

US Patent & Trademark Office

Patent Public Search | Text View

United States Patent Application Publication

20250266566

Kind Code

A1

Publication Date

August 21, 2025

Inventor(s)

Chen; Shaozhen et al.

Battery Module, Energy Storage Cabinet, and Energy Storage System

Abstract

A battery module includes a housing, and a plurality of battery cells and a first exhaust pipe that are disposed in the housing. The housing is provided with a first vent. The battery cell includes a battery cover and an explosion-proof valve, the battery cover is provided with a through hole, and the explosion-proof valve is configured to block the through hole. The first exhaust pipe communicates with an outside of the housing through the first vent, the first exhaust pipe is provided with an inlet communicating with the through hole of each battery cell, each inlet is covered with a heat-resistant film, and opening pressure of the heat-resistant film is less than opening pressure of the explosion-proof valve.

Inventors: Chen; Shaozhen (Shenzhen, CN), Zhou; Jianbing (Dongguan, CN), Liu; Chengyong (Dongguan, CN), Deng; Xiaoyi (Shenzhen, CN), Chen; Cheng (Shenzhen, CN)

Applicant: Huawei Digital Power Technologies Co., Ltd. (Shenzhen, CN)

Family ID: 1000008616117

Appl. No.: 19/202335

Filed: May 08, 2025

Foreign Application Priority Data

CN 202211438198.2

Nov. 16, 2022

Related U.S. Application Data

parent WO continuation PCT/CN2023/102167 20230625 PENDING child US 19202335

Publication Classification

Int. Cl.: H01M50/342 (20210101); **H01M10/658** (20140101); **H01M50/204** (20210101);
H01M50/262 (20210101); **H01M50/358** (20210101); **H01M50/367** (20210101);
H01M50/588 (20210101)

U.S. Cl.:

CPC H01M50/3425 (20210101); **H01M10/658** (20150401); **H01M50/262** (20210101);
H01M50/358 (20210101); **H01M50/367** (20210101); **H01M50/588** (20210101);
H01M50/204 (20210101); H01M2200/20 (20130101)

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This is a continuation of International Patent Application No. PCT/CN2023/102167 filed on Jun. 25, 2023, which claims priority to Chinese Patent Application No. 202211438198.2 filed on Nov. 16, 2022. The disclosures of the aforementioned applications are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

[0002] This application relates to the field of electronic device technologies, and in particular, to a battery module, an energy storage cabinet, and an energy storage system.

BACKGROUND

[0003] An energy storage system may be used as a load balancing apparatus and a backup power supply in a data center, to supply power to electronic devices such as a server and a supercomputer. The energy storage system may be usually disposed in a container or an equipment room, and may include a plurality of energy storage cabinets. Each energy storage cabinet may include a plurality of battery modules, and each battery module may be formed by connecting a plurality of battery cells. Lithium iron phosphate is commonly used for battery cells in the energy storage cabinet. There is a probability of a thermal runaway risk during use of the battery cells. In addition, a thermal runaway diffusion prevention solution is basically not used for current lithium battery energy storage products. If thermal runaway occurs in one battery cell, heat is quickly transferred to an adjacent battery cell, causing thermal runaway to occur in the adjacent battery cell. Once heat is diffused, thermal runaway occurs in the entire battery module and even the entire energy storage cabinet in succession, seriously affecting use safety of the energy storage system.

SUMMARY

[0004] This application provides a battery module, an energy storage cabinet, and an energy storage system, to reduce a risk of thermal runaway diffusion and improve use safety of the battery module.

[0005] According to a first aspect, this application provides a battery module, where the battery module may include a housing, a plurality of battery cells, and a first exhaust pipe, the plurality of battery cells and the first exhaust pipe are disposed in the housing, and the housing may be provided with a first vent. The battery cell may include a battery cover and an explosion-proof valve, the battery cover is provided with a through hole, the through hole may enable communication between the inside of the battery cell and the outside, and the explosion-proof valve covers the through hole and blocks the through hole. The first exhaust pipe may communicate with an outside of the housing through the first vent, the first exhaust pipe is provided with an inlet communicating with the through hole of each battery cell, each inlet is covered with a heat-resistant film, and opening pressure of the heat-resistant film is less than opening pressure of the explosion-proof valve. In this way, after the explosion-proof valve is opened under pressure inside the battery cell, the pressure definitely opens the heat-resistant film, so that high-temperature gas inside the battery cell smoothly enters the first exhaust pipe, and is

discharged to the outside of the housing through the first exhaust pipe, thereby reducing heat diffusion inside the housing. In addition, for the entire battery module, even if one or more battery cells in the same battery module are faulty and discharge gas to the first exhaust pipe, when high-temperature gas in the first exhaust pipe flows through a normal battery cell, the heat-resistant film can reduce heat transferred by the high-temperature gas to the normal battery cell through the inlet, thereby effectively reducing a risk of thermal runaway diffusion and improving use safety of the battery module.

[0006] In some possible implementation solutions, the heat-resistant film may be bonded and fastened to the inlet. A material of the heat-resistant film may include but is not limited to a heat insulation material such as glass fiber, asbestos, or rock wool.

[0007] In some possible implementation solutions, a heat insulation pad may be disposed between adjacent battery cells, to reduce heat transfer between the battery cells, and reduce a risk of thermal runaway diffusion inside the battery module.

[0008] For example, the heat insulation pad may be, but is not limited to, glass fiber, asbestos, rock wool, aerogel blanket, a vacuum plate, or the like.

[0009] In some possible implementation solutions, the battery module may further include an insulation bracket, the insulation bracket may continuously cover battery covers of the plurality of battery cells, and the first exhaust pipe may be fastened to the insulation bracket, to improve convenience of mounting the first exhaust pipe in the housing.

[0010] In some possible implementation solutions, the insulation bracket may further include a boss that protrudes away from the battery cover, a bottom wall is disposed on a side that is of the boss and that faces the battery cover, the bottom wall may be disposed in contact with the battery cover, an avoidance hole is provided at a position that is of the bottom wall and that corresponds to the through hole of each battery cell, and the first exhaust pipe may be embedded in the boss and the bottom wall. This not only facilitates mounting and fastening of the first exhaust pipe, and but also facilitates electrical isolation between the battery cover and the first exhaust pipe by using the bottom wall, so as to improve use safety of the battery module.

[0011] In some possible implementation solutions, the heat-resistant film may be specifically disposed on an inner wall of the bottom wall, and is disposed to cover the avoidance hole.

[0012] In some possible implementation solutions, the insulation bracket may further include a first fastening part and a second fastening part that are located on two sides of the boss. A first terminal and a second terminal are disposed on the battery cover of each battery cell, the first fastening part is located on a side that is of the first terminal and that faces away from the battery cell, and a first hole is provided at a position that is of the first fastening part and that corresponds to the first terminal of each battery cell; and the second fastening part is located on a side that is of the second terminal and that faces away from the battery cell, and a second hole is provided at a position that is of the second fastening part and that corresponds to the second terminal of each battery cell. The battery module may further include a busbar. The busbar is disposed on a side that is of the insulation bracket and that faces away from the battery cover. The busbar may include a plurality of conductive parts, and each conductive part may be configured to electrically connect two adjacent battery cells. For the two adjacent battery cells, the conductive part may be electrically connected to a first terminal of one of the battery cells through a first hole, and electrically connected to a second terminal of the other battery cell through a second hole. In this way, the plurality of conductive parts may be used to connect the battery cells in the battery module in series.

[0013] In some possible implementation solutions, a material of the first exhaust pipe may be galvanized steel. The galvanized steel has strong corrosion resistance, and therefore can improve a service life of the first exhaust pipe.

[0014] According to a second aspect, this application further provides an energy storage cabinet, where the energy storage cabinet may include a cabinet body, a second exhaust pipe, and a plurality of battery modules in any one of the possible implementation solutions of the first aspect, and the

plurality of battery modules and the second exhaust pipe are disposed in the cabinet body. The cabinet body may be provided with a second vent, the second exhaust pipe may communicate with an outside of the cabinet body through the second vent, and the second exhaust pipe communicates with a first vent of each battery module. In this way, after the battery cell in the battery module discharges the high-temperature gas to the first exhaust pipe, the high-temperature gas may be conveyed by the first exhaust pipe to the second exhaust pipe through the first air vent, and further discharged by the second exhaust pipe to the outside of the cabinet body through the second air vent. In this process, the high-temperature gas discharged by the battery modules in the energy storage cabinet is limited within the second exhaust pipe, and therefore heat transfer between the battery modules is limited. This can effectively reduce a risk of thermal runaway diffusion inside the energy storage cabinet.

[0015] In some possible implementation solutions, the second exhaust pipe may be provided with a connection pipe corresponding to the first air vent of each battery module, and the second exhaust pipe may communicate with each first air vent through the corresponding connection pipe. For example, an end of the connection pipe may be welded to the first vent of the corresponding battery module. Alternatively, a flange may be disposed at an end of the connection pipe, and the flange may be connected to a housing of the corresponding battery module through a fastener. In this case, a sealing ring may be disposed in a squeezing manner between the flange at the end of each connection pipe and the housing of the corresponding battery module, to reduce a risk of high-temperature gas leakage at a joint.

[0016] According to a third aspect, this application further provides an energy storage system. The energy storage system may include a container, a third exhaust pipe, and a plurality of energy storage cabinets in any one of the possible implementation solutions of the second aspect, and the plurality of energy storage cabinets and the third exhaust pipe are disposed in the container. The container may be provided with a third vent, the third exhaust pipe may communicate with an outside of the container through the third vent, and the third exhaust pipe communicates with a second vent of each energy storage cabinet. In this way, after the second exhaust pipe conveys high-temperature gas to the third exhaust pipe through the second air vent, the high-temperature gas may be further conveyed by the third exhaust pipe to the outside of the container through the third air vent. In this process, the high-temperature gas discharged by the energy storage cabinets in the container is limited within the third exhaust pipe, and therefore heat transfer between the energy storage cabinets is limited. This can effectively reduce a risk of thermal runaway diffusion in the container.

[0017] In some possible implementation solutions, the third exhaust pipe may include a main pipe and a plurality of subsidiary pipes. The plurality of subsidiary pipes is disposed in a one-to-one correspondence with the plurality of energy storage cabinets. One end of the subsidiary pipe communicates with the second air vent of the energy storage cabinet, the other end communicates with the main pipe, and the main pipe communicates with the third air vent. This design helps simplify a structure of the third exhaust pipe and reduce space occupied by the third exhaust pipe in the container.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0018] FIG. 1 is a diagram of a thermal runaway process of a battery cell;

[0019] FIG. 2 is a diagram of a structure of a battery module according to an embodiment of this application;

[0020] FIG. 3 is a diagram of a cross-sectional structure of a battery cell according to an embodiment of this application;

[0021] FIG. 4 is a diagram of a structure of an energy storage cabinet according to an embodiment of this application; and

[0022] FIG. 5 is a diagram of a structure of an energy storage system according to an embodiment of this application.

REFERENCE NUMERALS

[0023] **10**—battery module; **11**—housing; **111**—first vent; **12**—battery cell; **121**—battery cover; **1211**—through hole; [0024] **122**—battery casing; **123**—first terminal; **124**—second terminal; **125**—explosion-proof valve; **13**—heat insulation pad; **14**—insulation bracket; [0025] **141**—first fastening part; **1411**—first hole; **142**—second fastening part; **1421**—second hole; **143**—boss; [0026] **1431**—inner layer structure; **1432**—outer layer structure; **144**—bottom wall; **1441**—avoidance hole; **15**—busbar; **151**—conductive part; [0027] **16**—first exhaust pipe; **161**—inlet; **162**—heat-resistant film; [0028] **100**—energy storage cabinet; **20**—cabinet body; **21**—second vent; **30**—second exhaust pipe; **31**—connection pipe; [0029] **1000**—energy storage system; **200**—container; **201**—third vent; **300**—third exhaust pipe; **310**—main pipe; [0030] **320**—subsidiary pipe.

DESCRIPTION OF EMBODIMENTS

[0031] To make the objectives, technical solutions, and advantages of this application clearer, the following further describes embodiments of this application in detail with reference to the accompanying drawings. However, example implementations may be implemented in a plurality of forms, and should not be construed as being limited to implementations described herein. Identical reference numerals in the accompanying drawings represent identical or similar structures.

Therefore, repeated descriptions thereof are omitted. Expressions of positions and directions in embodiments of this application are described by using the accompanying drawings as examples. However, changes may be also made as required, and all the changes fall within the protection scope of this application. The accompanying drawings in embodiments of this application are merely used to illustrate a relative position relationship and do not represent an actual scale.

[0032] It should be noted that specific details are set forth in the following descriptions to facilitate understanding of this application. However, embodiments of this application can be implemented in a plurality of manners different from those described herein, and a person skilled in the art can perform similar promotion without departing from the connotation of embodiments of this application. Therefore, this application is not limited to the specific implementations disclosed in the following.

[0033] An energy storage system is a device that may store electric energy by using a specific medium, and release the stored energy for electricity generation when necessary. The energy storage system may be used as a load balancing apparatus and a backup power supply in a data center, to supply power to electronic devices such as a server and a supercomputer, or may be used as a power source in a new energy vehicle, to provide power for traveling of the vehicle.

[0034] Using the energy storage system used in the data center as an example, the energy storage system may be usually disposed in a container or an equipment room, and may include a plurality of energy storage cabinets. Each energy storage cabinet may include a plurality of battery modules, and each battery module may be formed by connecting a plurality of battery cells in series. Lithium iron phosphate is commonly used for battery cells in the energy storage cabinet. There is a probability of a thermal runaway risk during use of the battery cells. The thermal runaway risk means phenomena of overheating, fire, and explosion that are caused by a heat release chain reaction of a battery cell in a cabinet and that occur after a sharp change of a temperature-rise rate of the battery. A cause of thermal runaway usually includes squeeze, needle puncture, short circuit, overcharging, overheating, and the like.

[0035] FIG. 1 is a diagram of a thermal runaway process of a battery cell. Currently, a thermal runaway diffusion prevention solution is basically not used for current lithium battery energy storage products. If thermal runaway occurs in one battery cell, heat is quickly transferred to an

adjacent battery cell, causing thermal runaway to occur in the adjacent battery cell. Once heat is diffused, thermal runaway occurs in the entire battery module and even the entire energy storage cabinet in succession, seriously affecting use safety of the energy storage system.

[0036] For the foregoing problem, embodiments of this application provide a battery module, an energy storage cabinet, and an energy storage system, to reduce a risk of thermal runaway diffusion and improve use safety of the battery module. The following specifically describes, with reference to the accompanying drawings, a package structure provided in embodiments of this application.

[0037] FIG. 2 is a diagram of a structure of a battery module according to an embodiment of this application. A battery module **10** may include a housing **11** and a plurality of battery cells **12**, and the plurality of battery cells **12** are disposed in the housing **11**. In some implementations, the plurality of battery cells **12** may be disposed in parallel in a length direction of the housing **11**, and adjacent battery cells **12** may be separated by using a heat insulation pad **13**, to reduce heat transfer between the battery cells **12** and reduce a risk of thermal runaway diffusion inside the battery module **10**. For example, the heat insulation pad **13** may be, but is not limited to, glass fiber, asbestos, rock wool, aerogel blanket, a vacuum plate, or the like.

[0038] FIG. 3 is a diagram of a cross-sectional structure of a battery cell according to an embodiment of this application. With reference to both FIG. 2 and FIG. 3, the battery cell **12** may include a battery cover **121**, a battery casing **122**, and a jelly roll (not shown in the figure). The battery cover **121** and the battery casing **122** may be fixedly connected to form a sealed cavity, and the jelly roll is disposed in the sealed cavity. A first terminal **123** and a second terminal **124** may be disposed on the battery cover **121**, where the first terminal **123** and the second terminal **124** may be a positive terminal and a negative terminal respectively. In this case, the first terminal **123** may be electrically connected to a positive terminal of the jelly roll, and the second terminal **124** may be electrically connected to a negative terminal of the jelly roll. In a specific implementation, the battery cover **121** may be provided with a first mounting hole and a second mounting hole, the first mounting hole and the second mounting hole separately run through the battery cover **121**, the first terminal **123** may be electrically connected to the positive terminal of the jelly roll through the first mounting hole, and the second terminal **124** may be electrically connected to the negative terminal of the jelly roll through the second mounting hole. In addition, the battery cover **121** may be further provided with a liquid injection hole, and the liquid injection hole may run through the battery cover, to facilitate injection of an electrolyte into the battery cell through the liquid injection hole.

[0039] In addition, the battery module **10** may further include an insulation bracket **14** and a busbar **15**. The insulation bracket **14** may be disposed on battery covers **121** of the plurality of battery cells **12**, and the busbar **15** is disposed on a side that is of the insulation bracket **14** and that faces away from the battery cover **121**. In a specific implementation, the insulation bracket **14** may include a first fastening part **141** disposed to cover the first terminal **123** of each battery cell **12**, and a second fastening part **142** disposed to cover the second terminal **124** of each battery cell **12**. A first hole **1411** is provided at a position that is of the first fastening part **141** and that corresponds to the first terminal **123** of each battery cell **12**. A second hole **1421** is provided at a position that is of the second fastening part **142** and that corresponds to the second terminal **124** of each battery cell **12**. The busbar **15** may include a plurality of conductive parts **151**, and each conductive part **151** may be configured to electrically connect two adjacent battery cells **12**. For the two adjacent battery cells **12**, the conductive part **151** may be electrically connected to a first terminal **123** of one of the battery cells **12** through a first hole **1411**, and electrically connected to a second terminal **124** of the other battery cell **12** through a second hole **1421**. In this way, the plurality of conductive parts **151** may be used to connect the battery cells **12** in the battery module **10** in series.

[0040] For example, for the battery cell **12** shown in FIG. 3, a left conductive part **151** may be configured to electrically connect the first terminal **123** of the battery cell **12** to the second terminal **124** of a previous battery cell **12**, and a right conductive part **151** may be configured to electrically connect the second terminal **124** of the battery cell **12** to the first terminal **123** of a next battery cell

12. In this case, the conductive part **151** may be approximately of a Z-shaped structure. [0041] In a process of using the battery cell **12**, because side reactions continuously occur between the electrolyte and the positive and negative terminals of the jelly roll, gas is generated. As described above, the inside of the battery cell **12** is the sealed cavity formed by the battery casing **122** and the battery cover **121**. Therefore, with continuous accumulation of the gas, pressure inside the battery cell **12** increases continuously. To prevent a safety problem due to excessively high internal pressure of the battery cell **12**, an explosion-proof valve **125** may be further disposed on the battery cover **121**. When the battery cell **12** is faulty, and pressure inside the battery cell **12** is greater than opening pressure of the explosion-proof valve **125**, the explosion-proof valve **125** is opened, to discharge the gas inside the battery cell **12**, so as to reduce a temperature of the battery cell **12** and implement pressure relief, thereby preventing a more serious safety problem such as explosion of the battery cell **12**.

[0042] When the explosion-proof valve **125** is mounted on the battery cover **121**, the battery cover **121** may be provided with a through hole **1211** that enables communication between the inside of the battery cell **12** and the outside, and the explosion-proof valve **125** may be welded and fastened to a side surface of the battery cover **121**, to block the through hole **1211**. For example, the through hole **1211** may be located between the first terminal **123** and the second terminal **124**. The explosion-proof valve **125** may be disposed on a side that is of the battery cover **121** and that faces the inside of the battery cell **12**, or may be disposed on a side that is of the battery cover **121** and that faces away from the inside of the battery cell **12**. This is not limited in this application, provided that the through hole **1211** can be blocked. In the embodiment shown in FIG. 3, an example in which the explosion-proof valve **125** is disposed on the side that is of the battery cover **121** and that faces the inside of the battery cell **12** is used for description.

[0043] Still with reference to FIG. 2 and FIG. 3, in some embodiments, the housing **11** may be provided with a first vent **111**, and a first exhaust pipe **16** may be disposed in the housing **11**. The first exhaust pipe **16** may communicate with an outside of the housing **11** through the first vent **111**, and also communicate with the through hole **1211** provided on the battery cover **121** of each battery cell **12**. After the explosion-proof valve **125** of the battery cell **12** is opened, the high-temperature gas inside the battery cell **12** may enter the first exhaust pipe **16** through the through hole **1211**, and is further discharged to the outside of the housing **11** through the first exhaust pipe **16**. For example, the first exhaust pipe **16** may be prepared by using a galvanized steel material with strong corrosion resistance, to improve a service life of the first exhaust pipe **16**.

[0044] In a specific embodiment, the first exhaust pipe **16** may be provided with an inlet **161** communicating with the through hole **1211** of each battery cell **12**, and the high-temperature gas in the battery cell **12** may enter the first exhaust pipe **16** through the through hole **1211** of the battery cover **121** and the corresponding inlet **161** in sequence. In addition, a heat-resistant film **162** may be disposed at each inlet **161** of the first exhaust pipe **16**, and the heat-resistant film **162** may be disposed to cover the inlet **161**. For example, the heat-resistant film **162** may be bonded and fastened to the inlet **161**, and a material of the heat-resistant film **162** may include but is not limited to a heat insulation material such as glass fiber, asbestos, or rock wool.

[0045] It can be learned that, in this embodiment, the inside of the battery cell **12** is separated from the first exhaust pipe **16** through two barriers: the explosion-proof valve **125** and the heat-resistant film **162**. In a specific implementation, opening pressure of the heat-resistant film **162** is less than the opening pressure of the explosion-proof valve **125**. In this way, after the explosion-proof valve **125** is opened under the pressure inside the battery cell **12**, the pressure definitely opens the heat-resistant film **162**, so that the gas inside the battery cell **12** smoothly enters the first exhaust pipe **16**. For the entire battery module **10**, even if one or more battery cells **12** in the same battery module **10** are faulty and discharge gas to the first exhaust pipe **16**, when the high-temperature gas in the first exhaust pipe **16** flows through a normal battery cell **12**, due to a heat insulation function of the heat-resistant film **162**, the high-temperature gas can be prevented from transferring heat to

the normal battery cell **12** through the inlet **161**, thereby reducing a risk of heat diffusion in the entire battery module **10**, and improving use safety of the battery module **10**.

[0046] In some possible embodiments, the first exhaust pipe **16** may extend in an arrangement direction of the battery cells **12**, that is, extend in the length direction of the housing **11**, so as to enable communication between the first exhaust pipe **16** and the through hole **1211** of each battery cell **12**. In addition, the first vent **111** of the housing **11** may be provided on a side wall that is of the housing **11** and that faces the battery cover **121**. In this case, the first exhaust pipe **16** is located between the battery cover **121** and the side wall of the housing **11**, so as to enable communication between the first exhaust pipe **16** and the first vent **111**.

[0047] Still with reference to FIG. 2 and FIG. 3, in this embodiment of this application, the first exhaust pipe **16** may be disposed on the insulation bracket **14**, to improve convenience of mounting the first exhaust pipe **16** in the housing **11**. In a specific implementation, the insulation bracket **14** may include a boss **143** that protrudes away from the battery cover **121**. The boss **143** may extend in the length direction of the housing **11**, and a bottom wall **144** is disposed on a side that is of the boss **143** and that faces the battery cover **121**. In this way, the boss **143** and the bottom wall **144** may enclose a tubular structure, and the first exhaust pipe **16** may be embedded in the tubular structure. The bottom wall **144** may be disposed in contact with the battery cover **121** of each battery cell **12**, and an avoidance hole **1441** may be disposed at a position that is of the bottom wall **144** and that corresponds to the through hole **1211** of each battery cell **12**, so that the through hole **1211** communicates with the first exhaust pipe **16**. In this case, the tubular structure formed by the boss **143** and the bottom wall **144** may be considered as a two-layer structure including an inner layer and an outer layer. The first exhaust pipe **16** is an interlayer located between an inner layer structure **1431** and an outer layer structure **1432**. The heat-resistant film **162** may be specifically disposed on an inner wall of the bottom wall **144** and is disposed to cover the avoidance hole **1441**. This design not only facilitates mounting and fastening of the first exhaust pipe **16**, and but also facilitates electrical isolation between the battery cover **121** and the first exhaust pipe **16** by using the bottom wall **144**, so as to improve use safety of the battery module **10**.

[0048] In some possible embodiments, the insulation bracket **14** may wrap the first exhaust pipe **16** for shaping in an injection molding manner. In this way, not only reliability of connection between the insulation bracket **14** and the first exhaust pipe **16** can be improved, but also a subsequent assembly process can be omitted, so as to help simplify an overall preparation process of the battery module **10**.

[0049] FIG. 4 is a diagram of a structure of an energy storage cabinet according to an embodiment of this application. With reference to both FIG. 2 and FIG. 4, an energy storage cabinet **100** may include a cabinet body **20** and a plurality of battery modules **10** described in the foregoing embodiment, and the plurality of battery modules **10** are disposed in the cabinet body **20**. For example, the plurality of battery modules **10** may be disposed in parallel in a height direction of the cabinet body **20**. The cabinet body **20** may be provided with a second vent **21**, and a second exhaust pipe **30** may be further disposed in the cabinet body **20**. The second exhaust pipe **30** may communicate with an outside of the cabinet body **20** through the second vent **21**, and also communicate with the first vent **111** of each battery module **10**. For example, a material of the second exhaust pipe **30** may also be galvanized steel.

[0050] In this embodiment, after the battery cell **12** in the battery module **10** discharges the high-temperature gas to the first exhaust pipe **16**, the high-temperature gas may be conveyed by the first exhaust pipe **16** to the second exhaust pipe **30** through the first vent **111**, and further discharged by the second exhaust pipe **30** to the outside of the cabinet body **20** through the second vent **21**. In this process, the high-temperature gas discharged by the battery modules **10** in the energy storage cabinet **100** is limited within the second exhaust pipe **30**, and therefore heat transfer between the battery modules **10** is limited. This can effectively reduce a risk of thermal runaway diffusion inside the energy storage cabinet **100**.

[0051] In a specific implementation, the second exhaust pipe **30** may extend in an arrangement direction of the battery modules **10**, that is, extend in a length direction of the cabinet body **20**, so as to enable communication between the second exhaust pipe **30** and the first vent **111** of each battery module **10**. In addition, a connection pipe **31** corresponding to the first vent **111** of each battery module **10** in the cabinet body **20** may be disposed on the second exhaust pipe **30**, and the connection pipe **31** may be welded to the first vent **111** of the corresponding battery module **10**, so as to enable communication between the first vent **111** and the second exhaust pipe **30** through the corresponding connection pipe **31**.

[0052] Alternatively, in some other embodiments, a flange may be further disposed at an end of the connection pipe **31**, and the flange may be connected to the housing **11** of the corresponding battery module **10** through a fastener, so that the second exhaust pipe **30** is relatively fastened to each battery module **10**, and the second exhaust pipe **30** communicates with the first vent **111** of each battery module **10**. In this case, a sealing ring may be disposed in a squeezing manner between the flange at the end of each connection pipe **31** and the housing **11** of the corresponding battery module **10**, to reduce a risk of high-temperature gas leakage at a joint. For example, the sealing ring may be made of a high-temperature-resistant and anti-corrosion material, including but not limited to rubber, graphite, asbestos, and the like.

[0053] FIG. **5** is a diagram of a structure of an energy storage system according to an embodiment of this application. The energy storage system **1000** may include a container **200** and a plurality of energy storage cabinets **100** described in the foregoing embodiment, where the plurality of energy storage cabinets **100** are disposed in the container **200**. For example, the plurality of energy storage cabinets **100** may be disposed in an array in the container **200**. FIG. **5** shows a case in which the plurality of energy storage cabinets **100** are arranged in four rows and two columns. It should be understood that, a quantity and an arrangement manner of the energy storage cabinets **100** in FIG. **5** are merely used as an example, and do not constitute a limitation on an internal structure of the energy storage system **1000**.

[0054] The container **200** may be provided with a third vent **201**, and a third exhaust pipe **300** may be further disposed in the container **200**. The third exhaust pipe **300** may communicate with an outside of the container **200** through the third vent **201**, and also communicate with the second vent **21** of each energy storage cabinet **100**. For example, a material of the third exhaust pipe **300** may also be galvanized steel. In this design, after the battery cell in the battery module discharges the high-temperature gas to the first exhaust pipe, the high-temperature gas may be conveyed by the first exhaust pipe to the second exhaust pipe through the first vent, further conveyed by the second exhaust pipe to the third exhaust pipe **300** through the second vent **21**, and finally discharged by the third exhaust pipe **300** to the outside of the container **200** through the third vent **201**. In this process, the high-temperature gas discharged by the energy storage cabinets **100** in the container **200** is limited within the third exhaust pipe **300**, and therefore heat transfer between the energy storage cabinets **100** is limited. This can effectively reduce a risk of thermal runaway diffusion in the container **200**.

[0055] In a specific implementation, the third exhaust pipe **300** may include a main pipe **310** and a plurality of subsidiary pipes **320**. The plurality of subsidiary pipes **320** are disposed in a one-to-one correspondence with the plurality of energy storage cabinets **100**. One end of the subsidiary pipe **320** communicates with the second vent **21** of the energy storage cabinet **100**, the other end communicates with the main pipe **310**, and the main pipe **310** communicates with the third vent **201**. This design helps simplify a structure of the third exhaust pipe **300** and reduce space occupied by the third exhaust pipe **300** in the container **200**. In this case, the high-temperature gas discharged from the energy storage cabinets **100** may be gathered to the main pipe **310** through the subsidiary pipes **320** respectively corresponding to the energy storage cabinets **100**, and finally discharged from the third vent **201**.

[0056] In some embodiments, the subsidiary pipe **320** may be welded to the second vent **21** of the

corresponding energy storage cabinet **100**, to implement communication between the third exhaust pipe **300** and the second vent **21**. Alternatively, in some other embodiments, a flange may be disposed at an end that is of the subsidiary pipe **320** and that is away from the main pipe **310**, and the flange may be securely connected to the cabinet body of the corresponding energy storage cabinet **100** through a fastener, so that the third exhaust pipe **300** is relatively fastened to each energy storage cabinet **100**, and the third exhaust pipe **300** communicates with the second vent **21** of each energy storage cabinet **100**. In this case, a sealing ring may be disposed in a squeezing manner between the flange at the end of each subsidiary pipe **320** and the cabinet body of the corresponding energy storage cabinet **100**, to reduce a risk of high-temperature gas leakage at a joint. Similarly, the sealing ring herein may also be made of a high-temperature-resistant and anti-corrosion material such as rubber, graphite, or asbestos.

[0057] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

Claims

1. A battery module, comprising: a housing comprising an outer surface and comprising a first vent; a plurality of battery cells disposed in the housing, wherein each battery cell of the plurality of battery cells comprises: a battery cover comprising a through hole; and an explosion-proof valve configured to block the through hole; and a first exhaust pipe disposed in the housing and configured to communicate with the outer surface through the first vent, wherein the first exhaust pipe comprises an inlet covered with a heat-resistant film and configured to communicate with the through hole of each battery cell of plurality of battery cells, and wherein a first opening pressure of the heat-resistant film is less than a second opening pressure of the explosion-proof valve.
2. The battery module according to claim 1, further comprising a heat insulation pad disposed between adjacent battery cells of the plurality of battery cells.
3. The battery module according to claim 2, further comprising an insulation bracket configured to continuously cover a plurality of battery covers of the plurality of battery cells, wherein the first exhaust pipe is fastened to the insulation bracket.
4. The battery module according to claim 3, wherein the insulation bracket comprises: a boss protruding away from the battery cover; a bottom wall disposed on a side that is of the boss and that faces the battery cover, wherein the bottom wall is disposed in contact with the battery cover; and an avoidance hole disposed at a position that is of the bottom wall and that corresponds to the through hole, and wherein the first exhaust pipe is embedded in the boss and the bottom wall.
5. The battery module according to claim 4, wherein the bottom wall comprises an inner wall, and wherein the heat-resistant film is disposed on the inner wall and covers the avoidance hole.
6. The battery module according to claim 4, wherein the battery cover comprises a first battery cover side and a second battery cover side, wherein the battery module further comprises: a first terminal disposed on the battery cover at the first battery cover side, wherein the first terminal comprises a first terminal side opposite the battery cover; and a second terminal disposed on the battery cover at the second battery cover side, wherein the second terminal comprises a second terminal side opposite the battery cover, wherein the insulation bracket further comprises: an insulation bracket side comprising a first insulation bracket side opposite the battery cover; a first fastening part located on the first terminal side and comprising a first hole corresponding to the first terminal; and a second fastening part located on the second terminal side and comprising a second hole corresponding to the second terminal, wherein the battery module further comprises a busbar disposed on the first insulation bracket side, wherein the busbar comprises a conductive part

configured to electrically connect two adjacent battery cells of the plurality of battery cells, and wherein the conductive part is electrically connected to the first terminal of a first adjacent battery of the adjacent battery cells through the first hole and electrically connected to the second terminal of a second adjacent battery cell of the adjacent battery cells through the second hole.

7. The battery module according to claim 3, wherein the battery cover comprises a first battery cover side and a second battery cover side, wherein the battery module further comprises: a first terminal disposed on the battery cover at the first battery cover side, wherein the first terminal comprises a first terminal side opposite the battery cover; and a second terminal disposed on the battery cover at the second battery cover side, wherein the second terminal comprises a second terminal side opposite the battery cover, wherein the insulation bracket further comprises: an insulation bracket side comprising a first insulation bracket side opposite the battery cover; a first fastening part located on the first terminal side and comprising a first hole corresponding to the first terminal; and a second fastening part located on the second terminal side and comprising a second hole corresponding to the second terminal, wherein the battery module further comprises a busbar disposed on the first insulation bracket side, wherein the busbar comprises a conductive part configured to electrically connect two adjacent battery cells of the plurality of battery cells, and wherein the conductive part is electrically connected to the first terminal of a first adjacent battery of the adjacent battery cells through the first hole and electrically connected to the second terminal of a second adjacent battery cell of the adjacent battery cells through the second hole.

8. The battery module according to claim 2, wherein the first exhaust pipe comprises galvanized steel.

9. The battery module according to claim 1, further comprising an insulation bracket configured to continuously cover a plurality of battery covers of the plurality of battery cells, wherein the first exhaust pipe is fastened to the insulation bracket.

10. The battery module according to claim 9, wherein the insulation bracket comprises: a boss protruding away from the battery cover; a bottom wall disposed on a side that is of the boss and that faces the battery cover, wherein the bottom wall is disposed in contact with the battery cover; and an avoidance hole disposed at a position that is of the bottom wall and that corresponds to the through hole, and wherein the first exhaust pipe is embedded in the boss and the bottom wall.

11. The battery module according to claim 10, wherein the bottom wall comprises an inner wall, and wherein the heat-resistant film is disposed on the inner wall and covers the avoidance hole.

12. The battery module according to claim 11, wherein the battery cover comprises a first battery cover side and a second battery cover side, wherein the battery module further comprises: a first terminal disposed on the battery cover at the first battery cover side, wherein the first terminal comprises a first terminal side opposite the battery cover; and a second terminal disposed on the battery cover at the second battery cover side, wherein the second terminal comprises a second terminal side opposite the battery cover, wherein the insulation bracket further comprises: an insulation bracket side comprising a first insulation bracket side opposite the battery cover; a first fastening part located on the first terminal side and comprising a first hole corresponding to the first terminal; and a second fastening part located on the second terminal side and comprising a second hole corresponding to the second terminal, wherein the battery module further comprises a busbar disposed on the first insulation bracket side, wherein the busbar comprises a conductive part configured to electrically connect two adjacent battery cells of the plurality of battery cells, and wherein the conductive part is electrically connected to the first terminal of a first adjacent battery of the adjacent battery cells through the first hole and electrically connected to the second terminal of a second adjacent battery cell of the adjacent battery cells through the second hole.

13. The battery module according to claim 10, wherein the battery cover comprises a first battery cover side and a second battery cover side, wherein the battery module further comprises: a first terminal disposed on the battery cover at the first battery cover side, wherein the first terminal comprises a first terminal side opposite the battery cover; and a second terminal disposed on the

battery cover at the second battery cover side, wherein the second terminal comprises a second terminal side opposite the battery cover, wherein the insulation bracket further comprises: an insulation bracket side comprising a first insulation bracket side opposite the battery cover; a first fastening part located on the first terminal side and comprising a first hole corresponding to the first terminal; and a second fastening part located on the second terminal side and comprising a second hole corresponding to the second terminal, wherein the battery module further comprises a busbar disposed on the first insulation bracket side, wherein the busbar comprises a conductive part configured to electrically connect two adjacent battery cells of the plurality of battery cells, and wherein the conductive part is electrically connected to the first terminal of a first adjacent battery of the adjacent battery cells through the first hole and electrically connected to the second terminal of a second adjacent battery cell of the adjacent battery cells through the second hole.

14. The battery module according to claim 9, wherein the battery cover comprises a first battery cover side and a second battery cover side, wherein the battery module further comprises: a first terminal disposed on the battery cover at the first battery cover side, wherein the first terminal comprises a first terminal side opposite the battery cover; and a second terminal disposed on the battery cover at the second battery cover side, wherein the second terminal comprises a second terminal side opposite the battery cover, wherein the insulation bracket further comprises: an insulation bracket side comprising a first insulation bracket side opposite the battery cover; a first fastening part located on the first terminal side and comprising a first hole corresponding to the first terminal; and a second fastening part located on the second terminal side and comprising a second hole corresponding to the second terminal, wherein the battery module further comprises a busbar disposed on the first insulation bracket side, wherein the busbar comprises a conductive part configured to electrically connect two adjacent battery cells of the plurality of battery cells, and wherein the conductive part is electrically connected to the first terminal of a first adjacent battery cell of the adjacent battery cells through the first hole and electrically connected to the second terminal of a second adjacent battery cell of the adjacent battery cells through the second hole.

15. The battery module according to claim 1, wherein the first exhaust pipe comprises galvanized steel.

16. An energy storage cabinet comprising: a cabinet body comprising a second vent and an outer cabinet surface; a second exhaust pipe disposed in the cabinet body; and a plurality of battery modules disposed in the cabinet body, wherein each battery module of the plurality of battery modules comprises: a housing comprising an outer housing surface and comprising a first vent; a plurality of battery cells disposed in the housing, wherein each battery cell of plurality of battery cells comprises: a battery cover comprising a through hole; and an explosion-proof valve configured to block the through hole; and a first exhaust pipe disposed in the housing and configured to communicate with the outer housing surface through the first vent, wherein the first exhaust pipe comprises an inlet covered with a heat-resistant film and configured to communicate with the through hole of each battery cell of plurality of battery cells, wherein a first opening pressure of the heat-resistant film is less than a second opening pressure of the explosion-proof valve, wherein the second exhaust pipe is configured to communicate with the outer cabinet surface through the second vent, and wherein the second exhaust pipe communicates with the first vent of each battery module.

17. The energy storage cabinet according to claim 16, wherein the second exhaust pipe comprises a connection pipe corresponding to the first vent of each battery module, wherein the connection pipe is configured to facilitate communication between the second exhaust pipe and the first vent of each battery module, and wherein the connection pipe comprises: a connection pipe end welded to the first vent of each corresponding battery module; or the connection pipe end coupled to a flange, wherein the flange is connected to the housing of the corresponding battery module through a fastener.

18. An energy storage system, comprising: a container comprising a third vent and an outer

container surface; a plurality of energy storage cabinets disposed in the container, wherein each energy storage cabinet of the plurality of energy storage cabinets comprises: a cabinet body comprising a second vent and an outer cabinet surface; a second exhaust pipe disposed in the cabinet body and configured to communicate with the outer cabinet surface through the second vent; and a plurality of battery modules disposed in the cabinet body, wherein each battery module of the plurality of battery modules comprises: a housing comprising an outer housing surface and comprising a first vent; a plurality of battery cells disposed in the housing, wherein each battery cell of plurality of battery cells comprises: a battery cover comprising a through hole; and an explosion-proof valve configured to block the through hole; and a first exhaust pipe disposed in the housing and configured to communicate the outer housing surface through the first vent, wherein the first exhaust pipe comprises an inlet covered with a heat-resistant film and configured to communicate with the through hole of each battery cell of plurality of battery cells, and wherein a first opening pressure of the heat-resistant film is less than a second opening pressure of the explosion-proof valve, wherein the second exhaust pipe is configured to communicate with the first vent of each battery module; and a third exhaust pipe disposed in the container and configured to communicate with the outer container surface through the third vent, wherein the third exhaust pipe is configured to communicate with the second vent of each energy storage cabinet.

19. The energy storage system according to claim 18, wherein the second exhaust pipe comprises a connection pipe corresponding to the first vent of each battery module, wherein the connection pipe is configured to facilitate communication between the second exhaust pipe and the first vent of each battery module, and wherein the connection pipe comprises a connection pipe end welded to the first vent of each corresponding battery module.

20. The energy storage system according to claim 18, wherein the second exhaust pipe comprises a connection pipe corresponding to the first vent of each battery module, wherein the connection pipe is configured to facilitate communication between the second exhaust pipe and the first vent of each battery module, wherein the connection pipe comprises a connection pipe end coupled to a flange, and wherein the flange is connected to the housing of each corresponding battery module through a fastener.
