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(54) Keksinnön nimitys - Uppfinningens benämning - Title of the invention
Akkukaappi ja menetelmä akun varastoinniseksi paloturvallisesti
Batteriskåp och förfarande för brandsäker lagring av ett batteri
Battery cabinet and method of fire safely storing a battery

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(57) Tiivistelmä - Sammandrag - Abstract

Keksintö liittyy akkukaappiin (1), joka on järjestetty paloturvallisesti varastoidaan akku (10) ja menetelmään akun (10) varastoinniseksi paloturvallisesti akkukaapissa (1). Akkukaappi (1) käsittää: akun pidikkeen (2), joka on järjestetty tukemaan akkua (10) akkukaapissa (1); nestesäiliön (4) nesteen (20) pitämiseen; ja turvajärjestelyn, joka on järjestetty evakuoimaan akku (10) akun vikatilanteessa, turvajärjestely käsittää evakuointiyhteyden (101) akun pidikkeen (2) ja nestesäiliön (4) välillä akun (10) upottamiseksi nesteellä (20), joka on järjestetty nestesäiliöön (4).

The invention relates to a battery cabinet (1) arranged to fire safely store a battery (10) and a method of fire safely storing a battery (10) in a battery cabinet (1). The battery cabinet (1) comprises: a battery holder (2) arranged to support the battery (10) in the battery cabinet (1); a fluid container (4) for containing fluid (20); and a safety arrangement arranged to evacuate the battery (10) in the event of a battery failure, the safety arrangement comprising an evacuation connection (101) between the battery holder (2) and the fluid container (4) for immersing the battery (10) with fluid (20) provided in the fluid container (4).

BATTERY CABINET AND METHOD OF FIRE SAFELY STORING A BATTERY

FIELD OF THE INVENTION

The present invention relates to a battery cabinet arranged to fire safely store a battery and more particularly to a battery cabinet as defined in the
5 independent claim 1.

The present invention also relates to method of fire safely storing a battery and more particularly to a method as defined in the independent claim 17.

BACKGROUND OF THE INVENTION

Prior art teaches a battery cabinet that is provided for storing a battery,
10 and more particularly an electric bicycle battery, during for example office hours such that the battery is not stolen from the bike. The battery cabinet typically comprises multiple compartments for batteries such that the batteries from many bicycles can be stored effectively in one place. Each compartment of the battery cabinet is configured to receive at least one battery.

15 One of the problems associated with the prior art is that fire in the event of a battery failure each battery stored in a battery cabinet form a risk for fire. As the cabinet stores multiple batteries and the batteries are provided in a close proximity to each other, the fire will become unmanageable.

BRIEF DESCRIPTION OF THE INVENTION

20 An object of the present invention is to provide a battery cabinet for fire safely storing a battery. Another object of the invention is to provide a method for fire safely storing a battery within a cabinet.

The objects of the invention are achieved by a battery cabinet and a
25 method of fire safely storing a battery which are characterized by what is stated in the independent claims. The preferred embodiments of the invention are disclosed in the dependent claims.

The invention is based on the idea of providing a safety arrangement in connection with a battery cabinet which co-operates with the battery cabinet and provides an automatic evacuation for the battery in the event of the battery failure.
30 According to the invention a battery cabinet arranged to fire safely store a battery comprises a battery holder arranged to support the battery in the battery cabinet, a fluid container for containing fluid and a safety arrangement arranged to evacuate the battery in the event of a battery failure. The safety arrangement comprising an evacuation connection between the battery holder and the fluid

container for immersing the battery with fluid provided in the fluid container. In other words, the safety arrangement comprises a connection extending between the battery holder and the fluid container. The battery holder is a part of the battery cabinet in which the battery is arranged for storing the battery, and the fluid
 5 container is also part of the battery cabinet which comprises fluid which is used for immersing the battery in the event of a battery failure. In other words, the battery holder and the fluid container are provided at least partly within the battery cabinet, but preferably the battery holder and the fluid container both are provided entirely within the battery cabinet.

10 The battery holder is arranged within the battery cabinet and in a preferred embodiment of the invention the evacuation connection is also arranged within the battery cabinet. The fluid container may be arranged within the battery cabinet, partly within the battery cabinet or outside of the battery cabinet.

The battery cabinet in the context of this application is preferably a
 15 cabinet-like structure or a drawer or set of drawers. The battery cabinet is preferably a furniture-like structure which can be placed in offices or homes or public places. The battery cabinet may be arranged in connection with another piece of furniture or part so as to form a part of another part. The battery cabinet forms a one-piece unit with multiple battery holders.

20 The battery holder is preferably in a form of a box or an enclosure arranged within the battery cabinet such that the box or the enclosure is a closed structure within the battery cabinet and openable by a door or similar structure outside the battery cabinet. In other words, the battery holder in a form of the box or the enclosure form a closed compartment for a battery. The battery holder may
 25 form an independent compartment within the battery cabinet such that the independent compartment is connected to the battery cabinet. The connection between the battery holder and the battery cabinet may be a releasable connection such that the battery holder is releasable from the connection to the battery cabinet for moving the battery holder within the battery cabinet. Alternatively, the battery
 30 holder is in a form of a shelf or other open structure within the battery cabinet, but the battery cabinet is openable from outside the battery cabinet for providing a battery to the shelf or other open structure within the battery cabinet. This means that the batteries are provided within the battery cabinet in a common space within the battery cabinet. The battery cabinet and the battery holders inside the
 35 battery cabinet are preferably sized for electric bike batteries. In the context of this application the battery holder is referred as a singular battery holder although the

battery cabinet preferably comprises multiple battery holders.

The fluid container for containing fluid is preferably a container that is arranged to keep fluid within the container. The fluid container in the context of this application may be an open container for dropping a battery within the container or a closed container having an outlet for supplying fluid from the fluid
5 container to the battery holder. Alternatively, the fluid container may be a pipe containing fluid within the pipe. The fluid container may have a connection to a fluid source outside the battery cabinet for example such that there is a pipe extending between the fluid container and the fluid source for providing fluid to
10 the fluid container. Alternatively, the fluid may also be provided from the fluid source to the fluid container through the evacuation connection.

According to the invention the battery cabinet further comprises a charging unit arranged to charge the battery provided at the battery holder. The battery cabinet is therefore arranged to fire safely charge a battery. The charging
15 unit is preferably provided in connection with each battery holder such that a battery provided at the battery holder has an own charging unit. The charging unit is preferably an e-bike battery charger connected to a common electricity system or alternatively, the charging unit is in this context only a power socket provided in the battery cabinet to which a separate e-bike charger is connectable or any
20 combination of these. This means that only the power socket providing electricity to a separate charger is the charging unit in the meaning of this application. In other words, the charging unit may in the context of this application be the power socket provided in the battery cabinet into which a separate charger is connected, or the charging unit comprises a charger for charging the battery which the charger is
25 connected to a power socket in the battery cabinet, the charging unit is a charger integrated or connected to the battery cabinet. The charging unit preferably comprises a safety mechanism arranged to stop power supply to the charger or to the battery in the event of battery failure or when the battery is fully charged. The charging unit may receive a failure signal from a control unit connected to a sensor
30 or directly from the sensor which is arranged to send a battery failure signal to the control unit or to the charging unit in the event of battery failure so as to stop power supply to the charger or to the battery. The safety mechanism may comprise a detach mechanism arranged to detach the charger or the battery from the charging unit or in the case that the battery holder is removable from the
35 connection to the battery cabinet, the detach mechanism is arranged to detach the charging connection between the battery cabinet and the battery holder.

According to the invention the safety arrangement further comprising a sensor arranged to detect the battery failure during charge or otherwise. The battery cabinet is a closable structure and the sensor is arranged within the battery cabinet sensing conditions within the battery cabinet. Alternatively, the battery holder is a closable structure and the sensor is arranged within the battery holder. Alternatively, the battery cabinet and the battery holder are closable structures and a sensor is provided within each of the battery holders which are closable structures within the battery cabinet or alternatively the sensor is arranged in connection with a common space in the battery cabinet although the battery holders are closable structures within the battery cabinet. Alternatively, the sensor is provided in a common space of the battery cabinet and the battery holders are shelves or other open structures within the battery cabinet.

According to the invention the sensor is a temperature sensor arranged to detect a temperature change of a battery. Alternatively, or in addition, the temperature sensor is arranged to detect a temperature change of a charging unit. Alternatively, or in addition, the temperature sensor is arranged to detect a temperature change within the battery holder or within the battery cabinet or both. Alternatively, or in addition, the sensor is a gas detector arranged to detect gas release from the battery or from the charging unit. Alternatively, or in addition, the sensor is an optical sensor arranged to detect light rays from the battery or from the charging unit. Alternatively, or in addition the sensor is a fire sensor, or a smoke sensor arranged to detect fire. Alternatively, or in addition the sensor is a flame sensor arranged to detect presence of a flame or fire. The sensor can also be a sensor unit combining multiple sensors together for example such that there is a sensor that detects flammable gases and carbon monoxide, temperature changes and flames or any combination of these. The measurement of temperature changes is preferably based on infrared. The sensor unit may also comprise a relay that switches off the charging current if any one of these parameters exceeds a limit. Relays can also be provided with individual sensors. The relays can also provide power monitoring, in order to know when the battery is full and to ensure overcharging prevention and risk of burns. Sensors and/or relays and/or sensor units can be connected to the internet and can be operated and monitored remotely.

Although in the context of this application a sensor is referred, the battery cabinet may still comprise multiple sensors which can be similar sensors provided in different places in the battery cabinet or they can be different sensors

arranged to detect different changes of the battery or the charging unit during charging of the battery or they can be sensor unit combining multiple sensors together. The sensors in the sensor unit may be the same or different.

According to the invention the safety arrangement further comprising
5 a control unit arranged to receive a battery failure signal from the sensor and to activate the evacuation connection in response to the battery failure signal received from the sensor. The control unit is connected to the sensor and further to an activation mechanism of the evacuation connection which is arranged to activate the evacuation connection. The connection between the sensor and the
10 control unit may be wired or wireless connection. The same applies to the connection between the control unit and the activation mechanism of the evacuation connection. The control unit is arranged to form a link between the sensor and the activation mechanism of the evacuation connection.

According to the invention the control unit is connected to the battery
15 cabinet; or alternatively the control unit is arranged in connection with the battery cabinet; or alternatively within the battery cabinet; or alternatively within the battery holder. The battery cabinet may comprise multiple control units which can be placed in different locations.

According to the invention the safety arrangement further comprising
20 an opening mechanism for activating the evacuation connection. The opening mechanism is one embodiment of the activation mechanism of the evacuation connection. The opening mechanism is connected to the control unit such that the control unit is arranged to activate the evacuation connection by operating the opening mechanism in response to the battery failure signal from the sensor. The
25 opening mechanism is a mechanical mechanism for opening the evacuation connection; or alternatively or in addition, the opening mechanism is a magnetic mechanism for opening the evacuation connection; or alternatively or in addition, the opening mechanism is an electrical mechanism for opening the evacuation connection. The opening mechanism is arranged to activate the evacuation
30 connection such that an open passage between the battery holder and the fluid container is formed. The open passage is either for moving the battery from the battery holder to the fluid container or for supplying fluid from the fluid container to the battery holder. The active evacuation connection enables the battery to be immersed with fluid. During normal charging of the battery, when there is no
35 problem with charging or the battery is not damaged, the evacuation connection is passive, i.e. the evacuation connection is closed between the battery holder and the

fluid container. In the meaning of the closed evacuation connection it must be understood that there need not be any physical barrier between the battery holder and the fluid container, meaning that the battery may be provided at a shelf within the battery cabinet and the fluid container may be positioned below the shelf such that the evacuation connection extends between the shelf and the container but the battery remains in its position and is not immersed in the fluid when there is no failure in charging and the evacuation connection is not activated. Activation of the evacuation connection, for example in the case of a shelf and an open fluid container, can be accomplished through a moving mechanism which is described in connection with another embodiment of the invention. The opening mechanism can be for example a movable bottom of the battery holder which pushes or slides the battery from the battery holder through the evacuation connection to the fluid container. Alternatively, the opening mechanism can be a valve in connection with the fluid container or in connection with a pipe extending from the fluid container or from a fluid source such that fluid is supplied from the fluid container to the battery holder.

According to the invention the safety arrangement comprising the control unit and the opening mechanism connected together such that the control unit is arranged to receive a battery failure signal from the sensor and to activate the evacuation connection in response to the battery failure signal from the sensor by operating the opening mechanism. In other words, the sensor is arranged to send a failure signal to the control unit in the event of a battery failure during charge and in response to the failure signal the control unit is arranged to activate the opening mechanism.

According to the invention the safety arrangement further comprising a release mechanism arranged to release the battery holder from a connection to the battery cabinet such that the battery holder is arranged to move through the evacuation connection to the fluid container. In other words, a battery holder which comprises a battery within the battery holder and which the battery holder having preferably a closable structure, for example a closable compartment, is arranged to be released from the connection to the battery cabinet in response to a release command from the control unit when a battery failure occurs. When the battery holder is released from the connection to the battery cabinet, the battery holder is arranged to fall through the evacuation connection to the fluid container provided below the battery holder in a vertical direction of the battery cabinet. The control unit and the release mechanism are connected together such that the

control unit is arranged to receive a battery failure signal from the sensor provided in connection with the battery holder and to release the battery holder in response to the battery failure signal from the sensor by operating the release mechanism . The release mechanism can be for example a locking structure which opens in response to the signal from the control unit and releases the battery holder. In other words, the safety arrangement then comprises a control unit and the release mechanism is connected to the control unit.

According to the invention the battery cabinet is arranged to enclose the battery holder and the fluid container within the battery cabinet. This means that the battery cabinet is a closed structure having at least one opening to the battery holder for arranging a battery inside the battery cabinet to the battery holder. Alternatively, the battery cabinet is arranged to enclose the battery holder within the battery cabinet and the fluid container is arranged to extend from the battery cabinet to the outside of the battery cabinet, for example in a case that the fluid container is a pipe extending from the battery cabinet to a fluid source outside of the battery cabinet. The fluid source can be for example a common pipework containing water. In the context of this application fluid is preferably water or alternatively water comprising additives which contribute to extinguish the fire of a battery. The fluid can also be gel-like substance which has good cooling and/or quenching properties. In the context of this application the battery that is immersed to fluid or is immersible with fluid is preferably a light vehicle battery such as an electric bike battery. The battery is a rechargeable battery having capacity more than 10 Ah and preferably more than 20 Ah. The battery is also preferably a lithium-ion battery.

According to one embodiment of the invention the fluid container is provided below the battery holder in a vertical direction of the battery cabinet. The evacuation connection comprising a first passage extending between the battery holder and the fluid container. The first passage is arranged such that the battery is movable from the battery holder through the first passage to the fluid container for immersing the battery in the fluid provided in the fluid container.

According to the invention the safety arrangement further comprising a moving mechanism for activating the evacuation connection. The moving mechanism is one embodiment of the activation mechanism of the evacuation connection. The moving mechanism is arranged to move the battery provided at the battery holder from the battery holder through the evacuation connection to the fluid container. The moving mechanism may be for example an actuator

arranged in connection with the battery holder. The actuator is arranged move the battery at the battery holder for example such that the battery slides on the battery holder or that the actuator pushes the battery from the battery holder to the evacuation connection. Therefore, the activation of the evacuation connection may
5 be accomplished through the activation mechanism which is the moving mechanism such that the battery is moved from the battery holder to the evacuation connection and through the evacuation connection to the fluid container.

According to the invention the safety arrangement comprising a control
10 unit and the moving mechanism is connected to the control unit such that the control unit is arranged to receive a battery failure signal from the sensor and to activate the evacuation connection in response to the battery failure signal from the sensor by operating the moving mechanism. In other words, the sensor is arranged to send a failure signal to the control unit in the event of a battery failure
15 during charge and in response to the failure signal the control unit is arranged to activate the moving mechanism.

The control unit is preferably arranged to close electricity from the charging unit simultaneously with receiving the failure signal from the sensor. Alternatively, the control unit is arranged to close electricity from the charging unit
20 before or simultaneously with activating the opening mechanism or the moving mechanism or both.

In other words, the safety arrangement according to the invention comprises an activation mechanism of the evacuation connection which is arranged to activate the evacuation connection and evacuate the battery in the
25 event of the battery failure during charge. The activation mechanism is the opening mechanism of the evacuation connection arranged to activate the evacuation connection or the activation mechanism is the moving mechanism of the battery in connection with the battery holder which is arranged to activate the evacuation connection by moving the battery from the battery holder to the evacuation
30 connection, or alternatively the activation mechanism can be both the opening mechanism and the moving mechanism which are both activating the evacuation connection by moving the battery and by opening the evacuation connection. In the event of the activation mechanism being the moving mechanism, the evacuation connection is open between the battery holder and the fluid container, but the
35 battery is transferred to the evacuation connection by moving it with the moving mechanism. The control unit is arranged activate both the moving mechanism and

the opening mechanism.

In another embodiment of the invention the fluid container is provided above the battery holder in a vertical direction of the battery cabinet such that the evacuation connection is arranged to provide a second passage for fluid to flow
5 from the fluid container to the battery holder for immersing the battery in the fluid provided from the fluid container to the battery holder. The fluid container arranged in the battery cabinet above the battery holder is preferably a closed fluid container having a pipe connection or other fluid connection to the battery holder. The battery holder is preferably such that it comprises at least one side wall to form
10 a space having a volume for the fluid provided from the fluid container. The space must be such that the fluid will remain in the battery holder for immersing the battery in the fluid. In addition, the volume of the space must be such that the battery is covered with liquid, i.e. that the battery is immersed in the fluid.

According to another embodiment of the invention the fluid container
15 is provided in a form of a pipe having a first end connected to the battery cabinet and a second end connected to a fluid source outside of the battery cabinet. The first end of the pipe forming the evacuation connection providing a third passage for fluid to flow from the fluid container to the battery holder within the battery cabinet for immersing the battery in the fluid provided to the battery holder. The
20 fluid container in this embodiment is then the pipe extending between the fluid source and the end of the pipe. The end of the pipe forming the evacuation connection comprises preferably a valve which is the opening mechanism of the evacuation connection.

According to another embodiment of the invention the fluid container
25 is arranged around the battery holder such that in the event of battery failure the control unit is arranged to activate an evacuation connection between the battery holder and the fluid container such that the fluid is flown from the fluid container to the battery holder for immersing the battery into the fluid. The fluid is preferably sucked into the battery holder and in this embodiment of the invention the
30 evacuation connection preferably comprises a pump for moving the fluid from the fluid container to the battery holder. The fluid container may also be arranged around the battery cabinet such that in the event of battery failure the fluid is flown from the fluid container into the battery cabinet. In a preferable embodiment of the invention the fluid is flown from the fluid container only to the battery holder
35 comprising the battery that has failure.

The invention is also based on a method of fire safely storing a battery

in a battery cabinet. The method comprises the steps of supporting the battery at a battery holder in the battery cabinet, monitoring battery conditions with a sensor provided in the battery cabinet, providing a failure signal from the sensor to a control unit provided in connection with the battery cabinet in the event of a battery failure and immersing the battery as a response to the failure signal with fluid provided in a fluid container containing fluid. The battery cabinet, the battery holder, the sensor, the charging unit, the control unit and the fluid container may be any of those embodiments already described in connection with the battery cabinet.

Supporting the battery at the battery holder in the battery cabinet means that the battery is arranged at the battery holder inside the battery cabinet such that the battery stands at the battery holder. Charging the battery with a charging unit means that the charging connection between the charger and the battery is formed and that the charger is connected to power supply. As earlier described the charging unit of the battery cabinet may be the charger connected to the power supply or the charging unit may only be the power socket such that an independent and separate charger is connected to the charging unit and to the battery. Measuring the charging conditions with the sensor means that the sensor is arranged to detect for example gas release from the battery during charging of the battery or temperature change of the battery or of the charging unit or other parameters which are changing during charging of the battery. Providing a failure signal from the sensor to a control unit means that in the event of a battery failure during charging of the battery the sensor is arranged to send a signal to the control unit to indicate that there is an abnormal charging condition in the battery and the battery must be evacuated from fire or evacuated to prevent fire. Immersing the battery as a response to the failure signal with fluid provided in a fluid container containing fluid means that in order to extinguish the fire in the battery or to prevent starting fire in the battery the battery is immersed in fluid, either by moving the battery to a fluid container or by supplying fluid to the battery such that the battery will be immersed within the fluid.

According to the invention the method further comprises a step of charging the battery with a charging unit provided within the battery cabinet. Alternatively, the method further comprises steps of charging the battery with a charging unit provided within the battery cabinet and monitoring charging conditions of the battery with the sensor.

According to the invention the method further comprises the step of

moving the battery with a moving mechanism provided in connection with the battery holder to an evacuation connection extending between the battery holder and the fluid container for transferring the battery from the battery holder to the fluid container. Alternatively, the method further comprises the step of operating
5 an opening mechanism for activating the evacuation connection between the battery holder and the fluid container for transferring the battery from the battery holder to the fluid container. Alternatively the method further comprises the steps of operating an opening mechanism for activating the evacuation connection extending between the battery holder and the fluid container and moving the
10 battery with a moving mechanism provided in connection with the battery holder for transferring the battery from the battery holder through the evacuation connection to the fluid container.

According to another embodiment of the invention the method further comprises the step of transferring the fluid from the fluid container to the battery
15 holder by activating an opening mechanism in connection with the evacuation connection extending between the fluid container and the battery holder. This means that by activating an opening mechanism fluid is supplied from the fluid container to the battery holder, for example through a pipe which then forms the evacuation connection.

20 An advantage of the invention is that in a case when lithium-ion batteries are stored or stored and charged there may occur thermal escape or heat leakage and that may cause risks for explosions of batteries which can be prevented from expanding by a fast evacuation with the battery cabinet according to the invention. Another advantage of the invention is that batteries such as
25 electronic bike batteries can be charged in offices or houses where it may expose people to fire hazard, and now with the battery cabinet according to the invention the storing and charging can be done without the risk that there will be a fire that is not noticed and causes damages. Batteries of electronic bikes are commonly lithium-ion batteries or other similar batteries that burn in such an effective
30 manner that they require proper and effective extinguishing, which is not sufficient to use a fire blanket or foam extinguisher.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in detail by means of specific embodiments with reference to the enclosed drawings, in which
35 Figure 1 shows one embodiment of a battery cabinet according to the

invention;

Figure 2 shows the battery cabinet shown in figure 1 as a side view;

Figure 3 shows the battery cabinet shown in figure 1 as another side view;

5 Figure 4 shows another embodiment of a battery cabinet according to the invention;

Figure 5 shows the battery cabinet shown in figure 4 as a side view;

Figure 6 shows still another embodiment of a battery cabinet;

Figure 7 shows yet another embodiment of a battery cabinet; and

10 Figure 8 show still another embodiment of a battery cabinet.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a battery cabinet 1 according to the invention as seen from front of the battery cabinet. The embodiment of the battery cabinet 1 comprises doors 5 for opening an access to a battery holder 2 inside the battery cabinet 1. The battery cabinet 1 shown in figure 1 comprises multiple battery holders 2 for supporting batteries 10 of electrical bikes while charging them with charging units 3. The doors 5 of the battery cabinet 1 can be locked although not shown in the figure. The doors 5 of the battery cabinet 1 can also be provided in the cabinet otherwise than illustrated in this figure, for example the opening direction of the doors 5 can be different or the doors 5 can be integrated to the battery holders 2 when the battery holder 2 is formed as a drawer like structure. The battery 10 provided at the battery holder 2 is connected to the charging unit 3 which is represented in the figures with a wire although the charging unit in the context of this application may be only a power socket for supplying power to the users own charger. Therefore, the charger as such may not form the charging unit of the battery cabinet although in a case that the charger is for example permanently installed in the battery cabinet or in the battery holder then the charger is part of the charging unit. The fluid container 4 is provided below the battery holders 2 in the battery cabinet 1. The fluid container 4 is an open container such that the top of the fluid container facing toward the battery holders 2 is open. The fluid container 4 contains fluid 20. The battery cabinet 1 comprises at least one sensor 102 which is in this embodiment of the invention provided in the space of the battery holder 2.

35 Figure 2 shows the battery cabinet 1 shown in figure 1 as seen from side. The battery cabinet 1 comprises within the battery cabinet 1 multiple battery

holders 2 for supporting the batteries provided at the battery holders 2. The battery cabinet 1 also comprises a charging unit 3 which in the embodiment shown in figure 2 is provided in connection with each of the battery holders 2 such that each battery charged in the battery cabinet 1 comprises an own charging unit 3.

5 The battery cabinet 1 also comprises within the battery cabinet a fluid container 4 which is provided below the battery holders 2. The battery cabinet 1 further comprises a safety arrangement arranged to evacuate the battery 10 in the event of a battery failure during charge. The safety arrangement comprises a sensor 102 arranged to detect the battery failure during charge, a control unit 103 arranged to

10 receive a battery failure signal from the sensor 102 and to open the evacuation connection 101 in response to the battery failure signal received from the sensor 102 and an evacuation connection 101 between the battery holder 2 and the fluid container 4 for immersing the battery 10 with fluid 20 provided in the fluid container 4. The safety arrangement further comprises in the embodiment shown

15 in figure 2 an opening mechanism 104 for activating the evacuation connection 101. The sensor 102 is arranged in connection with each of the battery holders 2 which the battery holders 2 are formed as closed structures in this embodiment. The bottom of the battery holders 2 are openable with the opening mechanism 104 such that the battery is released from the battery holder 2. The form of the battery

20 holder 2 is such that the battery 10 is arranged to slide out from the battery holder 2 when the battery holder 2 is opened. The battery 10 slides from the battery holder 2 to the evacuation connection 101 which is the space within the battery cabinet 1 which connects the battery holders 2 and the fluid container 4, i.e. the passage extending between the battery holders 2 and the fluid container 4. To

25 activate the evacuation connection means that interface between the evacuation connection and the battery holder is transformed such that the battery 10 is able to move through the evacuation connection to the fluid container 4. The transformation of the interface is accomplished through an opening mechanism 104 or through a moving mechanism 105. Figure 2 shows only the opening

30 mechanism 104. Figures 4, 5 and 7 show embodiments in which activation of the evacuation connection means that the interface between the fluid container and the evacuation connection is changed such that the fluid from the fluid container 4 is able to be supplied to the battery holder 2.

35 The control unit 103 is provided in the battery cabinet 1 and serves all the sensors 102 of the battery cabinet 1. Alternatively, there may be multiple control units 103, for example in each battery holder 2.

Figure 3 shows the battery cabinet 1 shown in figures 1 and 2 in an activated mode in which the battery is immersed in the fluid. The evacuation connection 101 is active such that the battery 10 is evacuated from the battery holder 2 to the fluid container 4 by an activation mechanism of the evacuation connection 101. The activation mechanism is in this embodiment of the invention mainly the opening mechanism 104 which is arranged to open the battery holder 2 allowing the battery 2 transfer from the battery holder 2 to the fluid container 4. However, the activation mechanism also comprises also a moving mechanism 105 for moving the battery 10 from the battery holder 2 to the fluid container 4 since the bottom of the battery holder 2 is opened by the opening mechanism 104 into a position which allows the battery 10 to slide from the battery holder 2 to the evacuation connection 101. The fluid container 4 has a volume which is enough for covering the battery 10 such that the battery is totally immersed into the fluid contained in the fluid container 4.

Figure 4 shows a battery cabinet 1 according to one embodiment of the invention. The battery cabinet 1 comprises multiple battery holders 2 formed as compartments arranged on top of each other within the battery cabinet 1. Each battery holder 2 comprises a charging unit 3, a control unit 103 and a sensor 102. Each battery holder 2 formed as a closed compartment comprises an opening mechanism 104 for activating the evacuation connection 101 which the evacuation connection 101 in this embodiment of the invention is a pipe extending between the fluid container 4 and the battery holder 2. The opening mechanism 104 is arranged to open the evacuation connection 101 extending between the fluid container 4 and the battery holder 2. The opening mechanism 104 can be for example a valve arranged in connection with the pipe. When the failure during charge of the battery 10 occurs, the sensor 102 provided in the battery holder 2 sends a failure signal to the control unit 103 and the control unit 103 sends an activation signal to the opening mechanism 104 for activating the evacuation connection 101, i.e. opening the connection between the battery holder 2 and the fluid container 4. As the opening mechanism 104 is operated such that the evacuation connection 101 is activated, fluid is flowing from the fluid container 4 to the battery holder 2 and the battery 10 will be immersed with the fluid provided in the fluid container 4 and supplied through the evacuation connection to the battery holder 2. Each of the battery holder 2 are separate compartments such that in the event of failure of one battery 10 only that particular battery is evacuated,

and the other batteries are not affected of the failure. The evacuation of the battery 10 also comprises closing the power supply to the charging unit 3.

Figure 5 shows the battery cabinet 1 shown in figure 4 as a side view. Although the evacuation connection 101 in a form of a pipe is illustrated as a part outside of the battery cabinet 1 it can also be integrated in the battery cabinet 1 such that the evacuation connection 101 in a form of a pipe is for example part of the side wall of the battery cabinet 1. The pipe forming the evacuation connection 101 extends between the fluid container 4 and the battery holder 2. Otherwise the battery cabinet 1 shown in figure 5 is already described in connection with figure 4.

Figure 6 shows still another embodiment of a battery cabinet 1 in which the battery holders 2 inside the battery cabinet 1 are formed as shelves. The open space between the shelves and the fluid container 4 forms the evacuation connection 101. The safety arrangement arranged to activate the battery in the event of the battery failure during charge comprises in this embodiment of the invention a moving mechanism 105 arranged to move the battery 10 in the battery holder 2 to the evacuation connection 101 such that the battery 10 moves through the evacuation connection 101 to the fluid container 4. The moving mechanism 105 in this embodiment is a turnable arm that pushes the battery 10 out from the battery holder 2 which is in a form of a shelf. The moving mechanism 105 operates in response to a signal received from the control unit 103 after the control unit 103 has received a failure signal from the sensor 102 which indicates that there is a battery failure during charge of the battery 10. Figure 6 shows one battery 10 which is immersed in the fluid 20 contained in the fluid container 4. The charging unit 3 or a cable connecting the battery 10 to the charging unit 3 has a length which ensures that the battery extends from the battery holder 2 to the fluid container 4 and is immersed in the fluid 20 within the fluid container 4.

Figure 7 shows yet another embodiment of the invention in which the pipe extending between a common pipework as a fluid source 106 and the battery cabinet 1 forms the fluid container 4 and the connection between the pipe and the battery holder 2 forms the evacuation connection 101. The common pipework is for example a water supply network. The evacuation connection 101 comprises an opening mechanism 104 arranged to activate the evacuation connection 101 by opening for example a valve arranged in the evacuation connection 101 which regulates the fluid supply to the battery holder 2.

As described in connection with the figures, the battery holder may

comprise one or more battery supports such as shelves, boxes, compartments, closed structures, open structures or any other suitable structures for supporting a battery during charging.

5 The battery cabinet 1 according to the invention comprises the safety arrangement which the safety arrangement comprises an evacuation connection 101 between the battery holder 2 and the fluid container 4 for immersing the battery 10 with fluid 20 provided in the fluid container 4. The safety arrangement further comprises a sensor 102 arranged to detect the battery failure during charge, a control unit 10 arranged to receive a battery failure signal from the sensor 102 and to open the evacuation connection 101 in response to the battery failure signal received from the sensor 102 and an activation mechanism which is an opening mechanism 104 for activating the evacuation connection 101, or a moving mechanism 105 for activating the evacuation connection 101 by arranging to move the battery provided at the battery holder through the evacuation connection to the fluid container or both the opening mechanism 104 and the moving mechanism 105.

Figure 8 shows an embodiment of a battery cabinet 1 according to the invention in which the safety arrangement comprises a release mechanism 107 arranged to release the battery holder 2 from a connection to the battery cabinet 1. The sensor unit 102 has detected a battery failure in a battery 10 stored in the battery holder 2 either during storing or charging of the battery 10. The sensor 102 is arranged to send a failure signal to the control unit 103 which is arranged to activate the release mechanism 107 in response to the failure signal received from the sensor 102. When the release mechanism 107 receives the activation command from the control unit 103 it releases the battery holder 2 from the connection to the battery cabinet 1 such that the battery holder 2 is free to move and therefore falls downward in the battery cabinet 1. The evacuation connection 101 is arranged to form a first passage 101a such that the released battery holder 2 moves automatically to the evacuation connection 101 and through the evacuation connection 101 to the fluid container 4 provided within the battery cabinet 1. The battery holder 2 forming a compartment in which the battery 10 is provided is arranged to be immersed in fluid 20 provided in the fluid container 4. The battery 10 may have been connected to the charging unit 3 in the battery holder 2 but simultaneously as the battery holder is released from the connection to the battery cabinet 1 through the release mechanism, the power supply to the charging unit is disconnected. In other words, the release mechanism is also arranged to

disconnect power supply to the battery 10 or to the charging unit 3. The release mechanism 107 may be arranged to release the charging unit 3 from the battery 10 or the release mechanism 107 may be arranged to release the connection between the charging unit 3 and the battery cabinet 1 or between the charging unit 3 and the battery holder 2. The battery 10 and the charging unit 3 are arranged to fall together with the battery holder 2 into the fluid container 4 containing fluid 20.

The fluid 20 may be provided to the fluid container 4 from a fluid source arranged outside the battery cabinet 1. The fluid may for example be provided from the fluid source to the fluid container 4 through the evacuation connection 101 such that when the control unit 103 receives a failure signal from the sensor 102 the control unit 103 provides an opening signal for the fluid source to open the connection between the fluid source and the evacuation connection or the connection between the fluid source and the fluid container 4. This also applies to all other embodiments already described in connection with previous figures.

The invention has been described above with reference to the examples shown in the figures. However, the invention is in no way restricted to the above examples but may vary within the scope of the claims.

CLAIMS

1. A battery cabinet (1) arranged to fire safely store a battery (10), **characterized** in that the battery cabinet (1) comprises:

5 - a battery holder (2) arranged to support the battery (10) in the battery cabinet (1), the battery holder (2) comprises at least one side wall to form a space having a volume;

 - a fluid container (4) for containing fluid (20); and

 - a safety arrangement arranged to evacuate the battery (10) in the event of a battery failure, the safety arrangement comprising:

10 an evacuation connection (101) between the battery holder (2) and the fluid container (4) for immersing the battery (10) with fluid (20) provided in the fluid container (4); and

 an opening mechanism (104) arranged to activate the evacuation connection (101) such that an open passage between the battery holder (2) and the fluid container (4) is formed and fluid is supplied from the fluid container (4) to the battery holder (2),

 the space of the battery holder (2) being such that fluid provided from the fluid container remains in the battery holder (2) for immersing the battery in the fluid and the volume being such that the battery (2) is immersed in the fluid.

20

2. A battery cabinet (1) according to claim 1, **characterized** in that the battery cabinet (1) further comprises a charging unit (3) arranged to charge the battery (10) provided at the battery holder (2).

25

3. A battery cabinet (1) according to claim 1 or 2, **characterized** in that the safety arrangement further comprising a sensor (102) arranged to detect the battery failure.

30 4. A battery cabinet (1) according to claim 3, **characterized** in that:

 - the battery cabinet (1) is a closable structure and the sensor (102) is arranged within the battery cabinet (1); or

 - the battery holder (2) is a closable structure and the sensor (102) is arranged within the battery holder (2).

35

5. A battery cabinet (1) according to claim 3 or 4, **characterized** in that the sensor (102) being:

- a temperature sensor arranged to detect a temperature change of the battery (10) or a temperature change within the battery holder (2) or within the battery cabinet (1); or

- a gas detector arranged to detect gas release from the battery (10) or from the charging unit (3); or

- an optical sensor; or

- a fire sensor or a smoke sensor arranged to detect fire; or

- a flame sensor arranged to detect presence of a flame or fire.

6. A battery cabinet (1) according to any of claims 3-5, **characterized** in that the safety arrangement further comprising a control unit (103) arranged to receive a battery failure signal from the sensor (102) and to activate the evacuation connection (101) in response to the battery failure signal received from the sensor (102).

7. A battery cabinet (1) according to claim 6, **characterized** in that:

- the control unit (103) is connected to the battery cabinet (1); or

- the control unit (103) is arranged in connection with the battery cabinet (1); or

- the control unit (103) is arranged within the battery cabinet (1); or

- the control unit (103) is arranged within the battery holder (2).

8. A battery cabinet (1) according to any of claims 3-7, **characterized** in that the safety arrangement further comprising an opening mechanism (104) for activating the evacuation connection (101), the opening mechanism (104) is connected to the control unit (103) such that the control unit (103) is arranged to activate the evacuation connection (101) by operating the opening mechanism (104) in response to the battery failure signal from the sensor (102); the opening mechanism (104) being

- a mechanical mechanism for opening the evacuation connection (101);

or

- a magnetic mechanism for opening the evacuation connection (101);

or

- an electrical mechanism for opening the evacuation connection (101).

9. A battery cabinet (1) according to any preceding claim, **characterized** in that:

- 5 - the battery cabinet (1) is arranged to enclose the battery holder (2) and the fluid container (4) within the battery cabinet (1); or
- the battery cabinet (1) is arranged to enclose the battery holder (2) within the battery cabinet (1) and the fluid container (4) is arranged to extend from the battery cabinet (1) to the outside of the battery cabinet (1).

10

10. A battery cabinet (1) according to any of claims 1-9, **characterized** in that the fluid container (4) is provided above or at least partly next to the battery holder (2) in a vertical direction of the battery cabinet (1) such that the evacuation connection (101) is arranged to provide a second passage (101b) for fluid (20) to flow from the fluid container (4) to the battery holder (2) for immersing the battery in the fluid provided from the fluid container (4) to the battery holder (2).

11. A battery cabinet (1) according to any of claims 1-9, **characterized** in that the fluid container (4) is provided in a form of a pipe having a first end connected to the battery cabinet (1) and a second end connected to a fluid source (106) outside of the battery cabinet (1), the first end of the pipe forming the evacuation connection (101) providing a third passage (101c) for fluid to flow from the fluid container (4) to the battery holder (2) within the battery cabinet (1) for immersing the battery (10) in the fluid provided to the battery holder (2).

12. Method of fire safely storing a battery (10) in a battery cabinet (1), **characterized** in that the method comprises the steps of:

- 30 - supporting the battery (10) at a battery holder (2) in the battery cabinet (1), the battery holder (2) having at least one wall forming a space with a volume;
- monitoring battery conditions with a sensor (102) provided in the battery cabinet (1);
- 35 - providing a failure signal from the sensor (102) to a control unit (103) provided in connection with the battery cabinet (1) in the event of a battery failure;

- transferring the fluid (20) from the fluid container (4) to the battery holder (2) by activating an opening mechanism (104) in connection with the evacuation connection (101) extending between the fluid container (4) and the battery holder (2); and

- 5 - immersing the battery (10) as a response to the failure signal with fluid (20) provided in a fluid container (4) containing fluid (20) by supplying fluid such that the battery will be immersed within the fluid.

10 13. Method according to claim 12, **characterized** in that the method further comprises a steps of:

- charging the battery (10) with a charging unit (3) provided within the battery cabinet (1); or
- charging the battery (10) with a charging unit (3) provided within the battery cabinet (1) and monitoring charging conditions of the battery (10) with the
- 15 sensor (102).

PATENTTIVAATIMUKSET

1. Akkukaappi (1), joka on järjestetty paloturvallisesti varastoimaan
5 akku (10), **t u n n e t t u** siitä, että akkukaappi (1) käsittää:

- akun pidikkeen (2), joka on järjestetty tukemaan akkua (10)
akkukaapissa (1), akun pidike (2) käsittää vähintään yhden sivuseinän
muodostamaan tila, jolla on tilavuus;

- nestesäiliön (4) nesteen (20) pitämiseen; ja
10 - turvajärjestelyn, joka on järjestetty evakuoimaan akku (10) akun
vikatilanteessa, turvajärjestely käsittää:

evakuointiyhteyden (101) akun pidikkeen (2) ja nestesäiliön (4) välillä
akun (10) upottamiseksi nesteellä (20), joka on järjestetty nestesäiliöön (4); ja

avausmekanismin (104), joka on järjestetty aktivoimaan
15 evakuointiyhteys (101) siten, että avoin kanava muodostuu akun pidikkeen (2) ja
nestesäiliön (4) välille ja nestettä syötetään nestesäiliöstä (4) akun pidikkeeseen
(2),

akun pidikkeen (2) tilan on sellainen, että nestesäiliöstä tuleva neste jää
akun pidikkeeseen (2) akun upottamiseksi nesteeseen ja tilavuus on sellainen, että
20 akku (2) on upotettu nesteeseen.

2. Patenttivaatimuksen 1 mukainen akkukaappi (1), **t u n n e t t u** siitä,
että akkukaappi (1) edelleen käsittää latausyksikön (3), joka on järjestetty
lataamaan akkukaappiin (1) järjestettyä akkua (10).
25

3. Patenttivaatimuksen 1 tai 2 mukainen akkukaappi (1), **t u n n e t t u**
sitä, että turvajärjestely edelleen käsittää anturin (102), joka on järjestetty
havaitsemaan akkuvian.

4. Patenttivaatimuksen 3 mukainen akkukaappi (1), **t u n n e t t u** siitä,
30 että:

- akkukaappi (1) on suljettava rakenne ja anturi (102) on järjestetty
akkukaapin (1) sisään; tai

- akkukaappi (1) on suljettava rakenne ja anturi (102) on järjestetty akun
35 pidikkeen (2) sisään.

5. Patenttivaatimuksen 3 tai 4 mukainen akkukaappi (1), **tunnettu** siitä, että anturi (102) on:

- lämpötila-anturi, joka on järjestetty havaitsemaan akun (10) lämpötilan muutos tai lämpötilan muutos akun pidikkeessä (2) tai akkukaapissa (1);
- 5 tai
- kaasuanturi, joka on järjestetty havaitsemaan kaasun vapautuminen akusta (10) tai latausyksiköstä (3); tai
- optinen anturi; tai
- paloanturi tai savuanturi, joka on järjestetty havaitsemaan palo; tai
- 10 - liekkianturi, joka on järjestetty havaitsemaan liekin tai tulen läsnäolo.

6. Jonkin patenttivaatimuksen 3-5 mukainen akkukaappi (1), **tunnettu** siitä, että turvajärjestely edelleen käsittää ohjausyksikön (103), joka on järjestetty vastaanottamaan anturilta (102) akun vikasignaalin ja aktivoimaan

15 evakuointiyhteys (101) vasteena anturilta (102) vastaanotetulle akun vikasignaalille.

7. Patenttivaatimuksen 6 mukainen akkukaappi (1), **tunnettu** siitä, että:

- 20 - ohjausyksikkö (103) on yhdistetty akkukaappiin (1); tai
- ohjausyksikkö (103) on järjestetty akkukaapin (1) yhteyteen; tai
- ohjausyksikkö (103) on järjestetty akkukaapin (1) sisään; tai
- ohjausyksikkö (103) on järjestetty akun pidikkeen (2) sisään.

8. Jonkin patenttivaatimuksen 3-7 mukainen akkukaappi (1), **tunnettu** siitä, että turvajärjestely edelleen käsittää avausmekanismin (104) aktivoimaan evakuointiyhteys (101), avausmekanismi (104) on yhdistetty ohjausyksikköön (103) siten, että ohjausyksikkö (103) on järjestetty aktivoimaan evakuointiyhteys (101) käyttämällä avausmekanismia (104) vasteena anturilta

30 (102) tulevalle akun vikasignaalille; avausmekanismi (104) on

- mekaaninen mekanismi evakuointiyhteyden (101) avaamiseksi; tai
- magneettimekanismi evakuointiyhteyden (101) avaamiseksi; tai
- sähkömekanismi evakuointiyhteyden (101) avaamiseksi.

9. Jonkin edellisen patenttivaatimuksen mukainen akkukaappi (1), **tunnettu** siitä, että:

- akkukaappi (1) on järjestetty sulkemaan sisäänsä akun pidikkeen (2) ja

nestesäiliön (4) akkukaapin (1) sisällä; tai

- akkukaappi (1) on järjestetty sulkemaan sisäänsä akun pidikkeen (2) akkukaapin (1) sisällä ja nestesäiliö (4) on järjestetty ulottumaan akkukaapista (1) akkukaapin (1) ulkopuolelle.

5

10. Jonkin patenttivaatimuksen 1-9 mukainen akkukaappi (1), **tunnettu** siitä, että nestesäiliö (4) on sovitettu akun pidikkeen (2) yläpuolelle tai vähintään osittain akun pidikkeen (2) viereen akkukaapin (1) pystysuunnassa siten, että evakuointiyhteys (101) on järjestetty aikaansaamaan toisen kanavan (101b) nesteelle (20) virtaamaan nestesäiliöstä (4) akun pidikkeeseen (2) akun (10) upottamiseksi nesteeseen, joka on aikaansaatu nestesäiliöstä (4) akun pidikkeeseen (2).

11. Jonkin patenttivaatimuksen 1-9 mukainen akkukaappi (1), **tunnettu** siitä, että nestesäiliö (4) on aikaansaatu putken muotoon, jonka ensimmäinen pää on yhdistetty akkukaappiin (1) ja toinen pää on yhdistetty nestelähteeseen (106) akkukaapin (1) ulkopuolella, putken ensimmäinen pää muodostaa evakuointiyhteyden (101) aikaansaaden kolmannen kanavan (101c) nesteelle virrata nestesäiliöstä (4) akun pidikkeeseen (2) akkukaapissa (1) akun (10) upottamiseksi akun pidikkeeseen (2) aikaansaatuun nesteeseen.

12. Menetelmä akun (10) varastoimiseksi paloturvallisesti akkukaapissa (1), **tunnettu** siitä, että menetelmä käsittää vaiheet:

- tuetaan akkua (10) akun pidikkeessä (2) akkukaapissa (1), akun pidikkeessä (2) on vähintään yksi seinä, joka muodostaa tilan, jolla on tilavuus;

- seurataan akun tilaa akkukaapissa (1) olevalla anturilla (102);

- annetaan vikasignaali akkuvian sattuesssa anturista (102) ohjausyksikköön (103), joka on järjestetty yhteyteen akkukaapin (1) kanssa;

- siirretään neste (20) nestesäiliöstä (4) akun pidikkeeseen (2) aktivoimalla avausmekanismi (104) nestesäiliön (4) ja akun pidikkeen (2) välillä ulottuvan tyhjennysliitännän (101) yhteydessä. (2).

- upotetaan akku (10) vasteena vikasignaalille nesteellä (20), joka on järjestetty nestesäiliöön (4), joka käsittää nestettä (20) syöttämällä nestettä siten, että akku uppoaa nesteeseen.

35

13. Patenttivaatimuksen 12 mukainen menetelmä, **tunnettu** siitä, että menetelmä edelleen käsittää vaiheen:

- ladataan akkua (10) latausyksiköllä (3), joka on järjestetty akkukaapin (1) sisälle; tai

- ladataan akkua (10) latausyksiköllä (3), joka on järjestetty akkukaapin (1) sisälle ja seurataan akun (10) latausolosuhteita anturilla (102).

5

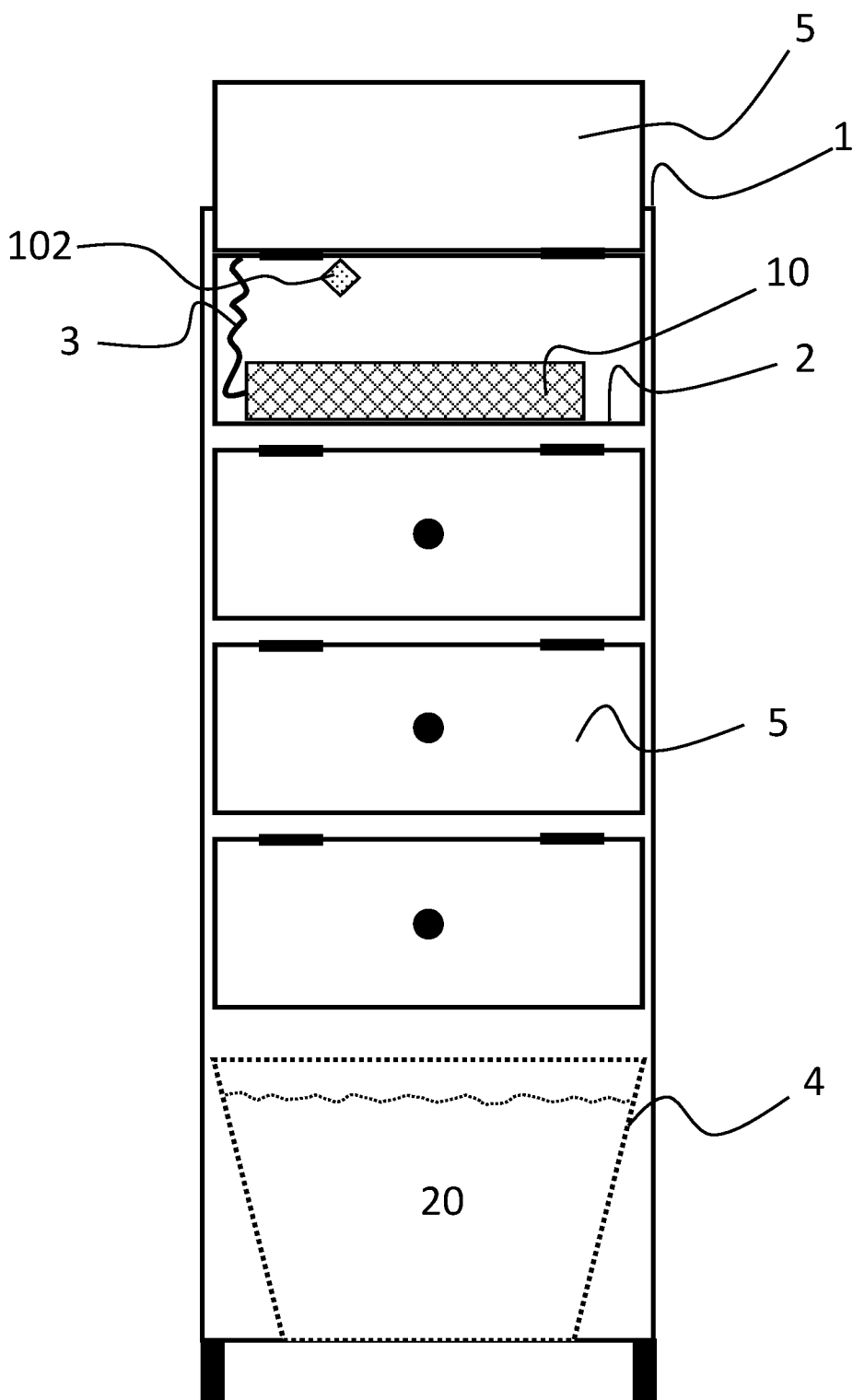


Fig. 1

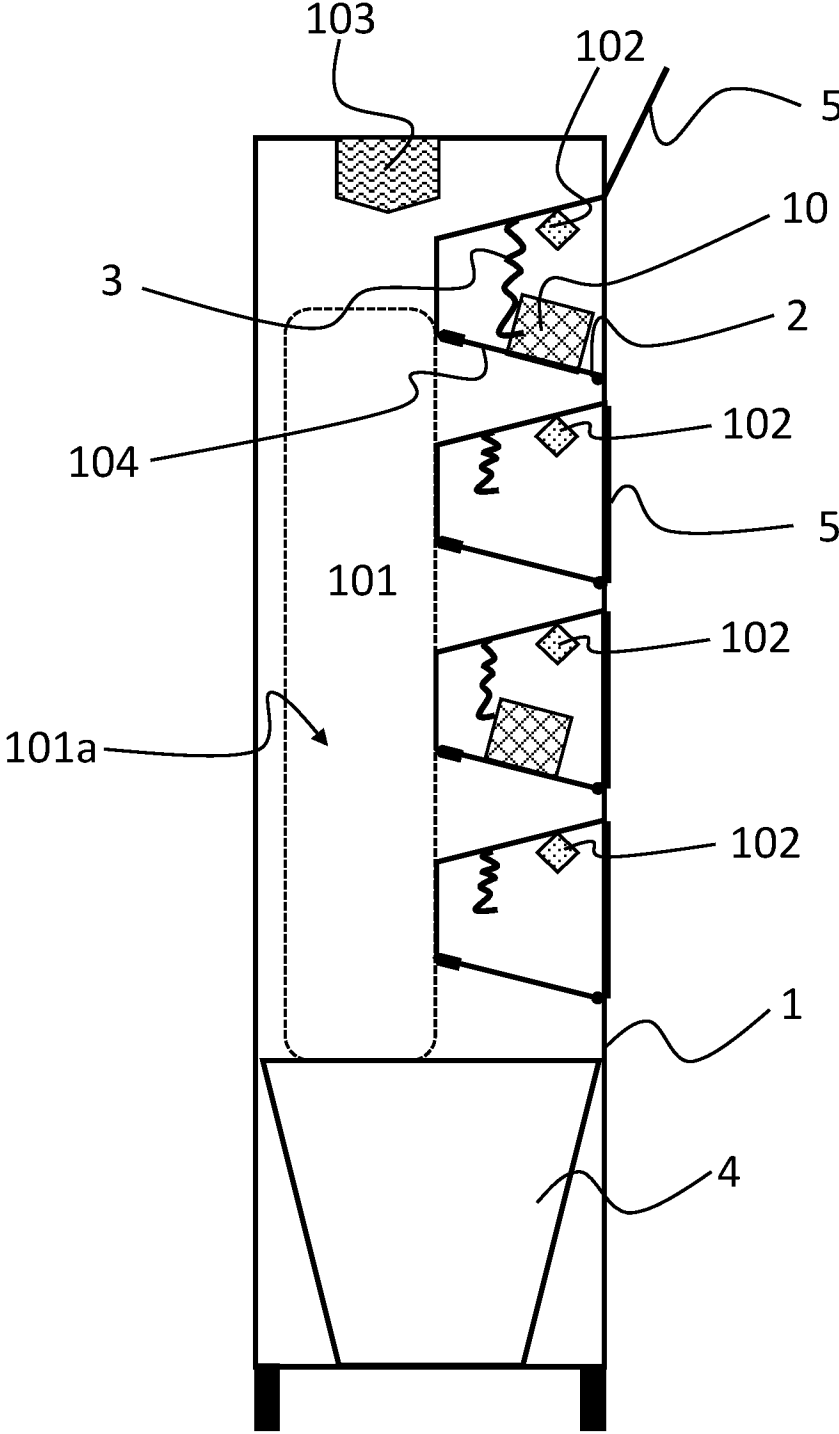


Fig. 2

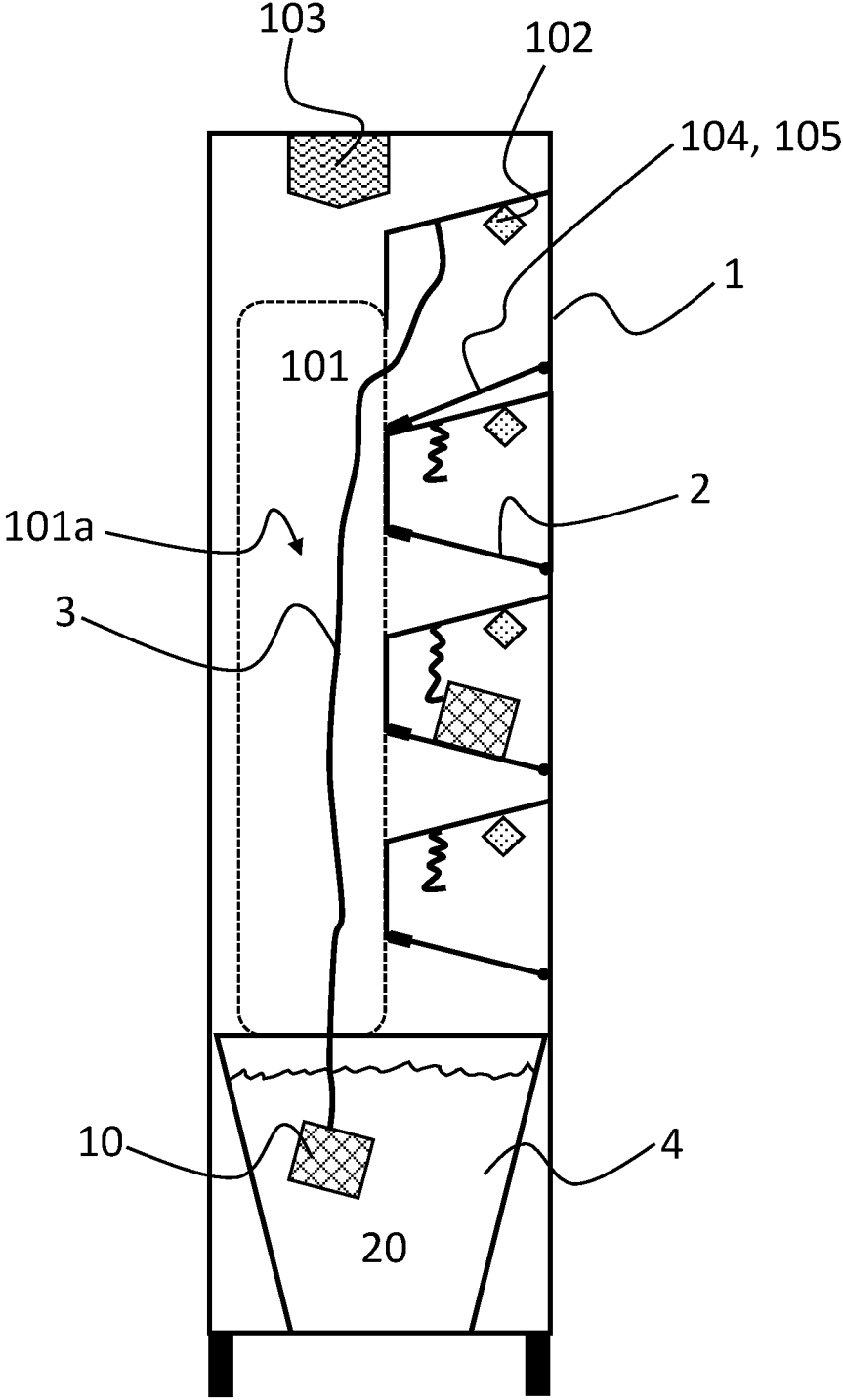


Fig. 3

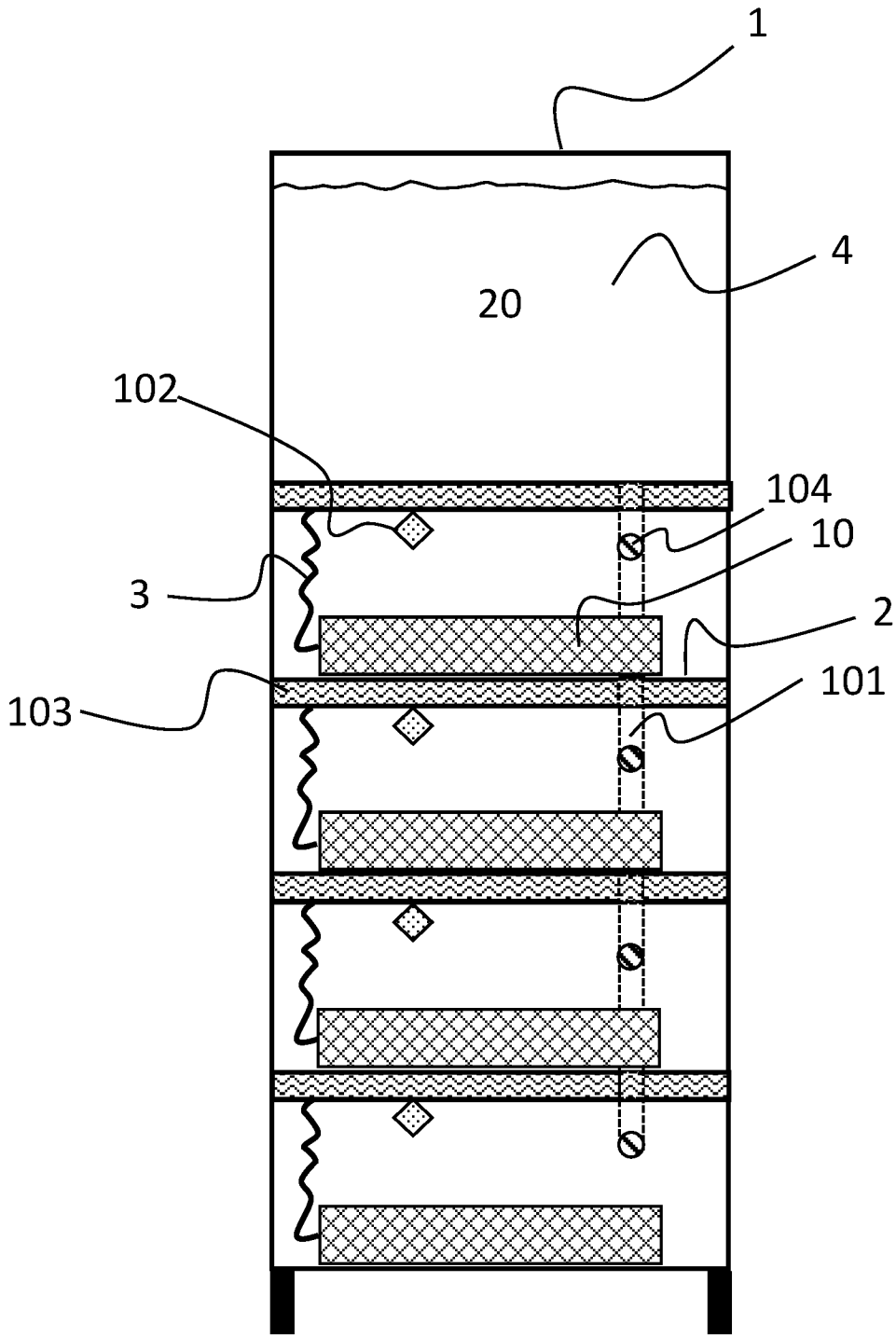


Fig. 4

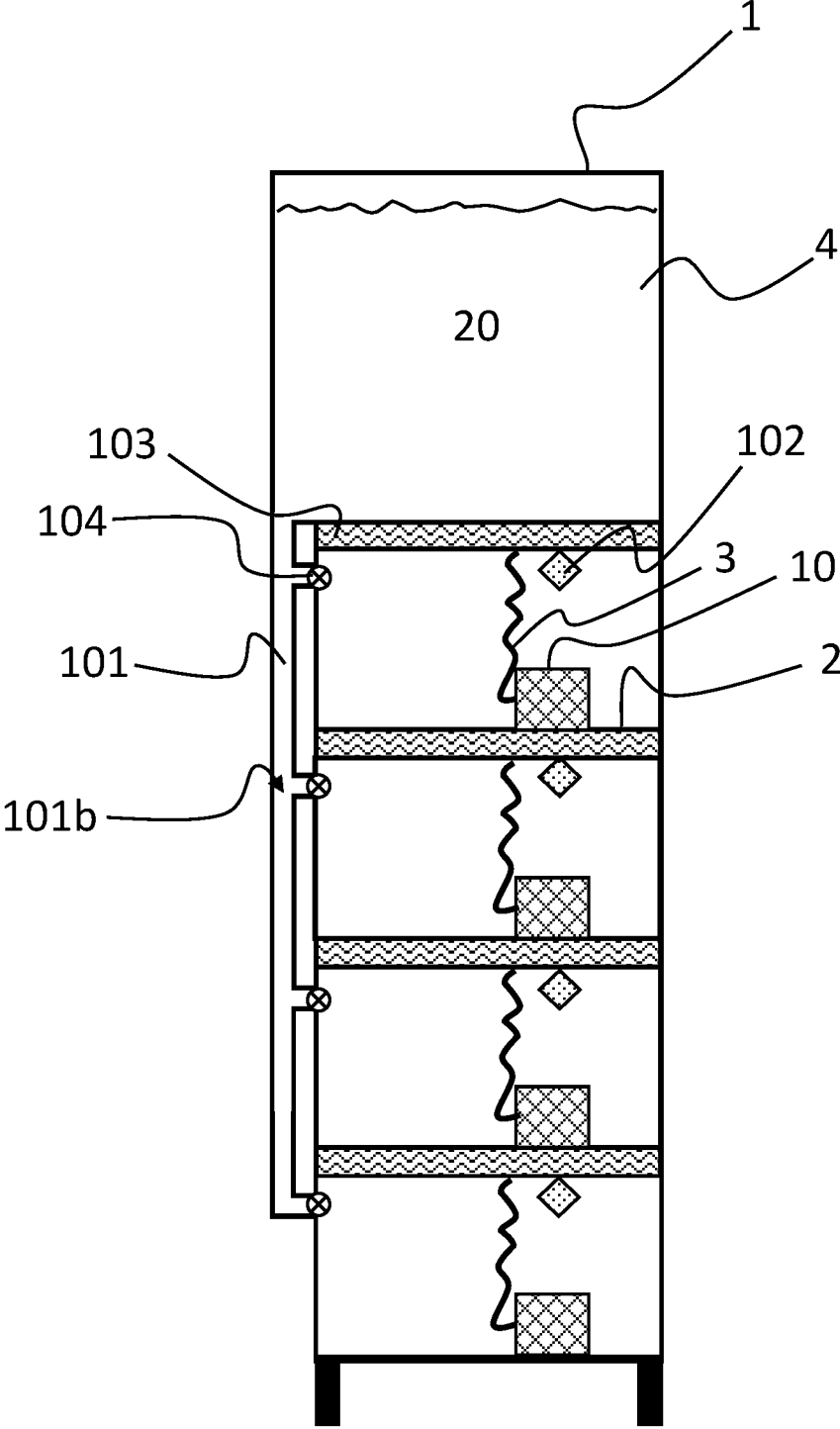


Fig. 5

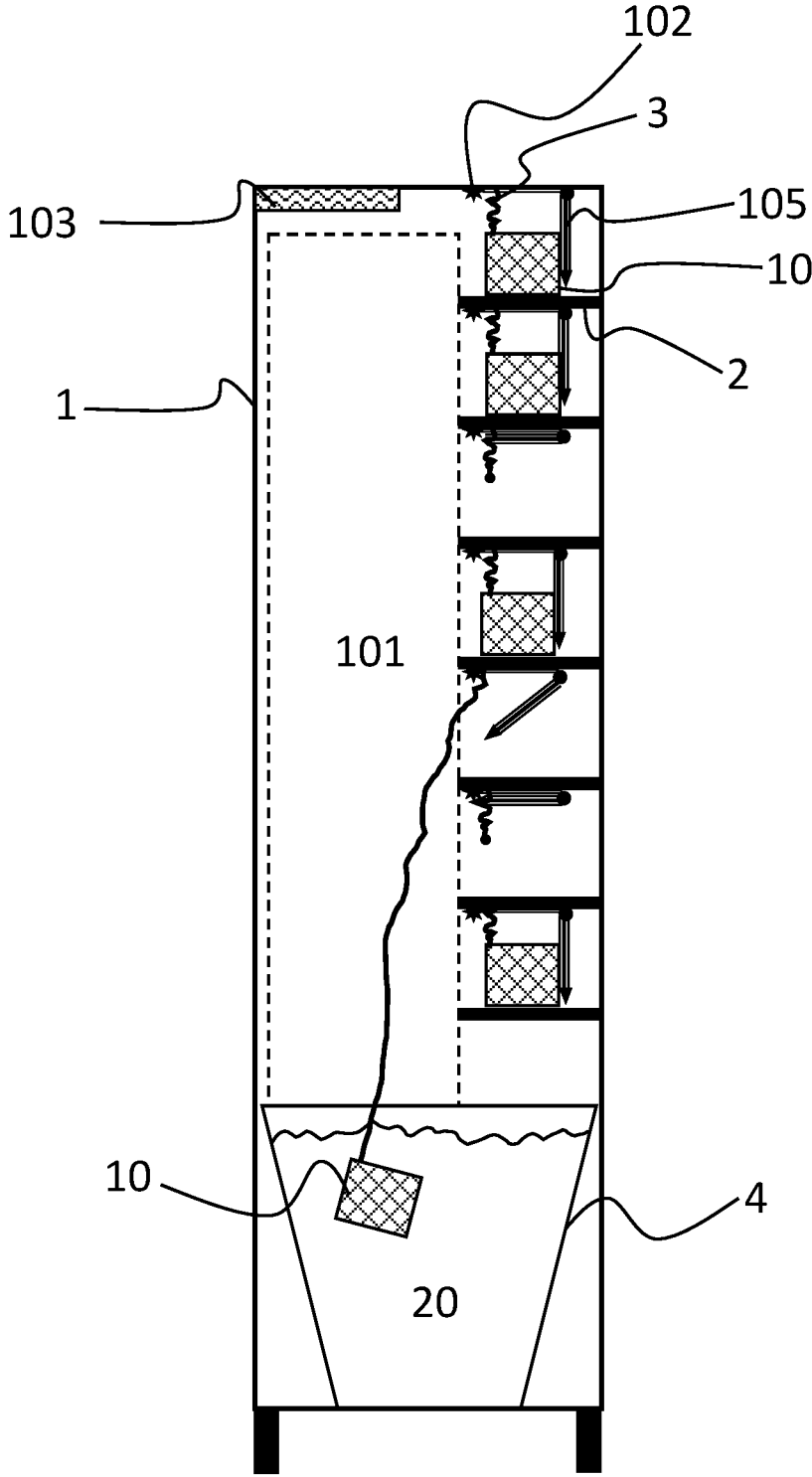


Fig. 6

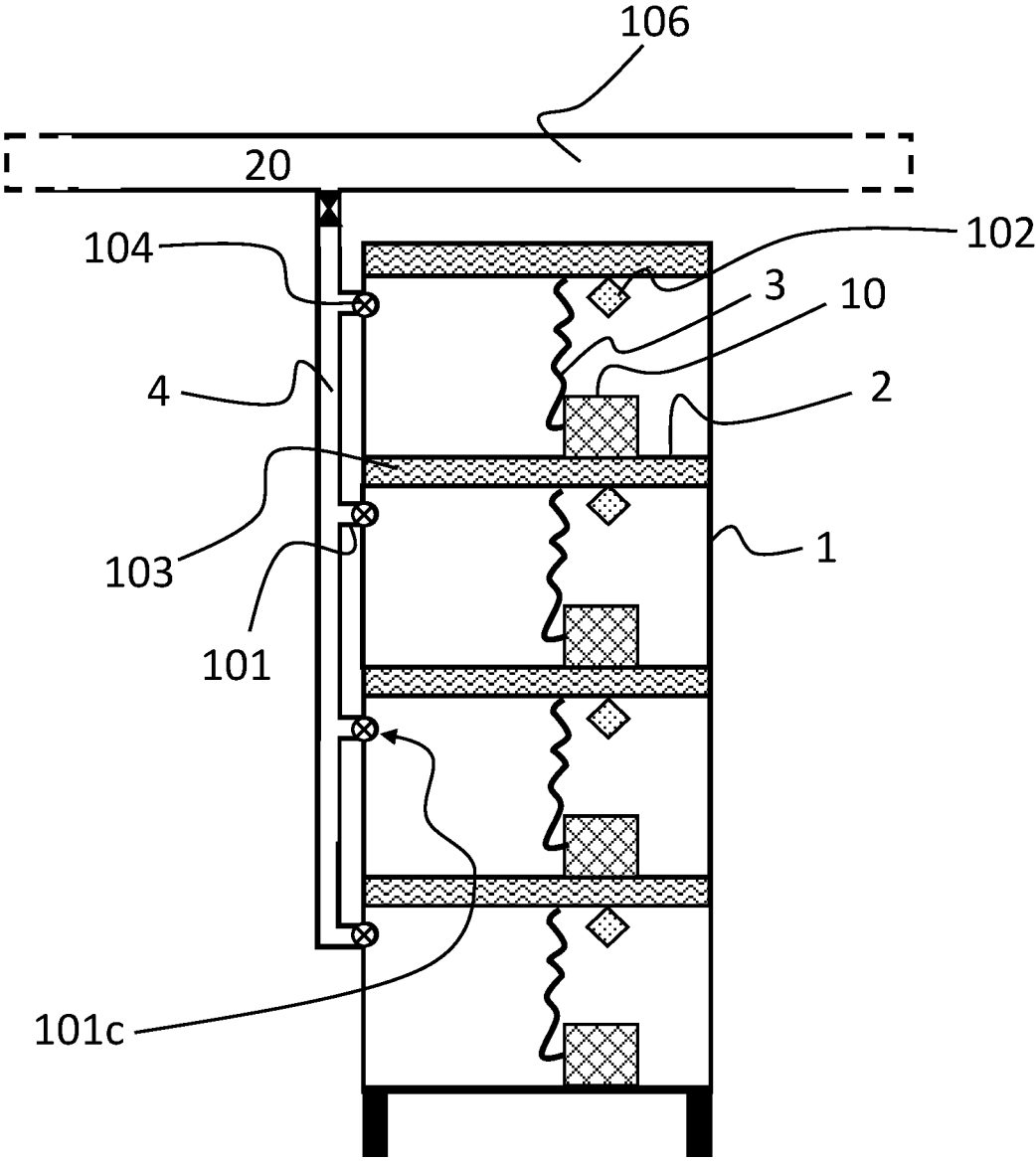


Fig. 7

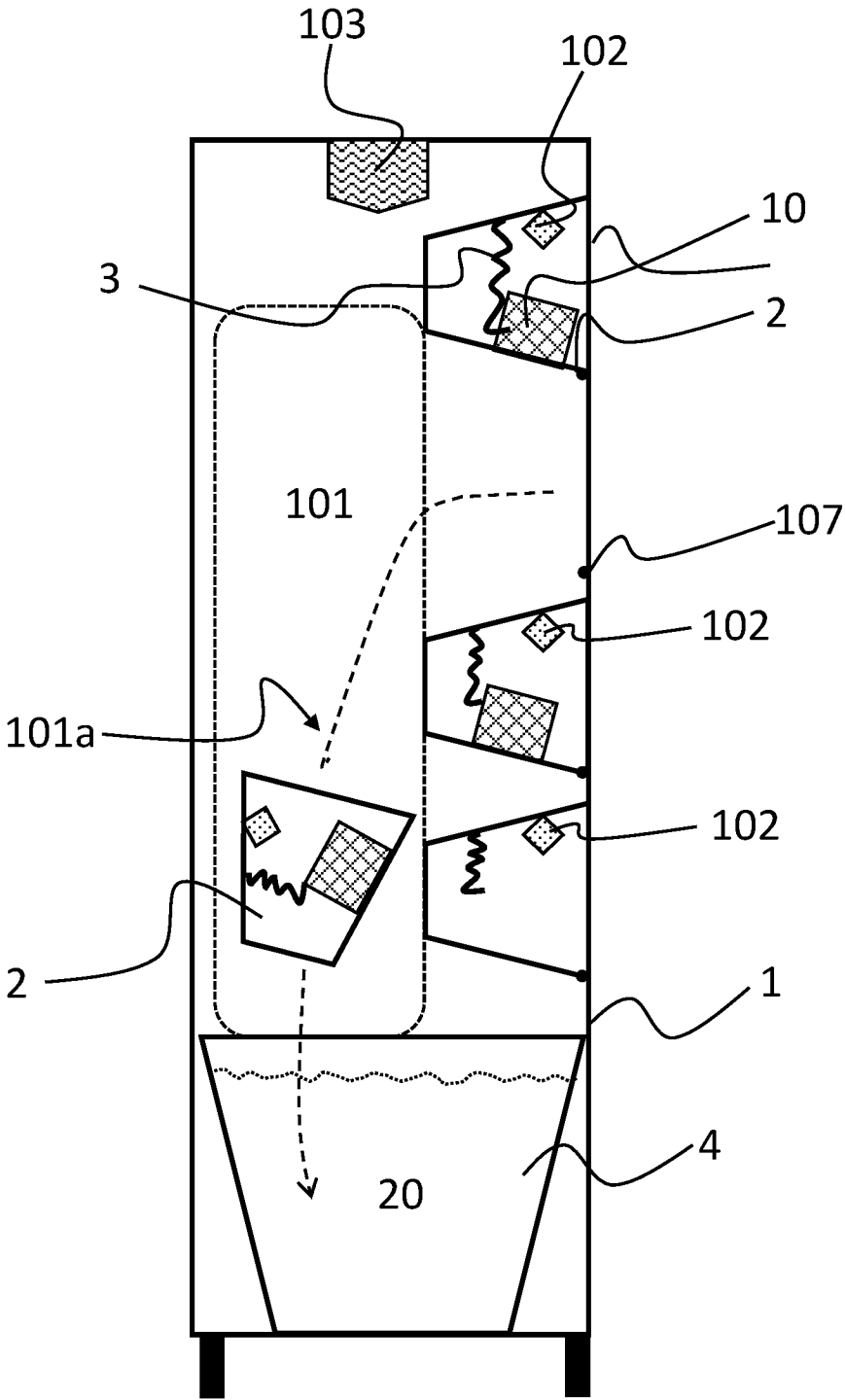


Fig. 8