a predetermined time interval (T4) of at least one lift plant vibrational parameter detected over time by generating a lift plant vibrational characteristic associated with said at least one vibrational parameter detected in the predetermined time interval (T4);
 c3 - sending said lift system vibrational characteristic in the predetermined time interval (T4) to a cloud server (200);

and/or wherein said method comprises a step of configuring, wherein said second threshold time interval (T2), and said third threshold time interval (T3) are set and stored.

4. A fault detection method according to claim 3, comprising the steps of:

c4 - comparing said lift system vibrational characteristic in the predetermined time interval (T4) with a system standard vibrational characteristic or with a previous system vibrational characteristic associated with said at least one vibrational parameter detected in a previous predetermined time interval (T4'),
 c5 - when said lift system vibrational characteristic in the predetermined time interval (T4) exceeds said system standard vibrational characteristic, or said previous system vibrational characteristic, beyond a vibration alarm threshold, sending an alarm signal, e.g., to a cloud server (200) and/or to a list of people in charge of maintenance;

and/or wherein said method comprises the step of associating said at least one vibrational parameter detected in step c1 with said at least one car movement parameter detected in step x.

5. A fault detection method according to the preceding claim, wherein following said step c5, it comprises:

c6 - sending a stop signal to a car control unit and/or to a switchboard of said lift system; and/or
 c7 - sending, e.g., from said cloud server (200), an intervention message to a list of people in charge of maintenance;

and/or wherein said steps c6 and/or c7 are parallel and/or simultaneous with step b5.

6. A fault detection method according to claim 3, comprising, in parallel with step b2, the following step of:
 b51 - sending, from said cloud server (200), said lift system vibrational characteristic in the predefined time interval (T4) to a list of people in charge of maintenance.

7. A fault detection method according to claim 3, wherein said at least one lift system vibrational parameter comprises at least one of either:

- car vibrations of said car (101) to be detected during a movement of said car (100);
- car door vibrations of said at least one car door (101) to be detected during a movement of said at least one car door (101);
- guide accelerations and/or guide vibrations to be detected, when said car (101) is stationary, on said car (101); and/or guide accelerations and/or guide vibrations to be detected, when said car (101) is stationary, on at least one guide (111) arranged in said travel shaft along which said car (101) is running.

8. A fault detection device (1) for a lift system (100), said lift system (100) comprising a car (101) movable in a travel shaft between a plurality of floors, said car (101) being provided with at least one car door (102) and each floor of said plurality of floors being provided with at least one floor door, said device (1) being connectible to said car (101) and comprising:

- a sensor module (2) configured to detect at least one movement parameter of said car (101) over time,
- a processing unit (4) configured to analyze over time changes of the at least one movement parameter detected by said sensor module (2),
- a signal transmission module (5) connected to said processing unit (4) and configured to send a fault signal to signal a fault of the lift system (100), e.g., a cloud server (200) and/or to a list of people in charge of maintenance;
- a signal converter module (6) connected to said processing unit (4),

said device (1) being **characterized in that**

said signal converter module (6) is electrically connectible by means of a second electrical connection (8) to a second floor second button (104) of a car button panel (105) of said car (101) so that

when the at least one analyzed movement parameter is unchanged for a second threshold time interval (T2), said device (1) is configured to send a second signal to the second floor second button (104) to move the car to a second floor position,

and when the at least one analyzed movement parameter is unchanged for a third threshold time interval (T3) successive to said second threshold time interval (T2), said device (1) is configured to send said fault signal.

9. A fault detection device (1) according to the preceding claim, wherein

said signal converter module (6) is electrically connectible by means of a first electrical connection (7) to a first floor first button (103) of a car button panel (105) in parallel with said second electrical connection (104) so that when the at least one analyzed movement parameter is unchanged for a first threshold time interval (T1) before said second threshold time interval (T2), said device (1) is configured to send to said second floor second button (103) a first signal to move the car (101) to a first floor position; and/or wherein said at least one car movement parameter is at least either:

car acceleration, shaft pressure, car position;

and wherein

said sensor module (2) comprises at least either:

- an accelerometer (9) configured to detect said car acceleration,
- a pressure sensor (10) configured to detect said shaft pressure,
- a position sensor (3) configured to detect over time said car position of said car (101) between said plurality of floors by communicating with a reference position indicating device (106) arranged at a reference floor of said plurality of floors.

10. A fault detection kit (20) for a lift system (100), comprising at least one fault detection device (1) according to any one of claims 8 to 9, connectible to said car (101), preferably on a roof of said car (101) near said at least one car door (102), and at least one guide sensor (110) associable with at least one guide (111) along which said car (101) is running, wherein said at least one guide sensor (110) comprises at least one guide inclinometer.

11. A fault detection kit (20) for a lift system (100) according to the preceding claim, comprising at least one guide accelerometer, a reference position indicating device (106) of a reference floor of said plurality of floors, preferably a ground floor, installable at a floor door of said reference floor, preferably wherein said at least one reference position indicating device (106) is a magnet; and/or wherein said fault detection kit (20) comprises at least one motor accelerometer (109) installable at a motor (112) of said lift system (100) to detect vibrations of said mo-

tor (112);

and/or wherein said fault detection kit (20) comprises at least one guide sensor (110) associable with at least one guide (111) along which said car (101) is running, wherein said at least one guide sensor (110) comprises at least one guide inclinometer and/or at least one guide accelerometer;
 and/or wherein said accelerometer (9) being configured to detect car vibrations when said car (101) is moving along said shaft, said accelerometer (9) being configured to detect car door vibrations when said at least one car door (102) is moving relative to said car (101), said accelerometer (9) being configured to detect shaft vibrations when said car (101) and said at least one car door (102) are stationary relative to said shaft,
 and/or
 said position sensor (3) is a magnetometer and said reference position signaling device (106) is a magnet fixed to a floor door of said reference floor of said plurality of floors, preferably a ground floor, to detect the current car position of said car (101) relative to said magnet (106);
 and/or wherein said sensor module (2) comprises a temperature sensor configured to detect the temperature in said shaft,
 and/or wherein said signal converter module (6) is electrically connectible to an alarm button (107) of said car button panel (105) by means of a third electrical connection (11) and/or a car roof alarm button so that when said alarm button (107) is activated, said sensor module (3) is configured to send an alarm signal to said cloud server (200),
 and/or wherein said signal converter module (6) is electrically connectible by means of a fourth electrical connection (12) to a maintenance button (108) of said car button panel (105) and/or a car roof maintenance button such that when said maintenance button (108) is activated, said sensor module (3) is configured to send a performed maintenance signal to said cloud server (200).

one of the claims from 8 to 9, wherein said fault detection device (1) is fixed to said car (101) and electrically connected to at least said second floor second button (104).

12. A lift system (100) comprising

- at least one car (101) movable in a shaft between a plurality of floors, said car (101) being provided with at least one car door (102) and each floor of said plurality of floors being provided with at least one floor door, wherein said car (101) comprises a car button panel (105) comprising at least a second floor second button (104); and
- a fault detection device (1) according to any

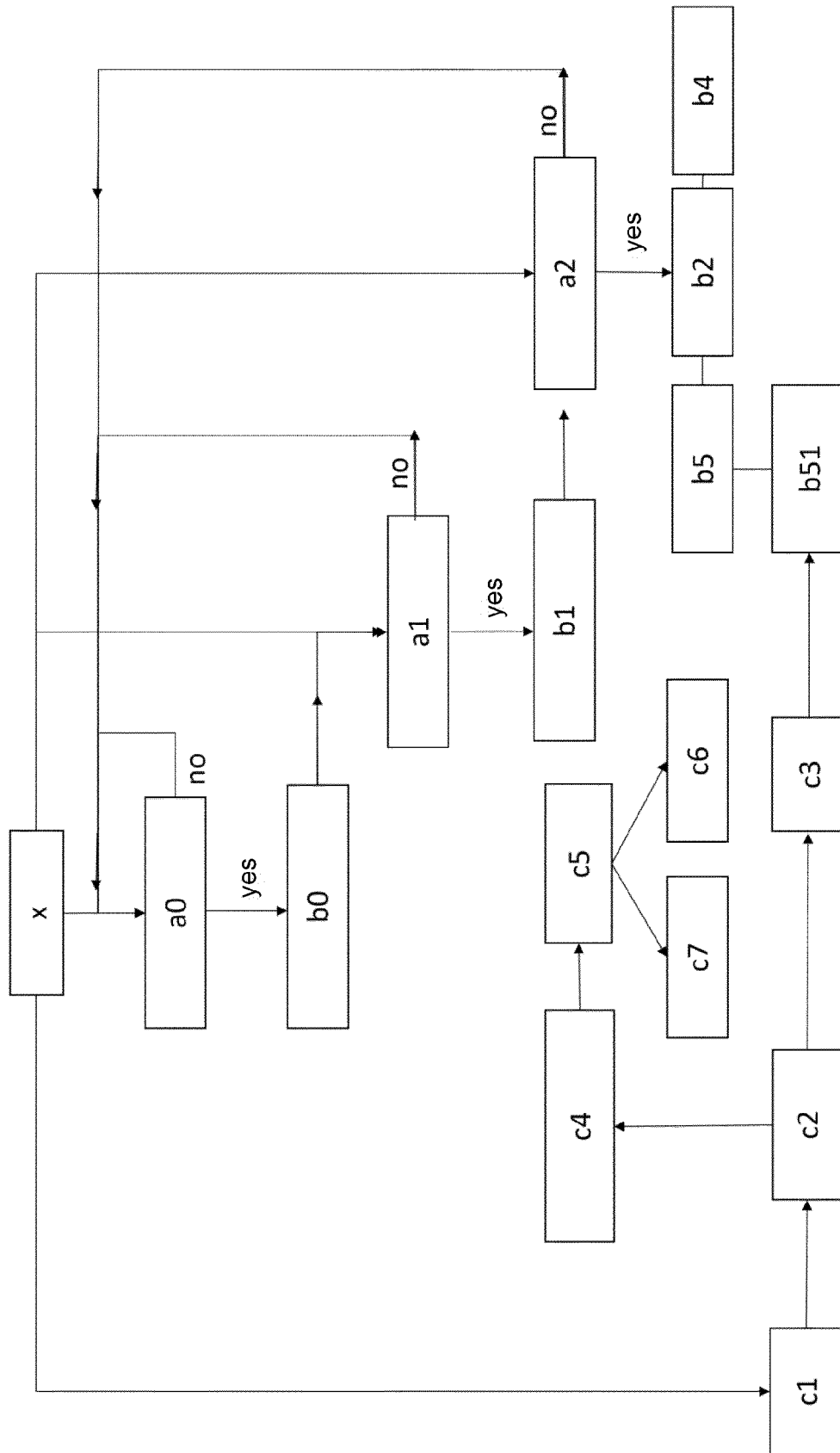


FIG. 1

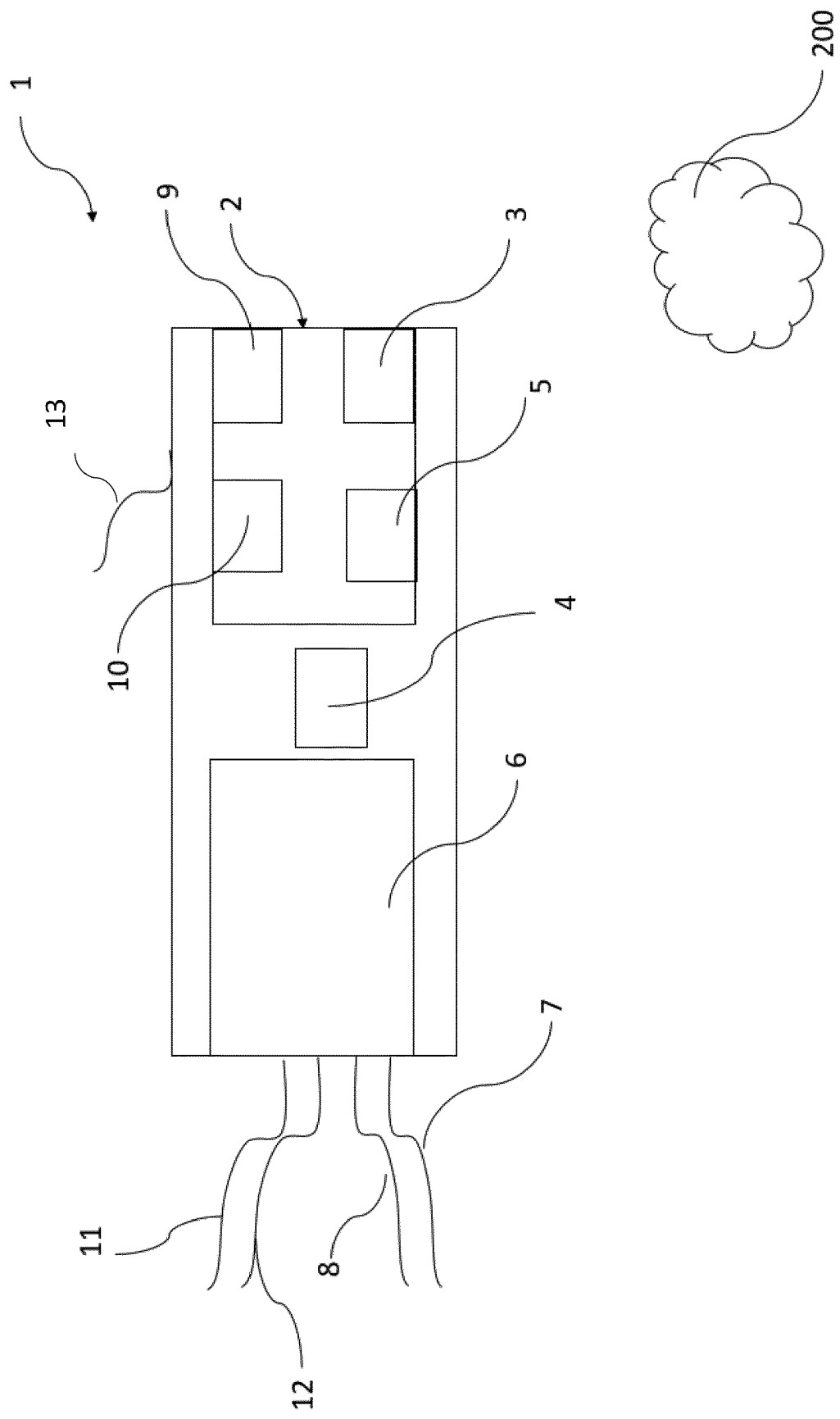


FIG. 2

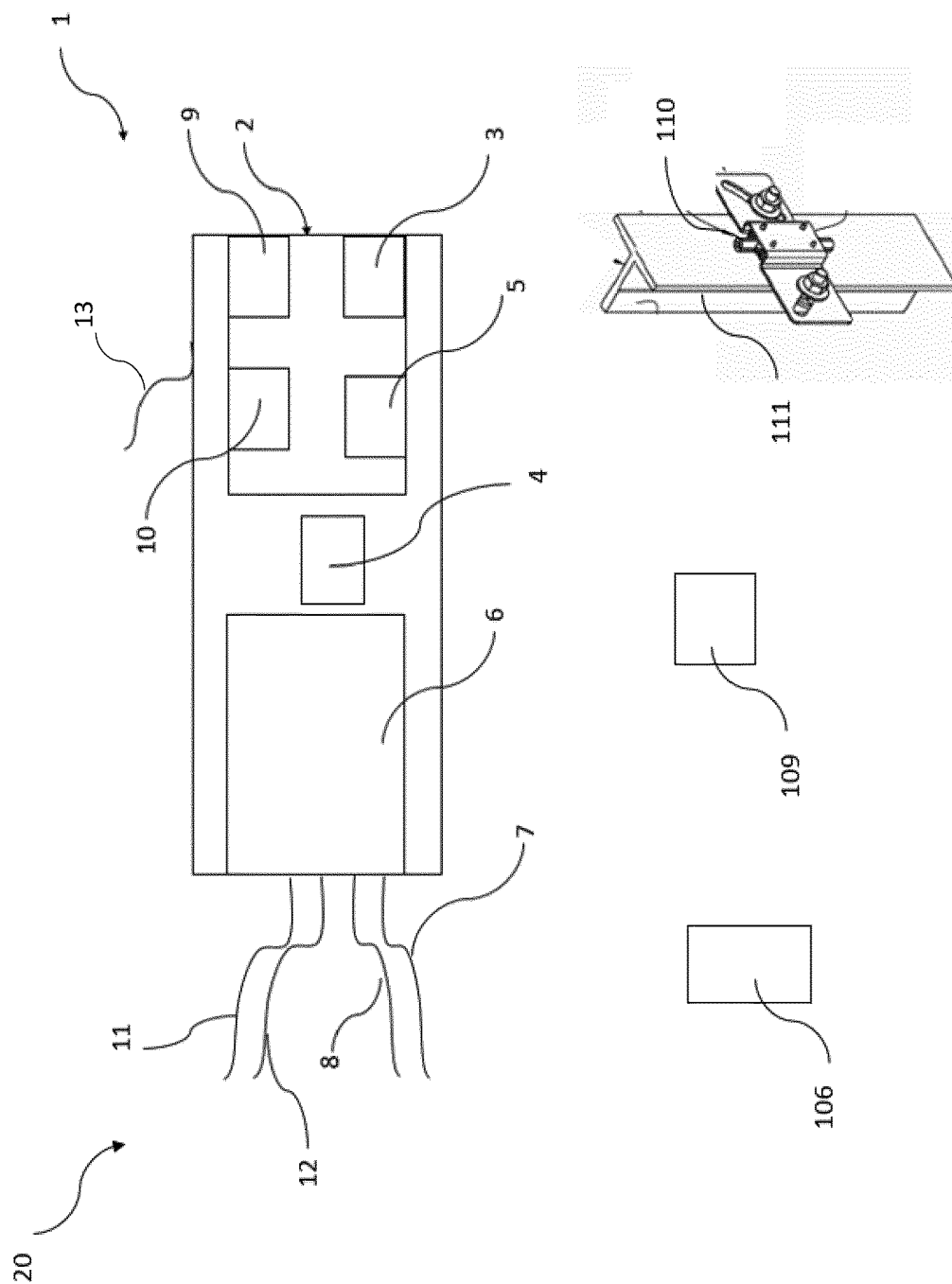


FIG. 3

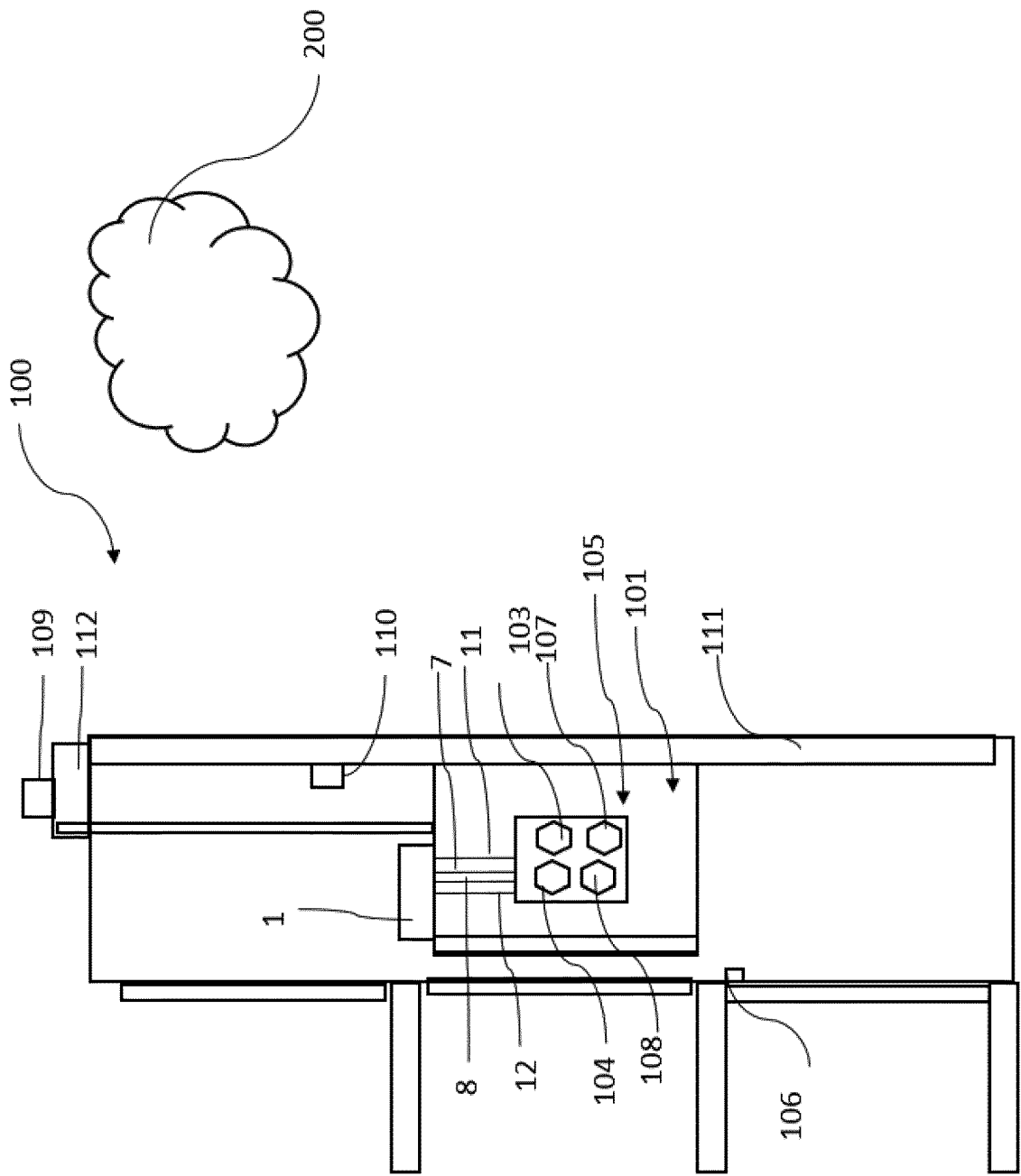


FIG. 4



EUROPEAN SEARCH REPORT

Application Number

EP 22 19 6190

5

10

15

20

25

30

35

40

45

50

55

1

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 9 926 170 B2 (INVENTIO AG [CH]) 27 March 2018 (2018-03-27) * column 1, line 13 - column 3, line 64 * * column 6, line 39 - column 11, line 8 * * figures 1-6 *	1-12	INV. B66B5/00
A	----- CN 106 006 263 B (VOLKSLIFT (CHINA) CO LTD) 29 June 2018 (2018-06-29) * paragraphs [0004] - [0029] *	1-12	
A	----- WO 2018/073484 A1 (KONE CORP [FI]) 26 April 2018 (2018-04-26) * page 2, line 6 - page 3, line 18 *	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			B66B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 24 January 2023	Examiner Baytekin, Hüseyin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 22 19 6190

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-01-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 9926170 B2	27-03-2018	BR 112015007078 A2	04-07-2017
		CN 104768862 A	08-07-2015
		EP 2914529 A1	09-09-2015
		ES 2619637 T3	26-06-2017
		HK 1210131 A1	15-04-2016
		PL 2914529 T3	30-06-2017
		US 2015307319 A1	29-10-2015
		WO 2014067814 A1	08-05-2014

CN 106006263 B	29-06-2018	NONE	

WO 2018073484 A1	26-04-2018	CN 109803909 A	24-05-2019
		EP 3529188 A1	28-08-2019
		US 2019210833 A1	11-07-2019
		WO 2018073484 A1	26-04-2018
