

LIQUID INJECTION DEVICE AND LIQUID INJECTION METHOD

TECHNICAL FIELD

[0001] The present disclosure relates to the field of lithium battery liquid
5 injection technologies, and more particularly, to a liquid injection device and a
liquid injection method.

BACKGROUND

[0002] With the rapid development of electric vehicles, a lithium battery is
10 also applied at a high speed. A performance and a service life of the lithium
battery may decline after long-term use, so that a decommissioned lithium battery
market also grows explosively.

[0003] As equipment for liquid injection, a liquid injection device is
operated according to a principle that: an electrolyte is injected into the lithium
15 battery through a liquid injection hole and the hole is sealed in time after liquid
injection.

SUMMARY

[0004] Technical problems

20 [0005] For a traditional liquid injection device, since a liquid injection hole
is reserved in a new lithium battery, the traditional liquid injection device is not
provided with a trepanning mechanism. However, an original liquid injection hole
of a decommissioned lithium battery module is sealed, and the decommissioned
lithium battery module has different degrees of surface expansion after long-term

use, a battery cell in the module is uneven, and the battery cell is provided with a wire harness, which limits a trepanning space, so that the liquid injection device may have a problem during trepanning, which may greatly affect a liquid injection efficiency and a quality of a finished product.

5 **[0006]** Solution of the problems

[0007] Technical solutions

[0008] An object of the present disclosure is to provide a liquid injection device and a liquid injection method, which is aimed at solving problems of a low liquid injection efficiency of a lithium battery module and a low quality of a
10 finished product in a traditional liquid injection device and a traditional liquid injection method.

[0009] The liquid injection device includes:

[0010] a frame;

[0011] a trepanning mechanism arranged on the frame and including a
15 trepanning assembly and a driving assembly, wherein the trepanning assembly is used for trepanning on a lithium battery, and the driving assembly includes a first driving assembly for driving the trepanning assembly to move along a first linear direction, a second driving assembly for driving the trepanning assembly to move along a second linear direction and a third driving assembly for driving the
20 trepanning assembly to move along a third linear direction; and

[0012] a liquid injection mechanism arranged on the frame and including a liquid injection assembly and a moving assembly, wherein the liquid injection assembly is used for injecting a liquid into the lithium battery, and the moving assembly includes a first moving assembly for driving the liquid injection

assembly to move along the first linear direction and a second moving assembly for driving the liquid injection assembly to move along the second linear direction;

[0013] the first linear direction and the second linear direction being on a same plane, and the third linear direction being arranged at an included angle with the plane.

[0014] In one embodiment, the trepanning assembly includes a hole milling structure, a hole drilling structure and a distance measuring device, the third driving assembly includes a hole milling driving member used for driving the hole milling structure to move and a hole drilling driving member used for driving the hole drilling structure to move, a measuring direction of the distance measuring device is along the third linear direction, and the distance measuring device is used for measuring a distance between the hole milling structure and an upper surface of the lithium battery, and a distance between the hole drilling structure and the upper surface of the lithium battery.

[0015] In one embodiment, the hole milling structure includes a milling cutter and a first power member for driving the milling cutter to rotate, the hole drilling structure includes a drill bit and a second power member for driving the drill bit to drill, the milling cutter is used for milling a cover on the upper surface of the lithium battery to form a trepanning portion, and the drill bit is used for drilling in the trepanning portion on the lithium battery, thus forming a liquid injection hole.

[0016] In one embodiment, the liquid injection assembly includes a vacuumizing structure and an injection structure, the vacuumizing structure is used for extracting air in the lithium battery, and the injection structure is used for

injecting an electrolyte into the lithium battery after vacuumizing.

[0017] In one embodiment, the liquid injection device further includes a rotary transportation mechanism arranged below the trepanning mechanism and the liquid injection mechanism, wherein the rotary transportation mechanism
5 includes a roller assembly and a power assembly for driving the roller assembly to rotate, and the roller assembly is used for bearing and rotationally transporting the lithium battery.

[0018] In one embodiment, the liquid injection device further includes a feeding positioning mechanism arranged at a feeding end of the rotary
10 transportation mechanism and a turnover worktable, wherein the feeding positioning mechanism is arranged at an upper portion of the turnover worktable and is used for fixing the lithium battery.

[0019] In one embodiment, the liquid injection device further includes a liquid storage mechanism used for providing an electrolyte for the liquid injection
15 mechanism, wherein the liquid storage mechanism includes a liquid storage pot, a liquid level sensor arranged in the liquid storage pot, a solenoid valve connected with an external liquid supplementing system and a control unit, the liquid level sensor is used for detecting a height of a liquid level in the liquid storage pot and transmitting a signal to the control unit, the control unit is used for controlling
20 opening of the solenoid valve, and the liquid supplementing system supplements a liquid into the liquid storage pot.

[0020] In one embodiment, the liquid injection device further includes a scrap sucking device arranged below the trepanning mechanism, wherein the scrap sucking device is used for sucking a scrap generated after the trepanning

mechanism performs processing.

[0021] In one embodiment, the liquid injection device further includes a liquid supplementing mechanism arranged downstream the liquid injection mechanism, wherein the liquid supplementing mechanism is used for forming
5 sealing of a liquid injection hole of the lithium battery; and the liquid supplementing mechanism includes a location adjusting assembly, a location shifting assembly and a liquid supplementing assembly, the location adjusting assembly is used for driving the liquid supplementing assembly to move along the first linear direction, the second linear direction and the third linear direction,
10 and is connected with the location shifting assembly, and the location shifting assembly is used for controlling a circular movement of the location adjusting assembly and the liquid supplementing assembly, and is connected with the frame.

[0022] In one embodiment, the liquid injection device further includes a liquid supplementing mechanism arranged downstream the liquid injection
15 mechanism, wherein the liquid supplementing mechanism is used for forming sealing of a liquid injection hole of the lithium battery; and the liquid supplementing mechanism includes a location adjusting assembly, a location shifting assembly and a liquid supplementing assembly, the location adjusting assembly is used for driving the liquid supplementing assembly to move along
20 the first linear direction, the second linear direction and the third linear direction, and is connected with the location shifting assembly, and the location shifting assembly is used for controlling a circular movement of the location adjusting assembly and the liquid supplementing assembly, and is connected with the frame.

[0023] The liquid injection method includes the following steps of:

[0024] moving a lithium battery to a first working position corresponding to a trepanning mechanism;

[0025] milling a cover on an upper surface of the lithium battery to form a trepanning portion, and drilling a liquid injection hole with a specified depth in
5 the trepanning portion;

[0026] moving the lithium battery to a second working position corresponding to a liquid injection mechanism;

[0027] extracting, by the liquid injection mechanism, air in the lithium battery and injecting an electrolyte into the lithium battery;

10 **[0028]** moving the lithium battery to a third working position corresponding to a liquid supplementing mechanism; and

[0029] forming, by the liquid supplementing mechanism, sealing of the liquid injection hole of the lithium battery.

[0030] Beneficial effects of the present disclosure

15 **[0031]** Beneficial effects

[0032] Implementing the embodiments of the present disclosure will have the following beneficial effects.

[0033] By using the above liquid injection device, the trepanning mechanism includes the trepanning assembly and the driving assembly, the
20 trepanning assembly is used for trepanning on the lithium battery, and the driving assembly includes the first driving assembly for driving the trepanning assembly to move along the first linear direction, the second driving assembly for driving the trepanning assembly to move along the second linear direction and the third driving assembly for driving the trepanning assembly to move along the third

linear direction; the first linear direction and the second linear direction are on the same plane, and the third linear direction is arranged at the included angle with the plane, so that the trepanning assembly can move at will on an upper surface of a lithium battery pack under driving of the driving assembly to select an optimal location for trepanning, thus having a high trepanning speed and a good quality, improving a trepanning efficiency and a trepanning quality, and further improving liquid injection efficiency and quality of the lithium battery. Therefore, liquid injection regeneration of the lithium battery is realized, a performance of the lithium battery is improved, a service life of the lithium battery is prolonged, and environmental pollution caused by a decommissioned lithium battery is reduced.

[0034] By using the above liquid injection method, the cover on the upper surface of the lithium battery is milled to form the trepanning portion, the liquid injection hole with the specified depth is drilled in the trepanning portion, the air in the lithium battery is extracted by the liquid injection mechanism and the electrolyte is injected into the lithium battery, the liquid supplementing mechanism forms the sealing of the liquid injection hole of the lithium battery, the trepanning portion can be adjusted to the optimal location, and the liquid injection hole is drilled to the specified depth, thus having a high trepanning speed and a good quality, and further improving liquid injection efficiency and quality of the lithium battery.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] Description of the drawings

[0036] In order to illustrate the technical solutions in the embodiments of the present disclosure or the prior art more clearly, the drawings used in the description of the embodiments or the prior art will be briefly described hereinafter. Apparently, the drawings in the following description are merely
5 some embodiments of the present disclosure. Those of ordinary skills in the art can also obtain other drawings according to these drawings without going through any creative work.

[0037] In the drawings:

[0038] FIG. 1 is a schematic diagram of a liquid injection device according
10 to an embodiment;

[0039] FIG. 2 is an enlarged view of a part A in the liquid injection device shown in FIG. 1;

[0040] FIG. 3 is an enlarged view of a part B in the liquid injection device shown in FIG. 1;

15 **[0041]** FIG. 4 is an enlarged view of a part C in the liquid injection device shown in FIG. 1;

[0042] FIG. 5 is a front view of the liquid injection device shown in FIG. 1;

[0043] FIG. 6 is a top view of the liquid injection device shown in FIG. 1;

[0044] FIG. 7 is a side view of the liquid injection device shown in FIG. 1;

20 **[0045]** FIG. 8 is a schematic diagram of a trepanning mechanism and a liquid injection mechanism in the liquid injection device shown in FIG. 1;

[0046] FIG. 9 is a schematic diagram of a frame and a rotary transportation mechanism in the liquid injection device shown in FIG. 1; and

[0047] FIG. 10 is a flow chart of a liquid injection method in an embodiment.

DETAILED DESCRIPTION

[0048] Embodiments of the present disclosure

[0049] The technical solutions in the embodiments of the present disclosure
5 will be clearly and completely described hereinafter with reference to the
drawings in the embodiments of the present disclosure. Apparently, the described
embodiments are merely some but not all of the embodiments of the present
disclosure. Based on the embodiments in the present disclosure, all other
embodiments obtained by those of ordinary skills in the art without going through
10 any creative work shall belong to the scope of protection of the present disclosure.

As shown in FIG. 1, FIG. 2, FIG. 5 and FIG. 8, a liquid injection device
according to an embodiment is mainly used for injecting an electrolyte into a
lithium battery, and includes: a frame 100, a trepanning mechanism 200 and a
liquid injection mechanism 300. The trepanning mechanism 200 and the liquid
15 injection mechanism 300 are arranged on the frame 100, and the trepanning
mechanism 200 includes a trepanning assembly 210 and a driving assembly 220.
The trepanning assembly 210 is used for trepanning on a lithium battery, and the
driving assembly 220 includes a first driving assembly 221 for driving the
trepanning assembly 210 to move along a first linear direction, a second driving
20 assembly 220 for driving the trepanning assembly 210 to move along a second
linear direction and a third driving assembly 223 for driving the trepanning
assembly 210 to move along a third linear direction. The first linear direction and
the second linear direction are on a same plane, and the third linear direction is
arranged at an included angle with the plane, so that trepanning is accurately
25 completed by the trepanning assembly 210 in a specified three-dimensional space,
thus forming a liquid injection hole. The liquid injection mechanism 300 includes

a liquid injection assembly 310 and a moving assembly 320. The liquid injection assembly 310 is used for injecting a liquid into the lithium battery, and the moving assembly 320 includes a first moving assembly 321 for driving the liquid injection assembly 310 to move along the first linear direction and a second moving assembly 322 for driving the liquid injection assembly 310 to move along the second linear direction, so that the liquid injection assembly 310 is accurately moved to a location of the liquid injection hole to complete liquid injection. The trepanning mechanism 200 is used to select an optimal location for trepanning, thus having a high trepanning speed and a good quality, improving a trepanning efficiency and a trepanning quality, and further improving liquid injection efficiency and quality of the lithium battery. Therefore, liquid injection regeneration of the lithium battery is realized, a performance of the lithium battery is improved, a service life of the lithium battery is prolonged, and environmental pollution caused by a decommissioned lithium battery is reduced.

15 **[0050]** In the embodiment, the trepanning assembly 210 includes a hole milling structure 211, a hole drilling structure 212 and a distance measuring device. The third driving assembly 223 includes a hole milling driving member 2231 used for driving the hole milling structure 211 to move and a hole drilling driving member 2232 used for driving the hole drilling structure 212 to move.

20 The hole milling driving member 2231 and the hole drilling driving member 2232 are provided with a distance measuring device used for measuring a distance, and a measuring direction of the distance measuring device is along the third linear direction. Moving distances of the hole drilling driving member 2232 and the hole drilling driving member 2232 along the third linear direction can be controlled by

25 measuring the distance via the distance measuring device, and the distance

measuring device is used for measuring a distance between the hole milling structure 211 and an upper surface of the lithium battery, and a distance between the hole drilling structure 212 and the upper surface of the lithium battery, thus controlling a hole milling depth of the hole milling structure 211 at a hole milling location on the lithium battery to mill a cover without damaging an internal structure of a battery cell, and controlling a hole drilling depth of the hole drilling structure 212 to obtain a liquid injection hole meeting a depth standard.

[0051] Specifically, the distance measuring device is a displacement sensor, and the third linear direction of distance measurement performed by the displacement sensor is a vertical direction. The displacement sensor is used for measuring a distance between a milling cutter 2111 and a drill bit 2121, and the upper surface of the lithium battery, thus controlling the milling cutter 2111 along the vertical direction, ensuring removal of rubber or plastic on the upper surface of the lithium battery without damaging the internal structure of the battery cell, controlling the drill bit 2121 along the vertical direction, and completing drilling of the specified depth, so as to form the standard liquid injection hole. Preferably, a hole drilling location of the drill bit 2121 is a central location of a trepanning portion to ensure a forming effect of the liquid injection hole. Heights of the milling cutter 2111 and a product of the lithium battery pack are measured by the displacement sensor, so that a depth of rubber milling is controlled, and the rubber is just milled by the milling cutter 2111, thus having a good processing effect. The battery cell in a lithium battery module is uneven, and a height is measured by the displacement sensor, so that a depth of hole drilling is accurately controlled, thus obtaining the liquid injection hole.

[0052] In the embodiment, the hole milling structure 212 includes the milling cutter 2111 and a first power member 2112 for driving the milling cutter 2111 to rotate. The hole drilling structure 212 includes the drill bit 2121 and a second power member 2122 for driving the drill bit 2121 to drill. The milling
5 cutter 2111 is used for milling the cover on the upper surface of the lithium battery to form the trepanning portion, the cover refers to the rubber or the plastic on the surface of the lithium battery, and the cover milling is intended to form a clean and flat trepanning portion on the upper surface of the lithium battery for convenience of subsequent hole drilling. The drill bit 2121 is used for drilling in
10 the trepanning portion on the lithium battery, thus forming the liquid injection hole. Preferably, the first power member 2112 and the second power member 2122 are private motors, and are used for driving the milling cutter 2111 and the drill bit 2121 to rotate through a power shaft.

[0053] In the embodiment, the trepanning mechanism 210 further includes
15 a bottom driving plate 230, a transverse driving plate 240 and a vertical driving plate 250. The bottom driving plate 230 extends along the first linear direction and supports the transverse driving plate 240, the transverse driving plate 240 extends along the second linear direction and is slidably arranged on the bottom driving plate 230, and the vertical driving plate 250 extends along the third linear
20 direction and is slidably arranged on the transverse driving plate 240. The first driving assembly 221 is arranged on the bottom driving plate 230 and is connected with the transverse driving plate 240, the second driving assembly 222 is arranged on the transverse driving plate 240 and is connected with the vertical driving plate 250, and the third driving assembly 223 and the trepanning assembly

210 are arranged on the vertical driving plate 250. The first driving assembly 221 and the second driving assembly 222 are used for driving the third driving assembly 223 and the trepanning assembly 210 to move in a horizontal plane, so that the trepanning assembly 210 rapidly and efficiently selects a trepanning
5 location along a horizontal direction, thus avoiding a wire harness on the lithium battery pack, and improving a trepanning quality and a trepanning efficiency.

[0054] In the embodiment, a movement of the transverse driving plate 240 along the first linear direction is an X-axis stroke, a movement of the vertical driving plate 250 along the second linear direction is a Y-axis stroke, and a
10 movement of the trepanning assembly 210 along the third linear direction is a Z-axis stroke, thus forming a complete coordinate system of a three-dimensional space. Wherein, a movement stroke of the transverse driving plate 240 on an X-axis is 600 mm to 800 mm, a movement stroke of the vertical driving plate 250 on a Y-axis is 200 mm to 500 mm, a movement stroke of the hole milling structure
15 212 in the trepanning assembly 210 on a Z-axis is 150 mm to 300 mm, and a movement stroke of the hole drilling structure 212 on the Z-axis is 150 mm to 300 mm. Moreover, the movement strokes of the hole milling structure 212 and the hole drilling structure 212 may be the same or different. Certainly, in other embodiments, the movement strokes of the transverse driving plate 240, the
20 vertical driving plate 250 and the trepanning assembly 210 may also have other options, which are intended to realize movement of the trepanning assembly 210 in a specified trepanning space to ensure the trepanning efficiency and the trepanning quality.

[0055] Preferably, the movement stroke of the transverse driving plate 240

on the X-axis is 350 mm, the movement stroke of the vertical driving plate 250 on the Y-axis is 740 mm, the movement stroke of the hole milling structure 212 in the trepanning assembly 210 on the Z-axis is 210 mm, and the movement stroke of the hole drilling structure 212 on the Z-axis is 210 mm. According to a size of the lithium battery module and the above stroke parameters, the movement of the trepanning assembly 210 in the three-dimensional space can be preferably completed, a better trepanning location is selected to complete trepanning processing, and a cost for a moving mechanism is saved.

[0056] With reference to FIG. 3, the liquid injection mechanism 300 further includes a bottom moving plate 330, a transverse moving plate 340 and a vertical moving plate 350. The bottom moving plate 330 extends along the first linear direction and supports the transverse moving plate 340, the transverse moving plate 340 extends along the second linear direction and is slidably arranged on the bottom moving plate 330, and the vertical moving plate 350 extends along the third linear direction and is slidably arranged on the transverse moving plate 340. The first moving assembly 321 is arranged on the bottom moving plate 330 and is connected with the transverse moving plate 340, the second moving assembly 322 is arranged on the transverse moving plate 340 and is connected with the vertical moving plate 350, and the liquid injection assembly 310 is arranged on the vertical moving plate 350. The first moving assembly 321 and the second moving assembly 322 are used for driving the liquid injection assembly 310 to move in the horizontal plane. After the liquid injection hole is trepanned by the trepanning assembly 210, the liquid injection assembly 310 is driven by the first moving assembly 321 and the second moving assembly 322 to directly face a

location of the trepanned liquid injection hole, and is automatically adjusted to complete liquid injection.

[0057] In the embodiment, the liquid injection assembly 310 includes a vacuumizing structure and an injection structure. The vacuumizing structure is used for extracting air in the lithium battery, and the injection structure is used for injecting an electrolyte into the lithium battery after vacuumizing. Due to the arrangement of the vacuumizing structure, a negative pressure is formed in the battery by vacuumizing, which is intended to accelerate a liquid discharging speed of the electrolyte in the lithium battery and solve a problem of difficult liquid discharging of the electrolyte caused by a surface tension generated in gaps between diaphragm pole pieces. After being moved to a liquid injection working position, the injection structure is tightly pressed with the lithium battery through a sealing ring to realize liquid injection.

[0058] With reference to FIG. 9, the liquid injection device further includes a rotary transportation mechanism 400 arranged below the trepanning mechanism 200 and the liquid injection mechanism 300. The rotary transportation mechanism 400 includes a roller assembly 410 and a power assembly 420 for driving the roller assembly 410 to rotate. The roller assembly 410 is used for bearing and rotationally transporting the lithium battery, so that the lithium battery can be rotationally transported through the rotary transportation mechanism 400 to complete movement of the lithium battery at a specified working position. Wherein, the power assembly 420 may be a motor belt transmission mechanism or a motor gear transmission mechanism, which is intended to drive the roller assembly 410 to rotationally transport the lithium battery. Certainly, in other

embodiments, the roller assembly 410 may also be a conveying belt or other conveying mechanisms, which is intended to convey the lithium battery between the working positions.

[0059] In the embodiment, the liquid injection device further includes a feeding positioning mechanism arranged at a feeding end of the rotary transportation mechanism 400 and a turnover worktable. The feeding positioning mechanism is arranged at an upper portion of the turnover worktable and is used for fixing the lithium battery, thus realizing feeding of the lithium battery on a production line. Preferably, the turnover worktable is a bull-eye bearing turnover worktable.

[0060] In the embodiment, the liquid injection device further includes a scrap sucking device arranged below the trepanning mechanism 200. The scrap sucking device is used for sucking a scrap generated after the trepanning mechanism performs processing, thus collecting the scrap.

[0061] In the embodiment, the rotary transportation mechanism 400 is provided with a turnover supporting plate 401, and the turnover supporting plate 401 is borne on the roller assembly 410 and can move rotationally. The turnover supporting plate 401 is provided with a lifting assembly and a positioning device for fixing the lithium battery. The lifting assembly is used for controlling lifting of the lithium battery along a vertical direction, and the lifting assembly and the positioning device are matched with the liquid injection assembly 310, thus realizing liquid injection through the liquid injection hole.

[0062] With reference to FIG. 4, the liquid injection device further includes a liquid supplementing mechanism 500 arranged downstream the liquid injection

mechanism 300, and the liquid supplementing mechanism 500 is used for forming sealing of the liquid injection hole of the lithium battery. The liquid supplementing mechanism 500 includes a location adjusting assembly 510, a location shifting assembly 520 and a liquid supplementing assembly 530. The location adjusting assembly 510 is used for driving the liquid supplementing assembly 530 to move along the first linear direction, the second linear direction and the third linear direction, and is connected with the location shifting assembly 520, and the location shifting assembly 520 is used for controlling a circular movement of the location adjusting assembly 510 and the liquid supplementing assembly 530, and is connected with the frame 100, thus being used for sealing the liquid injection hole after liquid injection of the liquid injection mechanism 300 to form a steel-ball sealing mode. Compared with a traditional mode of welding the liquid injection hole, the sealing mode is simple and effective.

[0063] Specifically, the location adjusting assembly 510 includes a Y-axis moving mechanism, an X-axis moving mechanism and a Z-axis moving mechanism to complete movement of the liquid supplementing assembly 530 in the three-dimensional space. The location shifting assembly 520 is an independently adjustable automatic location shifting mechanism, and the liquid supplementing assembly 530 is operated in cooperation with the liquid injection mechanism 300.

[0064] In the embodiment, the liquid injection device further includes a liquid storage mechanism 600 used for providing the electrolyte for the liquid injection mechanism 300. The liquid storage mechanism 600 includes a liquid storage pot, a liquid level sensor arranged in the liquid storage pot, a solenoid

valve connected with an external liquid supplementing system and a control unit. The liquid level sensor is used for detecting a height of a liquid level in the liquid storage pot and transmitting a signal to the control unit, the control unit is used for controlling opening of the solenoid valve, and the external liquid supplementing system supplements a liquid into the liquid storage pot, thus ensuring that the liquid storage pot has sufficient electrolyte to supply to the liquid injection mechanism 300.

5 [0065] Specifically, the liquid storage pot is also provided with a pressure sensor and a ball valve, and the pressure sensor is used for detecting that an internal pressure of the liquid storage pot is within a safe range value. When the liquid level sensor detects a lowest liquid level signal, the control unit receives the signal from the sensor and automatically controls liquid supplementation into the liquid storage pot. Preferably, the liquid storage pot is an automatic electrolyte supplementation and storage pot made of stainless steel, and the control unit is a PLC control system.

15 [0066] In the embodiment, the frame 100 includes a feeding portion, a main body portion and a turnover worktable portion, and has a preferred size of 3 m to 5 m in length, 1 m to 2 m in width and 1.5 m to 3 m in height. The size is formed to ensure installation of a functional component on the frame 100 and non-interference in an operation, and the frame 100 is externally painted and is provided with a visual window. The visual window is made of corrosion-resistant glass, thus avoiding corrosion and prolonging a service life. Preferably, the size of the frame 100 is 4 m in length, 1.5 m in width and 1.9 m in height, and a main body of the frame 100 is composed of an iron quadrate pipe of 50 mm×50 mm×3

mm and a flat pipe of 50 mm×100 mm×3 mm. Wherein, a key structure is the iron quadrate pipe of 50 mm×50 mm×3 mm and an iron plate with a thickness of 10 mm for strengthening and fixing, and a bottom plate of a platform is an iron plate with a thickness of 1.5 mm. Certainly, in other embodiments, the specific size of the frame 100 may be other options, only if the frame 100 is able to complete bearing and operation of the functional component.

[0067] In the embodiment, the liquid injection device further includes supporting mechanisms such as an outer glass cover, a customized automatic lifting forklift, an electric control system and the like. The feeding positioning mechanism, the turnover worktable, a feeding line and the rotary transportation mechanism 400 are used to transport the lithium battery or the lithium battery module to a hole milling working position. A rubber scrap on the surface of the lithium battery is milled by the hole milling structure, and is collected by the scrap sucking device, and at this time, the PLC control system has recorded a coordinate location of rubber milling. The electric control system controls an operation system of a whole machine, and various system parameters may be set through a touch screen. Liquid injection regeneration is performed on the module, which reduces processes of disassembling the module into the battery cell and then assembling the battery cell into the module after liquid injection, thus having a high degree of automation, accurate positioning and a high production efficiency, and greatly prolonging the service life of the battery.

[0068] As shown in FIG. 1 and FIG. 10, a liquid injection method according to an embodiment is mainly used for injecting an electrolyte into a lithium battery, including the following steps.

[0069] In S100, the lithium battery is moved to a first working position corresponding to a trepanning mechanism 200 using a rotary transportation mechanism 400. Preferably, a roller conveying mechanism is used as the rotary transportation mechanism 400, and rotation of a roller assembly 410 may be used
5 to drive the lithium battery to move, so that transportation and positioning are accurate, as shown in FIG. 9.

[0070] In S200, a cover on an upper surface of the lithium battery is milled using the trepanning mechanism 200 to form a trepanning portion, and a liquid injection hole with a specified depth is drilled in the trepanning portion.

10 **[0071]** Preferably, under control of a location sensor, a hole milling depth of a hole milling structure 211 is a thickness of the cover, and a hole drilling depth of a hole drilling structure 212 is a thickness of a cover plate, thus communicating an inside of a battery cell with the outside to form the liquid injection hole without damaging an internal structure of the battery cell, as shown in FIG. 2.

15 **[0072]** Specifically, a first driving assembly 221 and a second driving assembly 222 can drive a third driving assembly 223 and a trepanning assembly 210 to move in a horizontal plane, so that the trepanning assembly 210 rapidly and efficiently selects a trepanning location along a horizontal direction, thus avoiding a wire harness on a lithium battery pack, and improving a trepanning
20 quality and a trepanning efficiency, as shown in FIG. 8.

[0073] In S300, the lithium battery is moved to a second working position corresponding to a liquid injection mechanism 300 using the rotary transportation mechanism 400. Preferably, a liquid injection assembly 310 of the liquid injection mechanism 300 includes a plurality of liquid injection guns, which can

simultaneously inject liquids into a plurality of lithium batteries. The lithium batteries with the liquid injection holes are sequentially transported to the second working position, and are arranged corresponding to the liquid injection guns, thus having a high liquid injection efficiency, as shown in FIG. 3.

5 **[0074]** In S400, air in the lithium battery is extracted by the liquid injection mechanism 300, and an electrolyte is injected into the lithium battery.

[0075] Preferably, the liquid injection assembly 310 includes a vacuumizing structure and an injection structure. The vacuumizing structure extracts the air in the lithium battery, and the injection structure injects the electrolyte into the
10 lithium battery after vacuumizing. According to arrangement of the vacuumizing structure, a negative pressure is formed in the battery by vacuumizing, which is to accelerate a liquid discharging speed of the electrolyte in the lithium battery and solve a problem of difficult liquid discharging of the electrolyte caused by a surface tension generated in gaps between diaphragm pole pieces. Moreover, after
15 being moved to a liquid injection working position, the injection structure is tightly pressed with the lithium battery through a sealing ring to realize liquid injection.

[0076] Specifically, a first moving assembly 321 and a second moving assembly 322 drive the liquid injection assembly 310 to move in the horizontal
20 plane. After the liquid injection hole is trepanned by the trepanning assembly 210, the liquid injection assembly 310 is driven by the first moving assembly 321 and the second moving assembly 322 to directly face a location of the trepanned liquid injection hole, and is automatically adjusted to complete liquid injection.

[0077] In S500, the lithium battery is moved to a third working position

corresponding to a liquid supplementing mechanism 500.

[0078] In S600, sealing of the liquid injection hole of the lithium battery is formed by the liquid supplementing mechanism 500. Preferably, a location adjusting assembly 510 drives a liquid supplementing assembly 530 to move
5 along the first linear direction, the second linear direction and the third linear direction, and is connected with a location shifting assembly 520, and the location shifting assembly 520 controls a circular movement of the location adjusting assembly 510 and the liquid supplementing assembly 530, and is connected with a frame 100, thus sealing the liquid injection hole after liquid injection of the
10 liquid injection mechanism 300 to form a steel-ball sealing mode. Compared with a traditional mode of welding the liquid injection hole, the sealing mode is simple and effective.

[0079] In the embodiment, in the step S200, while the trepanning mechanism 200 is operated, a scrap sucking device is used to suck a scrap
15 generated after the trepanning mechanism performs processing, so that the scrap is collected, thus avoiding the scrap from entering the liquid injection hole to affect liquid injection, and keeping a process environment clean.

[0080] By using the liquid injection method in the embodiment, the driving assembly 220 can drive the trepanning assembly 210 to mill rubber and trepan at
20 any location on the upper surface of the lithium battery, thus having a high trepanning efficiency and a good quality. Therefore, liquid injection regeneration of the lithium battery is realized, a performance of the lithium battery is improved, a service life of the lithium battery is prolonged, and environmental pollution caused by a decommissioned lithium battery is reduced.

WHAT IS CLAIMED IS:

1. A liquid injection device, comprising:

a frame;

5 a trepanning mechanism arranged on the frame and comprising a trepanning assembly and a driving assembly, wherein the trepanning assembly is used for trepanning on a lithium battery, and the driving assembly comprises a first driving assembly for driving the trepanning assembly to move along a first linear direction, a second driving assembly for driving the trepanning assembly to move
10 along a second linear direction and a third driving assembly for driving the trepanning assembly to move along a third linear direction; and

 a liquid injection mechanism arranged on the frame and comprising a liquid injection assembly and a moving assembly, wherein the liquid injection assembly is used for injecting a liquid into the lithium battery, and the moving assembly
15 comprises a first moving assembly for driving the liquid injection assembly to move along the first linear direction and a second moving assembly for driving the liquid injection assembly to move along the second linear direction;

 the first linear direction and the second linear direction being on a same plane, and the third linear direction being arranged at an included angle with the
20 plane.

2. The liquid injection device according to claim 1, wherein the trepanning assembly comprises a hole milling structure, a hole drilling structure and a distance measuring device, the third driving assembly comprises a hole milling driving member used for driving the hole milling structure to move and a hole
25 drilling driving member used for driving the hole drilling structure to move, a measuring direction of the distance measuring device is along the third linear

direction, and the distance measuring device is used for measuring a distance between the hole milling structure and an upper surface of the lithium battery, and a distance between the hole drilling structure and the upper surface of the lithium battery.

5 3. The liquid injection device according to claim 2, wherein the hole milling structure comprises a milling cutter and a first power member for driving the milling cutter to rotate, the hole drilling structure comprises a drill bit and a second power member for driving the drill bit to drill, the milling cutter is used for milling a cover on the upper surface of the lithium battery to form a trepanning
10 portion, and the drill bit is used for drilling in the trepanning portion on the lithium battery, thus forming a liquid injection hole.

 4. The liquid injection device according to claim 1, wherein the liquid injection assembly comprises a vacuumizing structure and an injection structure, the vacuumizing structure is used for extracting air in the lithium battery, and the
15 injection structure is used for injecting an electrolyte into the lithium battery after vacuumizing.

 5. The liquid injection device according to claim 1, further comprising a rotary transportation mechanism arranged below the trepanning mechanism and the liquid injection mechanism, wherein the rotary transportation mechanism
20 comprises a roller assembly and a power assembly for driving the roller assembly to rotate, and the roller assembly is used for bearing and rotationally transporting the lithium battery.

 6. The liquid injection device according to claim 5, further comprising a feeding positioning mechanism arranged at a feeding end of the rotary
25 transportation mechanism and a turnover worktable, wherein the feeding positioning mechanism is arranged at an upper portion of the turnover worktable

and is used for fixing the lithium battery.

7. The liquid injection device according to claim 1, further comprising a liquid storage mechanism used for providing an electrolyte for the liquid injection mechanism, wherein the liquid storage mechanism comprises a liquid storage pot, a liquid level sensor arranged in the liquid storage pot, a solenoid valve connected with an external liquid supplementing system and a control unit, the liquid level sensor is used for detecting a height of a liquid level in the liquid storage pot and transmitting a signal to the control unit, the control unit is used for controlling opening of the solenoid valve, and the liquid supplementing system supplements a liquid into the liquid storage pot.

8. The liquid injection device according to claim 1, further comprising a scrap sucking device arranged below the trepanning mechanism, wherein the scrap sucking device is used for sucking a scrap generated after the trepanning mechanism performs processing.

9. The liquid injection device according to claim 1, further comprising a liquid supplementing mechanism arranged downstream the liquid injection mechanism, wherein the liquid supplementing mechanism is used for forming sealing of a liquid injection hole of the lithium battery; and the liquid supplementing mechanism comprises a location adjusting assembly, a location shifting assembly and a liquid supplementing assembly, the location adjusting assembly is used for driving the liquid supplementing assembly to move along the first linear direction, the second linear direction and the third linear direction, and is connected with the location shifting assembly, and the location shifting assembly is used for controlling a circular movement of the location adjusting assembly and the liquid supplementing assembly, and is connected with the frame.

10. A liquid injection method, comprising the following steps of:

moving a lithium battery to a first working position corresponding to a trepanning mechanism;

5 milling a cover on an upper surface of the lithium battery to form a trepanning portion, and drilling a liquid injection hole with a specified depth in the trepanning portion;

moving the lithium battery to a second working position corresponding to a liquid injection mechanism;

extracting, by the liquid injection mechanism, air in the lithium battery and injecting an electrolyte into the lithium battery;

10 moving the lithium battery to a third working position corresponding to a liquid supplementing mechanism; and

forming, by the liquid supplementing mechanism, sealing of the liquid injection hole of the lithium battery.