



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.07.2011 Bulletin 2011/28

(51) Int Cl.:
B25F 5/00 (2006.01)

(21) Application number: **11150267.0**

(22) Date of filing: **05.01.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(30) Priority: **07.01.2010 JP 2010002050**

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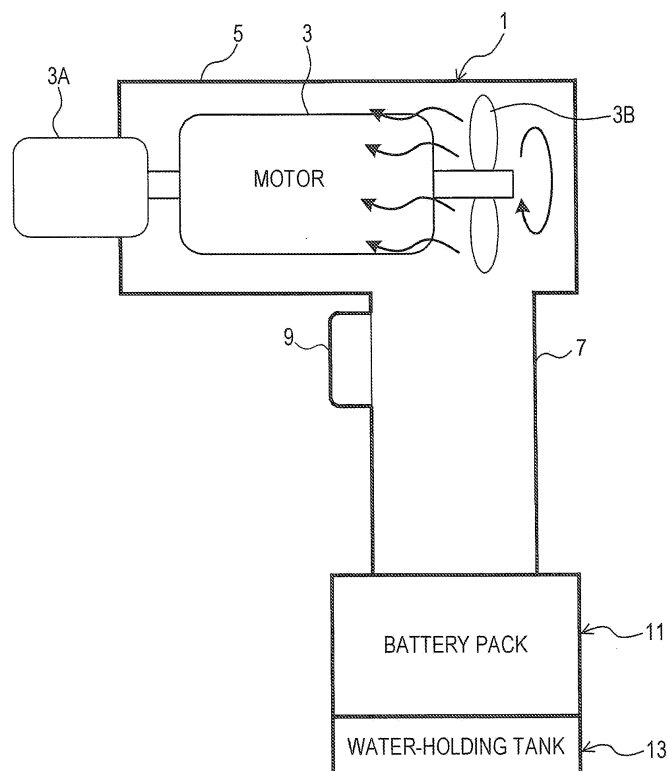
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(54) **Electric power tool**

(57) An electric power tool (1) includes a tool portion (3A), a fuel cell (11A), a power drive source (3), and a

water-holding unit (13). The water-holding unit (13) holds a reaction water produced in the fuel cell (11A) by oxidation reaction between a fuel and an oxidizing agent.

FIG.1



Description

BACKGROUND

[0001] The present invention relates to an electric power tool provided with a fuel cell.

[0002] An electric power tool disclosed in Unexamined Japanese Patent Application Publication No. 2008-132551 is provided with a fuel cell, and is configured to provide electric power from the fuel cell to an electric motor.

SUMMARY

[0003] While a fuel cell generates electric power by oxidizing a fuel such as hydrogen with an oxidizing agent such as oxygen, reaction water is produced by oxidation reaction. In the aforementioned electric power tool, however, particular measures concerning a method of processing the reaction water (water, in the above-referenced Publication) are not explicitly disclosed.

[0004] If the reaction water is directly discharged from the interior of an electric power tool to the outside, a user and a work object such as a building material undesirably get wet.

[0005] It is preferable that the present invention can provide an electric power tool which can inhibit reaction water produced in a fuel cell from being directly discharged from the electric power tool.

[0006] An electric power tool according to the present invention includes a tool portion, a fuel cell, a power drive source, and a water-holding unit. The fuel cell generates electric power by oxidation reaction between a fuel and an oxidizing agent. The power drive source receives electric power to drive the tool portion. The water-holding unit holds a reaction water produced in the fuel cell by the oxidation reaction.

[0007] In the electric power tool of the present invention configured as such, the reaction water produced in the fuel cell is held in the water-holding unit. Thus, the reaction water can be inhibited from being directly discharged from the electric power tool.

[0008] The water-holding unit can be configured in any manner in order to hold the reaction water. For example, the water-holding unit may be configured to be detachably installed in the electric power tool. In this case, for example, the electric power tool may include a holder portion that detachably holds the water-holding unit. In the electric power tool configured as such, the reaction water held in the water-holding unit can be easily processed (disposed of), by detaching the water-holding unit from the electric power tool. Or, the water-holding unit may be configured to be attachable to or detachable from the fuel cell or a battery pack housing the fuel cell, or have other configurations.

[0009] In the present invention, the water-holding unit may include a drainage inlet to which the reaction water flows in. The electric power tool may include a drainage

outlet from which the reaction water is discharged. In this case, the electric power tool may include a positioner which positions the drainage inlet with respect to the drainage outlet, so that the reaction water flows in from the drainage outlet to the drainage inlet. In the electric power tool configured as such, the reaction water can be reliably received in the water-holding unit.

[0010] A packing may be provided around at least one of the drainage outlet and the drainage inlet. In this case, the positioner may be configured to position the drainage inlet with respect to the drainage outlet along such a direction that the packing is inhibited from being damaged. In the electric power tool configured as such, the packing can be inhibited from being damaged, and further inhibit the reaction water from being discharged from the electric power tool due to damage in the packing.

[0011] The drainage outlet may be provided in any section of the electric power tool. For example, the drainage outlet may be provided in a section where the water-holding unit is held.

[0012] Also, the electric power tool of the present invention may be provided with an operation prohibiting unit that prohibits operation of the power drive source, when the drainage inlet is not located at a position where the reaction water can flow in from the drainage outlet to the drainage inlet. In the electric power tool configured as such, the electric power tool does not operate when the drainage inlet is not located at a position where the reaction water can flow in from the drainage outlet to the drainage inlet. Thus, the reaction water can be inhibited from being discharged from the electric power tool due to vibration, and so on, which occurs by the operation of the electric power tool. A user and a work object can be inhibited from getting wet.

[0013] The operation prohibiting unit may be configured in any manner in order to prohibit operation of the power drive source. For example, the operation prohibiting unit may be configured to prohibit the operation of the power drive source by interrupting a supply passage of electric power from the fuel cell to the power drive source. In this case, since electric power is not supplied to the power drive source, the operation of the power drive source can be reliably prohibited.

[0014] Also, the electric power tool of the present invention may include a reaction water remover that removes the reaction water held in the water-holding unit from the water-holding unit. In the electric power tool configured as such, the reaction water held in the water-holding unit can be inhibited from being accumulated to fill up the water-holding unit with the reaction water.

[0015] The reaction water remover may be configured in any manner in order to remove the reaction water from the water-holding unit. For example, the reaction water remover may include a reaction water outlet formed in the water-holding unit in order to discharge the reaction water held in the water-holding unit out of the water-holding unit. In this case, the reaction water can be removed from the water-holding unit via the reaction water outlet.

Or, if the electric power tool includes a fan that is driven by the power drive source, the reaction water remover may be configured to pass at least part of an air flow induced by the fan through an interior of the water-holding unit. In this case, evaporation of the reaction water is facilitated by the air flow, so that the reaction water can be removed from the water-holding unit. As a result, the number of times of operation to remove the reaction water can be reduced.

[0016] Also, the electric power tool of the present invention may include a fuel tank that stores a fuel to be supplied to the fuel cell. In this case, the fuel tank and the water-holding unit may be integrally formed. If the fuel tank and the water-holding unit are integrally formed, the reaction water accumulated in the water-holding unit can be easily processed (disposed of). Also, the fuel tank can be easily replenished with the fuel.

[0017] Also, the electric power tool of the present invention may be provided with a main body portion that includes the tool portion and the power drive source. In this case, the water-holding unit may be separately provided from the main body portion. In case that the water-holding unit is separately provided from the main body portion, the water-holding unit may be configured to be attachable to a user of the electric power tool. If the water-holding unit is configured as such, the user can operate the electric power tool with the water-holding unit being attached to the user.

[0018] Also in the present invention, the water-holding unit may include a drainage inlet to which the reaction water flows in, and a back flow inhibiting unit that inhibits the reaction water held in the water-holding unit from flowing backward from the drainage inlet out of the water-holding unit. In the electric power tool configured as such, the reaction water can be inhibited from directly being discharged from the electric power tool due to a back flow of the reaction water from the drainage inlet.

[0019] In the present invention, the water-holding unit may include an absorber that absorbs and holds the reaction water. In the electric power tool configured as such, the reaction water can be inhibited from flowing backward out of the water-holding unit, regardless of posture of the electric power tool, since the absorber absorbs and holds the reaction water.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The present invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a schematic diagram of an electric power tool according to a first embodiment of the present invention;

FIG. 2 is a schematic diagram of a battery pack according to the first embodiment of the present invention;

FIG. 3A is a view taken in a front-back direction of a

water-holding tank according to the first embodiment of the present invention in a state being detached from the battery pack;

FIG. 3B is a view taken in the front-back direction of the water-holding tank according to the first embodiment of the present invention in a state being attached to the battery pack;

FIGS. 4A and 4B are explanatory views taken in a right-left direction of the water-holding tank according to the first embodiment of the present invention in an attached state;

FIG. 5 is a block diagram showing an electrical configuration of the electric power tool according to the first embodiment of the present invention;

FIGS. 6A and 6B are views taken in the front-back direction of a water-holding tank according to a second embodiment of the present invention in an attached state;

FIGS. 7A and 7B are views taken in the right-left direction of a water-holding tank according to a third embodiment of the present invention in an attached state;

FIG. 8A is a view schematically showing configurations of a battery pack and a water-holding tank according to a fourth embodiment of the present invention;

FIG. 8B is a circuit diagram showing a schematic electrical configuration of an electric power tool according to the fourth embodiment of the present invention;

FIG. 9 is a view schematically showing a configuration of a water-holding tank according to a fifth embodiment of the present invention;

FIG. 10 is a view schematically showing a configuration of a water-holding tank according to a sixth embodiment of the present invention;

FIG. 11 is a view schematically showing a configuration of a water-holding tank according to a seventh embodiment of the present invention;

FIG. 12 is a view schematically showing a configuration of a water-holding tank according to an eighth embodiment of the present invention;

FIG. 13 is a view schematically showing a configuration of a main body of an electric power tool according to the eighth embodiment of the present invention;

FIG. 14A is a view taken in a front-back direction of a water-holding tank according to a ninth embodiment of the present invention in a state being detached from a battery pack;

FIG. 14B is a view taken in a right-left direction of the water-holding tank according to the ninth embodiment of the present invention in a state being attached to the battery pack;

FIG. 15 is a schematic diagram of an electric power tool according to a tenth embodiment of the present invention; and

FIG. 16 is a schematic diagram of a battery pack

according to an eleventh embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] The following embodiments are examples in which an electric power tool according to the present invention is adapted to an electric power tool such as an electric driver, an electric drill, and others. In the following embodiments, the same reference numerals are given to components identical or similar in function, and the description thereof may be simplified or omitted.

[First Embodiment]

[0022] As shown in FIG. 1, an electric power tool 1 according to the present first embodiment includes a main body portion 5 and a handle portion 7. A main body of the electric power tool 1 is formed by the main body portion 5 and the handle portion 7. The main body portion 5 has a substantially cylindrical outer shape. An electric motor 3 that rotates/drives a driver bit and a drill bit is housed in the main body portion 5. The handle portion 7 is provided in the main body portion 5 in such a manner as to protrude from the main body portion 5. Particularly, the electric power tool 1 is formed into a pistol-like shape.

[0023] To a rotation shaft of the electric motor 3 are provided a chucking 3A that secures the driver bit and a fan 3B that blows cooling air to the electric motor 3. When the electric motor 3 rotates, the chucking 3A and the fan 3B are integrally rotated with the rotation shaft of the electric motor 3.

[0024] The handle portion 7 is a gripper to be gripped by a user. The handle portion 7 is provided with a tool switch (trigger) 9 for the user to activate the electric power tool 1 (electric motor 3).

[0025] At an end of the handle portion 7, a battery pack 11 that supplies electric power to the electric motor 3 is detachably installed. As schematically shown in FIG. 2, the battery pack 11 includes a casing 11E. Inside the casing 11E, at least a fuel cell (FC stack) 11A, a fuel tank 11B, a rechargeable battery 11C and a fuel pump 11D are housed.

[0026] The fuel cell 11A generates electric power by oxidizing a fuel with an oxidizing agent. The fuel cell 11A of the present first embodiment is not a fuel cell which is supplied with a reformed fuel (hydrogen), but is a so-called direct methanol fuel cell (DMFC) that is directly supplied with a liquid fuel (methanol) stored in the fuel tank 11B. The rechargeable battery 11C is a chargeable and dischargeable chemical battery or a capacitor.

[0027] The fuel stored in the fuel tank 11B is supplied by the fuel pump 11D to the fuel cell 11A. The fuel pump 11D is driven by electric power supplied from the rechargeable battery 11C.

[0028] Returning to FIG. 1, in a downward side of the battery pack 11, a water-holding tank 13 that retains re-

action water produced in the fuel cell 11A is detachably fitted to the battery pack 11 (more particularly, the casing 11E). A volume of the water-holding tank 13 of the present first embodiment is adapted to a volume which can hold reaction water produced when all the fuel stored in the fuel tank 11B is reacted.

[0029] Here, the downward side of the battery pack 11 indicates a lower side of the drawing sheet when the electric power tool 1 is arranged as shown in FIG. 1. Hereinafter, if not otherwise specified, an upper side of the drawing sheet when the electric power tool 1 is arranged as shown in FIG. 1 is referred to as an upward side, and the lower side of the drawing sheet is referred to as the downward side.

[0030] As shown in FIGS. 3A and 3B, the water-holding tank 13 includes a resin-made tank portion 13B that retains the reaction water. The tank portion 13B is provided with a drainage inlet 13A from which the reaction water flows in. A packing (O-ring) 13C made of an elastic body such as rubber is fitted around the drainage inlet 13A.

[0031] In a section of the battery pack 11 (more particularly, the casing 11E) where the water-holding tank 13 is held, that is, on the downward side of the battery pack 11, a drainage outlet 11F is provided from which the reaction water is discharged. A packing (O-ring) 11G made of an elastic body such as rubber is also fitted around the drainage outlet 11F.

[0032] As shown in FIGS. 3A, 3B, 4A and 4B, positioning portions 11H, 11J, 13D and 13E that position the drainage inlet 13A with respect to the drainage outlet 11F so that the reaction water flows in from the drainage outlet 11F to the drainage inlet 13A are respectively provided in either of the water-holding tank 13 or the battery pack 11 (more particularly, the casing 11E).

[0033] More particularly, the water-holding tank 13 is, as shown in FIGS. 4A and 4B, attached to the battery pack 11 in such a manner as to move parallel to a direction orthogonal to an up and down direction with respect to the battery pack 11 (hereinafter, the direction is referred to as a front-back direction). When the water-holding tank 13 is attached to the battery pack 11, the positioning portion 13E provided in the water-holding tank 13 comes into contact with the positioning portion 11J provided in the battery pack 11, thereby positioning the water-holding tank 13 in the front-back direction with respect to the battery pack 11, as shown in FIG. 4B.

[0034] As shown in FIG. 3A, the pair of positioning portions 11H provided in the battery pack 11 are constituted by two wall surfaces of the casing 11E, spaced apart in a direction orthogonal to the up and down direction and to the front-back direction (hereinafter, the direction is referred to as a right and left direction). As shown in FIG. 3B, when the water-holding tank 13 is attached to the battery pack 11, the pair of positioning portions 13D provided in the water-holding tank 13 come into contact with the pair of positioning portions 11H provided in the battery pack 11, thereby positioning the water-holding tank 13 in the right and left direction with respect to the battery

pack 11.

[0035] As noted above, when the position of the water-holding tank 13 in the right and left direction and in the front-back direction with respect to the battery pack 11 is determined, the drainage outlet 11F of the battery pack 11 and the drainage inlet 13A of the water-holding tank 13 coincide with each other, thereby allowing the reaction water to flow in from the drainage outlet 11F to the drainage inlet 13A. The position of the water-holding tank 13 in the up-down direction with respect to the battery pack 11 is determined by contact of an upper surface side of the water-holding tank 13 to an undersurface side of the battery pack 11 (more particularly, the casing 11E).

[0036] As shown in FIG. 3A, a pair of holder portions 11K which detachably hold the water-holding tank 13 with respect to the battery pack 11 are provided on the undersurface side of the battery pack 11. The pair of holder portions 11K respectively extend in the front-back direction, and are formed into a shape protruding in a direction facing to each other, in cross sections orthogonal to the front-back direction (i.e., a near L or hook-like shape). The pair of holder portion 11K hold the water-holding tank 13 by engaging with a pair of hook portions 13F provided in the water-holding tank 13. The pair of hook portions 13F are respectively formed into a shape protruding in a direction separating from each other along the right and left direction, in cross sections orthogonal to the front-back direction.

[0037] As shown in FIG. 4A, an engaging body 13G, which engages with an engaging portion 11L provided in the battery pack 11, is provided in the water-holding tank 13.

[0038] The engaging portion 11L is configured by a concave portion which is dented upward from the undersurface of the battery pack 11. The engaging body 13G is projectably and retractably housed in a hole which extends downward from the upper surface of the water-holding tank 13 facing the undersurface of the battery pack 11. The engaging body 13G is pressed (biased) toward the battery pack 11 (upward) by an elastic body such as a spring 13H housed in the water-holding tank 13.

[0039] Thus, a front end side of the engaging body 13G (a side facing the undersurface of the battery pack 11) is normally in a state protruding from the upper surface of the water-holding tank 13 by the elastic force of the spring 13H. When an operating portion 13J is displaced downward by a user, the engaging body 13G is integrally displaced with the operating portion 13J. Thereby, the whole engaging body 13G is housed inside the hole (water-holding tank 13).

[0040] On the side of the positioning portion 13E in the front end side of the engaging body 13G, a tilted surface 13K is provided which is tilted in a direction opposite to a direction in which the water-holding tank 13 is attached to the battery pack 11. Thus, if the water-holding tank 13 is displaced in parallel toward the positioning portion 11J with the pair of hook portions 13F caught by the pair of holder portions 11K, the tilted surface 13K and the battery

pack 11 (casing 11E) are brought into contact. Thereby, a force that presses the engaging body 13G into the water-holding tank 13 operates on the engaging body 13G.

[0041] When the water-holding tank 13 is displaced in parallel until the positioning portion 13E provided in the water-holding tank 13 and the positioning portion 11J provided in the battery pack 11 are brought into contact, the front end of the engaging body 13G is fitted into the engaging portion 11L to engage the engaging body 13G with the engaging portion 11L, as shown in FIG. 4B. As a result, the position of the water-holding tank 13 with respect to the battery pack 11 is held/fixed.

[0042] As shown in FIG. 5, the electric power tool 1 includes a controller 20. Operation of the electric motor 3 and the fuel pump 11D is controlled by the controller 20. The controller 20 drives the electric motor 3 and the fuel pump 11D by electric power supplied from the rechargeable battery 11C and the fuel cell 11A. The controller 20 itself operates by electric power supplied from the rechargeable battery 11C.

[0043] Particularly, when the tool switch 9 is turned ON by a user, the controller 20 first supplies electric power to the fuel pump 11D and the electric motor 3 from the rechargeable battery 11C to activate the fuel pump 11D and the electric motor 3, thereby supplying the fuel in the fuel tank 11B to the fuel cell 11A to generate electric power in the fuel cell 11A, and also rotate the electric motor 3.

[0044] When electric power from the fuel cell 11A is started to be supplied, the controller 20, depending on the remaining power of the rechargeable battery 11C and the electric power required by the electric motor 3, supplies the power supplied from the fuel cell 11A to at least one of the electric motor 3 and the rechargeable battery 11C.

[0045] When the tool switch 9 is turned OFF by a user, the controller 20 stops electric power supply to the fuel pump 11D and to the electric motor 3.

[0046] In the electric power tool 1 of the present first embodiment configured as above, the reaction water produced in the fuel cell 11A is held in the water-holding tank 13. Thus, the reaction water is inhibited from being discharged directly from the electric power tool 1.

[0047] Also, in the electric power tool 1 of the present first embodiment, the water-holding tank 13 is detachably attached to the battery pack 11. Thus, by removing the water-holding tank 13 from the battery pack 11, the reaction water retained in the water-holding tank 13 can be easily processed (disposed of).

[0048] Further, the electric power tool 1 of the present first embodiment includes the positioning portions 11H, 11J, 13D and 13E which position the drainage inlet 13A with respect to the drainage outlet 11F. Thus, upon attachment of the water-holding tank 13, the position of drainage inlet 13A with respect to the drainage outlet 11F is determined so that the drainage outlet 11F and the drainage inlet 13A coincide with one another, and the reaction water flows in from the drainage outlet 11F to

the drainage inlet 13A. Accordingly, in the electric power tool 1 of the present first embodiment, the reaction water discharged from the drainage outlet 11F can be reliably received by the water-holding tank 13.

[0049] Further, in the electric power tool 1 of the present first embodiment, the packings 13C and 11G are respectively fitted around the drainage inlet 13A and the drainage outlet 11F. Thus, the reaction water can be inhibited from leaking outside the electric power tool 1 from a joint surface between the drainage outlet 11F and the drainage inlet 13A.

[0050] In the present first embodiment, the chucking 3A is an example of the tool portion of the present invention. The electric motor 3 is an example of the power drive source of the present invention. The water-holding tank 13 is an example of the water-holding unit of the present invention.

[Second Embodiment]

[0051] The present second embodiment is a variation of the above-described first embodiment. Particularly, in the first embodiment, the engaging body 13G is configured to be displaced in the up and down direction. In the present second embodiment, as shown in FIGS. 6A and 6B, the pair of the hook portions 13F are replaced with the pair of engaging bodies 13G, and the pair of engaging bodies 13G are configured to be displaceable in the right and left direction. Thereby, the pair of engaging bodies 13G are projectable and retractable with respect to the water-holding tank 13.

[0052] In the present second embodiment, the water-holding tank 13 is attached to and detached from the battery pack 11 by displacing the water-holding tank 13 in the up and down direction with respect to the battery pack 11. Thus, the tilted surfaces 13K of the engaging bodies 13G are provided on the undersurface side of the battery pack 11 on the front end sides of the engaging bodies 13G.

[0053] Also, in the present second embodiment, the water-holding tank 13 is attached to and detached from the battery pack 11 by displacing the water-holding tank 13 in the up and down direction with respect to the battery pack 11. Thus, upon attaching the water-holding tank 13 to the battery pack 11, a force that may crush both the packings 13C and 11G acts on the packings 13C and 11G. It is difficult for a shear force to act. Accordingly, at least one of the packings 13C and 11G can be inhibited from being damaged upon attaching the water-holding tank 13 to the battery pack 11. Further, the reaction water can be inhibited from being discharged from the electric power tool 1, due to damage to at least one of the packings 13C and 11G.

[Third Embodiment]

[0054] The present third embodiment is a variation of the first embodiment. Particularly, as shown in FIGS. 7A

and 7B, the drainage inlet 13A is provided in the positioning portion 13E on the side of the water-holding tank 13, and the drainage outlet 11F is provided in the positioning portion 11J on the side of the battery pack 11. Further, the packings 13C and 11G are fitted respectively around the drainage inlet 13A or the drainage outlet 11F. Both the positioning portions 13E and 11J are tilted with respect to a horizontal plane along the front-back direction.

[0055] With such configuration, even if the water-holding tank 13 is moved parallel in the front-back direction and attached to the battery pack 11, it is difficult for a shear force to act on both the packings 13C and 11G. Thus, upon attaching the water-holding tank 13 to the battery pack 11, at least one of the packings 13C and 11G can be inhibited from being damaged. That is, the reaction water can be inhibited from being discharged from the electric power tool 1 due to damage to at least one of the packings 13C and 11G.

[0056] The present third embodiment is not limited to the configuration shown in FIGS. 7A and 7B. It is only necessary for both the positioning portions 13E and 11J to be tilted with respect to a plane along a direction in which the water-holding tank 13 is attached. For example, if the water-holding tank 13 is attached to the battery pack 11 obliquely from the front and downward of the battery pack 11, both the positioning portions 13E and 11J can be provided parallel to a plane along the up and down direction.

[Fourth Embodiment]

[0057] The present fourth embodiment is configured to prohibit operation of the electric motor 3, when the drainage inlet 13A is not at a position where the reaction water can flow in from the drainage outlet 11F to the drainage inlet 13A (hereinafter, this position is referred to as an attachment complete position).

[0058] Particularly, as shown in FIG. 8A, in at least one of the positioning portions 11H and 11J (in the positioning portion 11J, in the present fourth embodiment) of the battery pack 11, a tank detection switch 21 is provided which is configured to be a closed state when the water-holding tank 13 is positioned at the attachment complete position, and to be an open state when the water-holding tank 13 is not positioned at the attachment complete position.

[0059] As shown in FIG. 8B, in the electric power tool 1 of the present fourth embodiment, the tank detection switch 21 is connected in series with the electric motor 3, together with a tool switch 9, so as to be able to connect and interrupt a supply passage of electric power from the fuel cell 11A and the rechargeable battery 11C to the electric motor 3.

[0060] With such configuration, when the water-holding tank 13 is not positioned at the attachment complete position, the tank detection switch 21 is in an open state. Regardless of a state of the tool switch 9, electric power is not supplied to the electric motor 3. When the water-

holding tank 13 is positioned at the attachment complete position, the tank detection switch 21 is in a closed state. Depending on the state of the tool switch 9, electric power is supplied to the electric motor 3. In other words, in the present fourth embodiment, the tank detection switch 21 functions as an example of the operation prohibiting unit of the present invention, which prohibits operation of the electric motor 3 when the drainage inlet 13A is not at the attachment complete position.

[0061] Accordingly, in the present fourth embodiment, when the drainage inlet 13A is not at the attachment complete position, electric power is not supplied to the electric motor 3. The electric motor 3 is reliably inhibited from being operated. Thus, the reaction water can be inhibited from being discharged from the electric power tool 1 due to vibration, and so on, which occurs by the operation of the electric motor 3. A user and a work object can be inhibited from getting wet.

[0062] The operation prohibiting unit is not limited to the tank detection switch 21. For example, the operation prohibiting unit may be configured to mechanically lock the tool switch 9, so that the tool switch 9 cannot be operated when the drainage inlet 13A is not at the attachment complete position.

[Fifth Embodiment]

[0063] As shown in FIG. 9, in the present fifth embodiment, a back-flow inhibiting valve 13L that inhibits the reaction water retained in the tank portion 13B from flowing backward out of the tank portion 13B from the drainage inlet 13A is provided in the water-holding tank 13. The back-flow inhibiting valve 13L is an example of the back-flow inhibiting unit of the present invention.

[0064] Particularly, the back-flow inhibiting valve 13L is installed in the water-holding tank 13 in such a manner as to be able to be displaced between a position to close the drainage inlet 13A (position shown by a chain double-dashed line in FIG. 9) and a position to open the drainage inlet 13A (position shown by a solid line in FIG. 9) by gravity that acts on the back-flow inhibiting valve 13L.

[0065] More particularly, the plate-like back-flow inhibiting valve 13L is swingably installed in the water-holding tank 13 at a position to open/close the drainage inlet 13A inside the tank portion 13B. Therefore, when the drainage outlet 11F is positioned upward of the drainage inlet 13A in a direction of gravitational force, the back-flow inhibiting valve 13L swings downward in the direction of gravitational force by gravity that acts on the back-flow inhibiting valve 13L, thereby to be displaced to a position to open the drainage inlet 13A. When at least part of the drainage outlet 11F is not positioned upward of the drainage inlet 13A in the direction of gravitational force, due to, for example, tilting of the electric power tool 1, the back-flow inhibiting valve 13L swings downward in the direction of gravitational force by the gravity that acts on the back-flow inhibiting valve 13L, thereby to be displaced to a position to close the drainage inlet 13A.

[0066] Accordingly, when the drainage outlet 11F is positioned upward of the drainage inlet 13A in the direction of gravitational force, the reaction water discharged from the drainage outlet 11F moves downward by the gravity. Thus, the reaction water retained in the tank portion 13B is inhibited from flowing backward out of the tank portion 13B from the drainage inlet 13A.

[0067] When at least part of the drainage outlet 11F is not positioned upward of the drainage inlet 13A in the direction of gravitational force, the drainage inlet 13A is closed by the back-flow inhibiting valve 13L. Thus, the reaction water retained in the tank portion 13B is inhibited from flowing backward out of the tank portion 13B from the drainage inlet 13A.

[0068] As described in the above, in the present fifth embodiment, regardless of posture of the electric power tool 1, the reaction water retained in the tank portion 13B can be inhibited from flowing backward out of the tank portion 13B from the drainage inlet 13A. The reaction water can be inhibited from being directly discharged from the electric power tool 1.

[0069] In the present fifth embodiment, in order that the drainage inlet 13A is closed by the back-flow inhibiting valve 13L even when the water-holding tank 13 is rotated either to the right (clockwise) or to the left (counterclockwise) with respect to the drawing sheet, the back-flow inhibiting valve 13L is installed in the water-holding tank 13 so as to be tilted with respect to a vertical direction (up and down direction), in the state shown in FIG. 9.

[Sixth Embodiment]

[0070] As shown in FIG. 10, in the present sixth embodiment, an absorber 13M which absorbs and holds the reaction water is arranged inside the tank portion 13B. As the absorber 13M, for example, a sponge-like porous body may be used.

[0071] With such configuration, in the present sixth embodiment, the reaction water retained in the tank portion 13B is absorbed and held by the absorber 13M. Regardless of the posture of the electric power tool 1, the reaction water retained in the tank portion 13B can be inhibited from flowing backward out of the tank portion 13B from the drainage inlet 13A. The reaction water can be also inhibited from being fluctuated, depending on the posture of the electric power tool 1.

[Seventh Embodiment]

[0072] In the above-described first to sixth embodiments, the water-holding tank 13 is detachably installed in the battery pack 11. Thus, upon discharging the reaction water retained in the tank portion 13B, the water-holding tank 13 is removed from the battery pack 11 to discharge the reaction water from the drainage inlet 13A. To the contrary to these embodiments, in the present seventh embodiment, a pair of drainage openings 13N which discharge the reaction water retained in the tank

portion 13B are provided downward side of the water-holding tank 13, as shown in FIG. 11. Further, the pair of drainage openings 13N are sealed with a pair of caps 13P attachable to and detachable from the pair of drainage openings 13N.

[0073] With such configuration, in the electric power tool 1 according to the present seventh embodiment, the reaction water retained in the tank portion 13B can be discharged by removing the caps 13P without removing the water-holding tank 13 from the battery pack 11. Thereby, the reaction water held in the water-holding tank 13 can be inhibited from being accumulated to fill up the water-holding tank 13.

[0074] The drainage openings 13N correspond to an example of the reaction water remover and the reaction water outlet of the present invention.

[Eighth Embodiment]

[0075] In the present eighth embodiment, as shown in FIG. 12, the water-holding tank 13 and the battery pack 11 are integrated. Further, the water-holding tank 13 is configured such that at least part of the air flow induced by the fan 3B is introduced into the water-holding tank 13 (tank portion 13B) and evaporation of the reaction water retained in the tank portion 13B is promoted.

[0076] Particularly, as shown in FIG. 13, a wind guide path 7A that guides part of the air flow induced by the fan 3B (hereinafter, this part of the air flow is referred to as a guide wind) into the water-holding tank 13 (tank portion 13B) is provided in the main body of the electric power tool 1 (i.e., the main body portion 5 and the handle portion 7). In the water-holding tank 13 integrated with the battery pack 11, as shown in FIG. 12, an air inlet 13Q which communicates the wind guide path 7A and the inside of the tank portion 13B, and an air outlet 13R which discharges the guide wind guided into the inside of the tank portion 13B out of the water-holding tank 13, are provided.

[0077] In the electric power tool 1 according to the present eighth embodiment configured as such, when the tool switch 9 is turned ON and the electric motor 3 is started to rotate, the guide wind passes through the inside the tank portion 13B. Thus, evaporation of the reaction water discharged from the fuel cell 11A (battery pack 11) and retained in the tank portion 13B is promoted. The evaporated reaction water is discharged out of the water-holding tank 13 from the air outlet 13R together with the guide wind.

[0078] Accordingly, in the electric power tool 1 according to the present eighth embodiment, too much of the reaction water can be inhibited from being retained in the tank portion 13B (the water-holding tank 13). The number of operation of discharging the reaction water can be reduced. The wind guide path 7A, the air inlet 13Q and the air outlet 13R correspond to an example of the reaction water remover of the present invention.

[0079] In FIG. 13, part of the air flow induced by the

fan 3B is guided into the water-holding tank 13 as the guide wind. The present invention is not limited to the above configuration. For example, the electric power tool 1 may be configured such that the fan 3B is arranged on the side of the chucking 3A, and all the air flow induced by the fan 3B is guided into the water-holding tank 13 as the guide wind.

[0080] Also, in FIG. 12, the absorber 13M is arranged inside the tank portion 13B. The absorber 13M may be removed.

[Ninth Embodiment]

[0081] In the first embodiment, the pair of holder portions 11K are formed into a hook-like shape, and sections of the pair of holder portions 11K facing each other are open. In the present ninth embodiment, as shown in FIG. 14A, the sections of the pair of holder portions 11K facing each other are connected and closed. Inside the closed section, the water-holding tank 13 is housed. In the electric power tool 1 according to the present ninth embodiment as well, the water-holding tank 13 can be attached to or detached from the battery pack 11 by displacing (sliding) the water-holding tank 13 in parallel to the front-back direction, as shown in FIG. 14B.

[Tenth Embodiment]

[0082] In the above-described first to ninth embodiments, the water-holding tank 13 is provided separate from the main body of the electric power tool 1. However, the water-holding tank 13 is installed in the main body of the electric power tool 1 or in the battery pack 11 attached to the main body, upon use. The water-holding tank 13 is used in a state integrated with the main body. In the electric power tool 1 of the present tenth embodiment, at least the water-holding tank 13 is provided in a separate body 14 that can be attached to a user (for example, attached to the back, the waist, the arm, or the leg of a user), as shown in FIG. 15.

[0083] The separate body 14 in the present tenth embodiment is configured to be attached to (secured to) the user by means of a belt 22. In the electric power tool 1 according to the present tenth embodiment configured as such, the user can operate the electric power tool 1 with the water-holding tank 13 being attached to the user.

[0084] In FIG. 15, only the water-holding tank 13 is provided in the separate body 14. The present invention is not limited to this configuration. The separate body 14 may house the water-holding tank 13 and the battery pack 11.

[Eleventh Embodiment]

[0085] In the battery pack 11 of the above-described first embodiment, the fuel cell 11A, the fuel tank 11B, and the rechargeable battery 11C are integrated. The water-holding tank 13 is detachably attached to the battery pack

11.

[0086] As compared to such the battery pack 11 of the first embodiment, in the battery pack 11 in the eleventh embodiment, the fuel cell 11A and the rechargeable battery 11C are integrally provided inside the casing 11E, while the water-holding tank 13 and the fuel tank 11B are integrally provided inside a casing 11S detachably attached to the casing 11E, as shown in FIG. 16.

[0087] When the casing 11S is attached to the casing 11E, the drainage outlet 11F provided in the casing 11E and the drainage inlet 13A provided in the casing 11S communicate with each other. Also, the casing 11E and the casing 11S are respectively provided with a fuel supply opening 11T or 13T for feeding the fuel inside the fuel tank 11B into the fuel cell 11A. When the casing 11S is attached to the casing 11E, the fuel supply openings 11T and 13T communicate with each other. The fuel inside the fuel tank 11B is fed into the fuel cell 11A by the fuel pump 11D.

[0088] In the electric power tool 1 of the eleventh embodiment configured as such, when the casing 11S is detached, the reaction water accumulated in the water-holding tank 13 can be easily processed (disposed of). Also, the fuel tank 11B can be easily replenished with the fuel.

[Other Embodiments]

[0089] The embodiments of the present invention are described in the above. However, the present invention is not limited to the above-described embodiments and can take various forms within a scope not departing from the gist of the invention.

[0090] In the above-described first to eleventh embodiments, the present invention is applied to a pistol-shaped electric power tool. Adaptation of the present invention is not limited to such electric power tools. The present invention can be applied to gardening tools such as a lawnmower, for example.

[0091] In the above-described first to eleventh embodiments, the direct methanol fuel cell (DMFC) is adopted as the fuel cell 11A. The present invention is not limited to such configuration. Any types of fuel cells can be adopted.

[0092] In the above-described first to eleventh embodiments, the fuel cell 11A and the rechargeable battery 11C are housed in the same casing 11E. The present invention is not limited to such configuration. For example, the rechargeable battery 11C may be housed in the main body of the electric power tool 1.

[0093] In the above-described first to eleventh embodiments, the fuel cell 11A and the rechargeable battery 11C are provided as power sources. If, for example, high-pressure hydrogen is used as the fuel, the fuel pump 11D is no longer necessary. Thus, the rechargeable battery 11C may be removed.

[0094] In the above-described fourth embodiment, the electric power tool 1 is configured to prohibit the operation

of the electric motor 3 when the drainage inlet 13A is not at the attachment complete position. The electric power tool 1 may be configured to prohibit the operation of the electric motor 3 when an amount of the reaction water retained in the water-holding tank 13 exceeds a predetermined amount. In this case, for example, a detecting unit which detects whether or not the amount of the reaction water retained in the water-holding tank 13 exceeds a predetermined amount may be provided in the electric power tool 1.

[0095] In the above-described first to eleventh embodiments, the drainage outlet 11F is provided in the section of the battery pack 11 where the water-holding tank 13 is held. The present invention is not limited to such configuration. For example, the drainage outlet 11F may be provided in a different section other than the section in the battery pack 11 where the water-holding tank 13 is held.

[0096] In the above-described first embodiment, the engaging portion 11L is provided in the battery pack 11, and the engaging body 13G is provided in the water-holding tank 13. The engaging portion 11L may be provided in the water-holding tank 13, and the engaging body 13G may be provided in the battery pack 11.

[0097] It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

Claims

1. An electric power tool (1) comprising:

a tool portion (3A);
a fuel cell (11A) that generates electric power by oxidation reaction between a fuel and an oxidizing agent;
a power drive source (3) that receives electric power to drive the tool portion (3A); and
a water-holding unit (13) that holds a reaction water produced in the fuel cell (11A) by the oxidation reaction.

2. The electric power tool (1) according to claim 1, further comprising:

a holder portion (11K) that detachably holds the water-holding unit (13).

3. The electric power tool (1) according to claim 1 or 2, wherein the water-holding unit (13) includes:

a drainage inlet (13A) to which the reaction water flows in, and the electric power tool (1) includes:

a drainage outlet (11F) from which the reaction water is discharged; and a positioner (11H, 11J, 13D, 13E) that positions the drainage inlet (13A) with respect to the drainage outlet (11F), so that the reaction water flows in from the drainage outlet (11F) to the drainage inlet (13A).

4. The electric power tool (1) according to claim 3, wherein a packing (11G, 13C) is provided around at least one of the drainage outlet (11F) and the drainage inlet (13A), and the positioner (11H, 11J, 13D, 13E) is configured to position the drainage inlet (13A) with respect to the drainage outlet (11F) along such a direction in which the packing (11G, 13C) is inhibited from being damaged.

5. The electric power tool (1) according to claim 3 or 4, wherein the drainage outlet (11F) is provided in a section where the water-holding unit (13) is held.

6. The electric power tool (1) according to any one of claims 3 to 5, further comprising:

an operation prohibiting unit (21) that prohibits operation of the power drive source (3), when the drainage inlet (13A) is not located at a position where the reaction water can flow in from the drainage outlet (11F) to the drainage inlet (13A).

7. The electric power tool (1) according to claim 6, wherein the operation prohibiting unit (21) is configured to prohibit the operation of the power drive source (3) by interrupting a supply passage of electric power from the fuel cell (11A) to the power drive source (3).

8. The electric power tool (1) according to any one of claims 1 to 7, further comprising:

a reaction water remover (7A, 13N, 13Q, 13R) that removes the reaction water held in the water-holding unit (13) from the water-holding unit (13).

9. The electric power tool (1) according to claim 8,

wherein

the reaction water remover (13N) includes a reaction water outlet (13N) formed in the water-holding unit (13) in order to discharge the reaction water held in the water-holding unit (13) out of the water-holding unit (13).

10. The electric power tool (1) according to claim 8, further comprising:

a fan (3B) that is driven by the power drive source (3), wherein the reaction water remover (7A, 13Q, 13R) is configured to pass at least part of an air flow induced by the fan (3B) through an interior of the water-holding unit (13).

11. The electric power tool (1) according to any one of claims 1 to 10, further comprising:

a fuel tank (11B) that stores a fuel to be supplied to the fuel cell (11A), wherein the fuel tank (11B) and the water-holding unit (13) are integrally formed.

12. The electric power tool (1) according to any one of claims 1 to 11, further comprising:

a main body portion (5) that includes the tool portion (3A) and the power drive source (3), wherein the water-holding unit (13) is separately provided from the main body portion (5).

13. The electric power tool (1) according to claim 12, wherein the water-holding unit (13) is configured to be attachable to a user of the electric power tool (1).

14. The electric power tool (1) according to any one of claims 1 to 13, wherein the water-holding unit (13) includes:

a drainage inlet (13A) to which the reaction water flows in, and a back flow inhibiting unit (13L) that inhibits the reaction water held in the water-holding unit (13) from flowing backward from the drainage inlet (13A) out of the water-holding unit (13).

15. The electric power tool (1) according to any one of claims 1 to 14, wherein the water-holding unit (13) includes an absorber (13M) that absorbs and holds the reaction water.

FIG.1

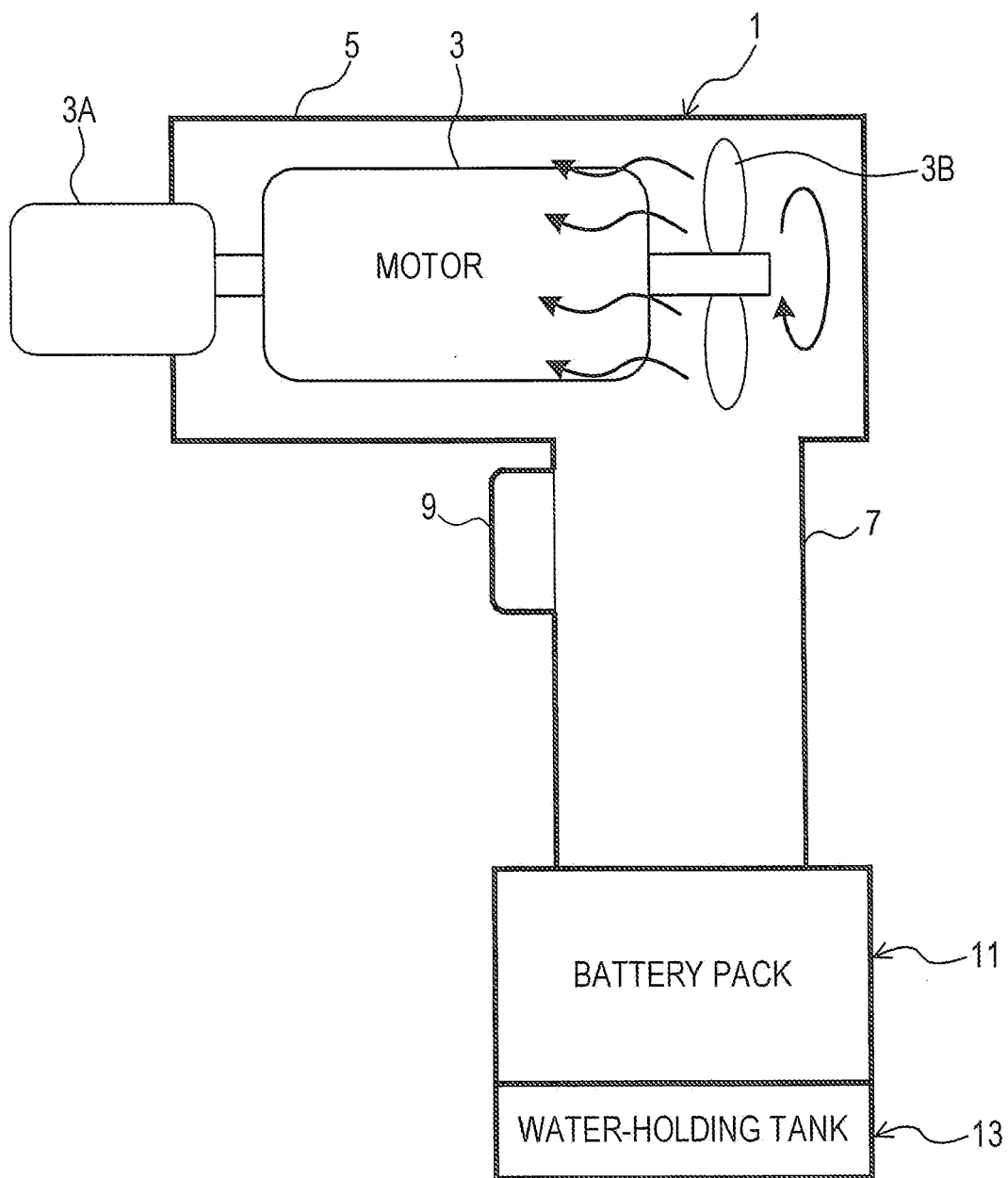


FIG.2

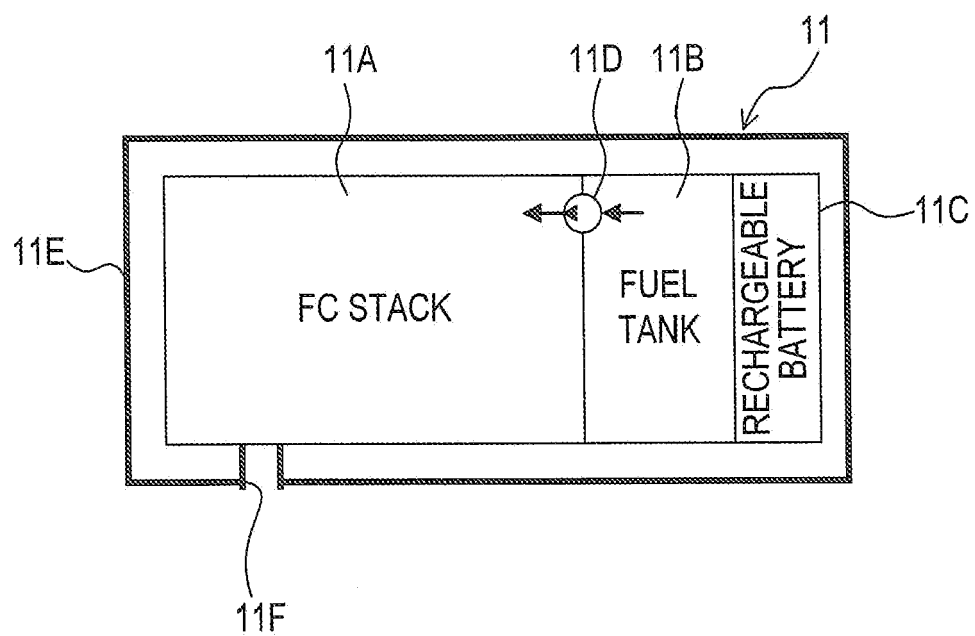


FIG.3B

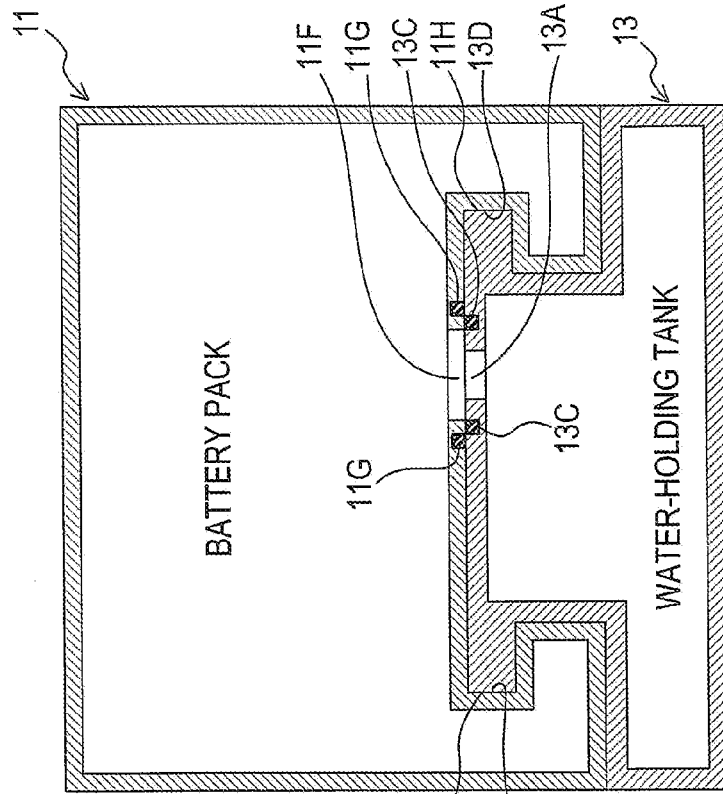


FIG.3A

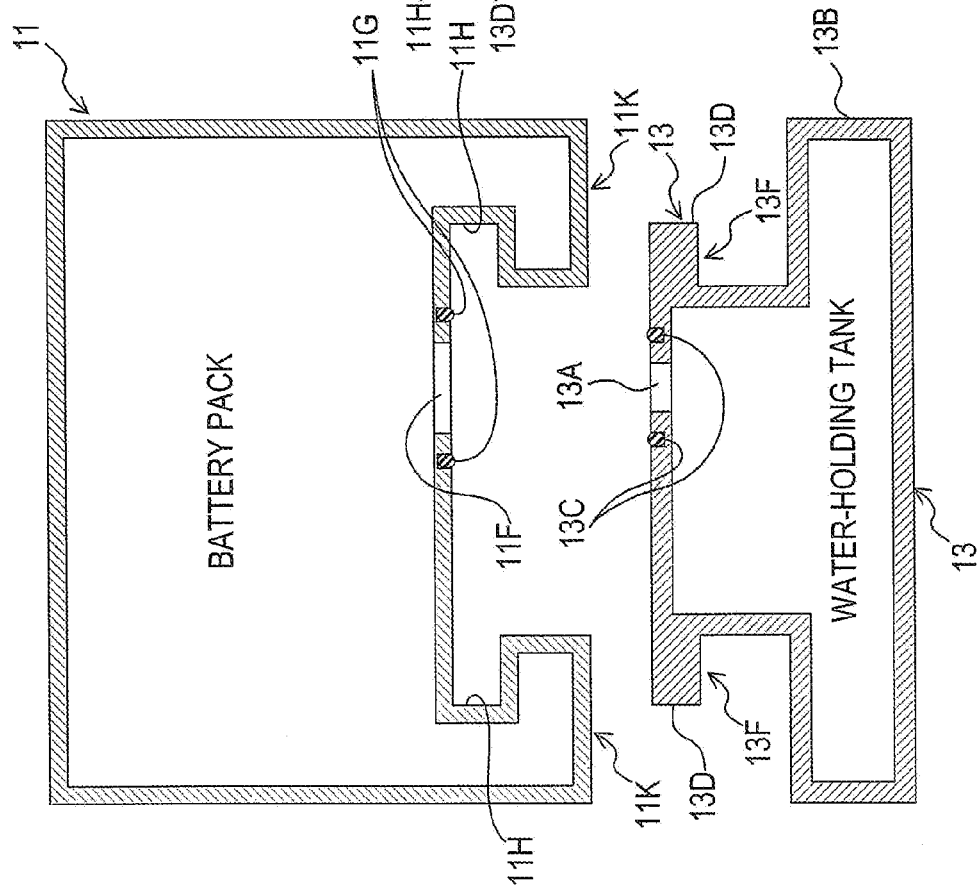


FIG.4A

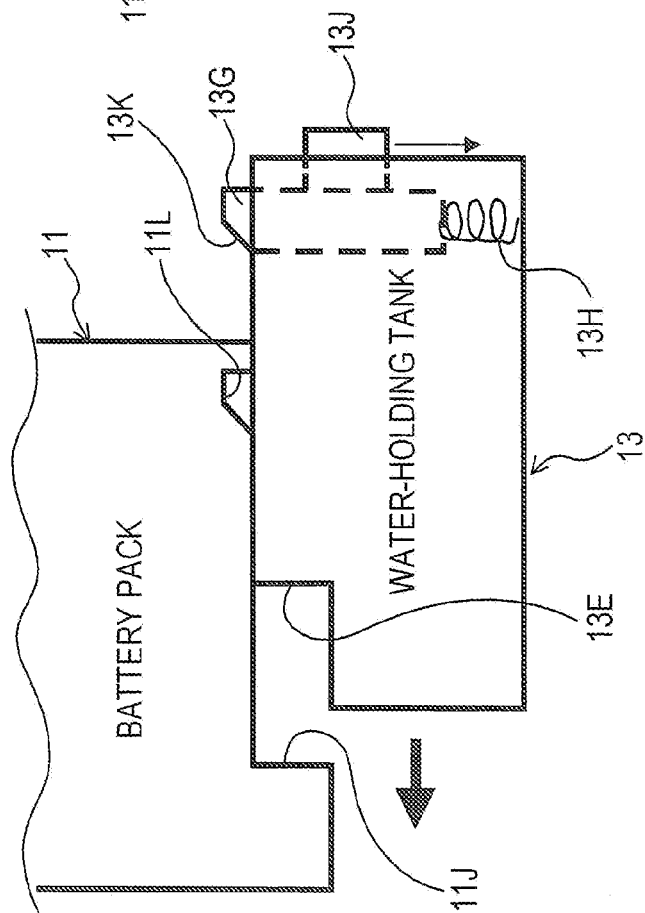


FIG.4B

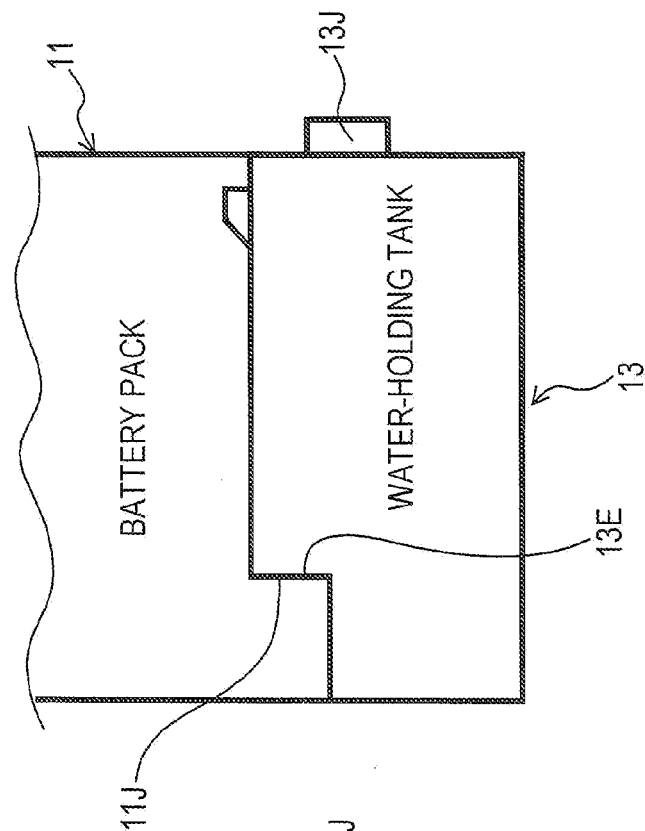


FIG.5

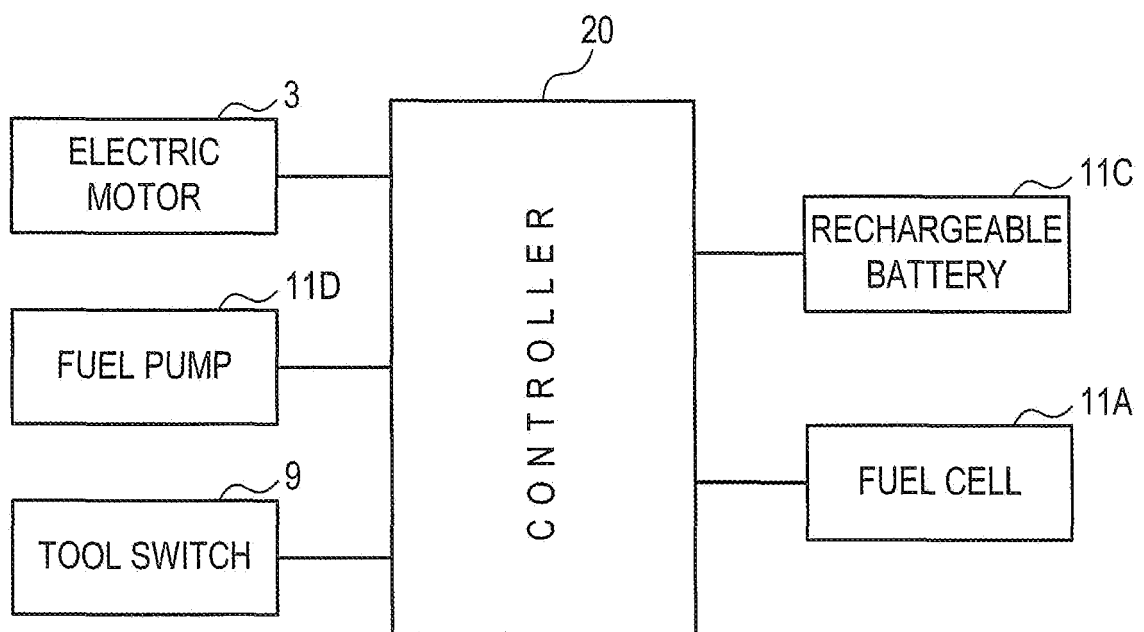


FIG.6B

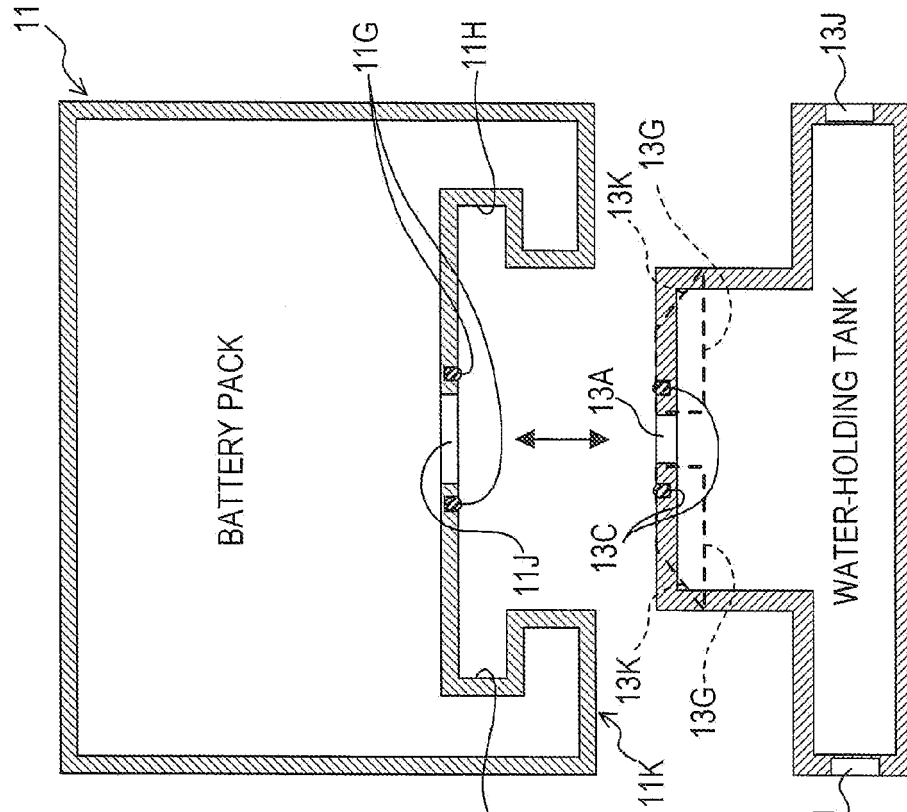


FIG.6A

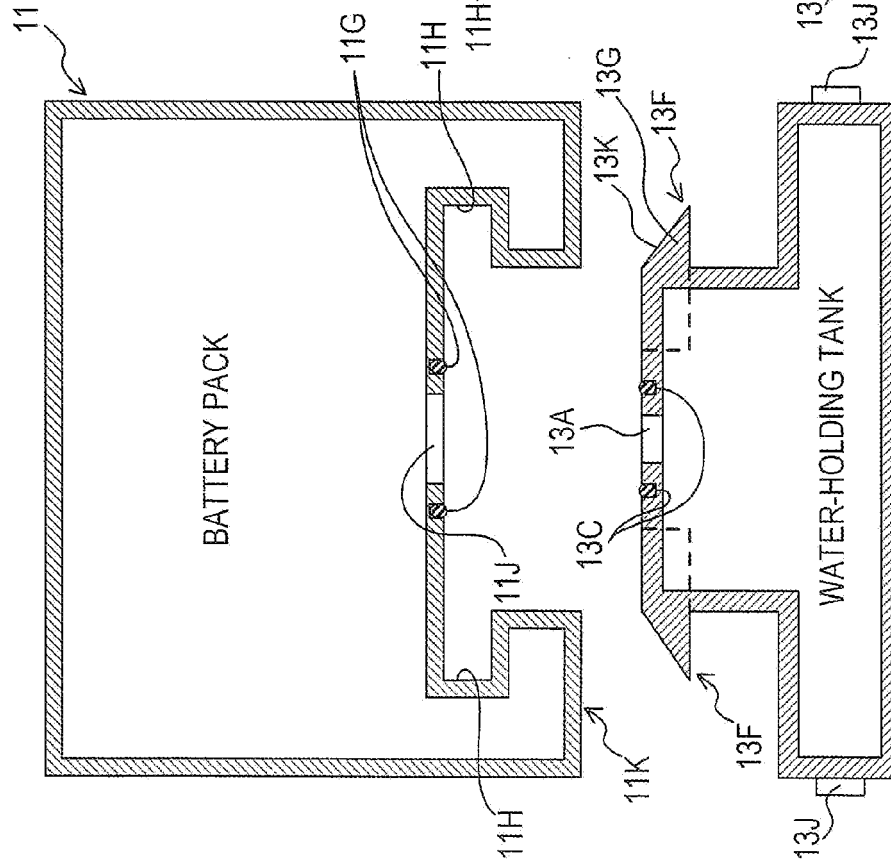


FIG.7A

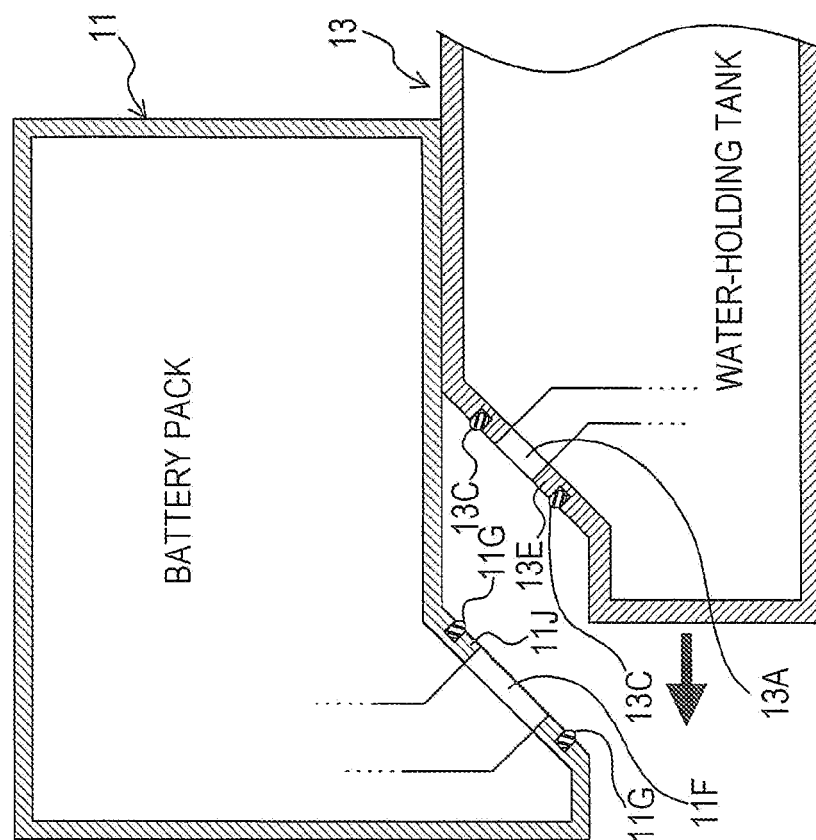


FIG.7B

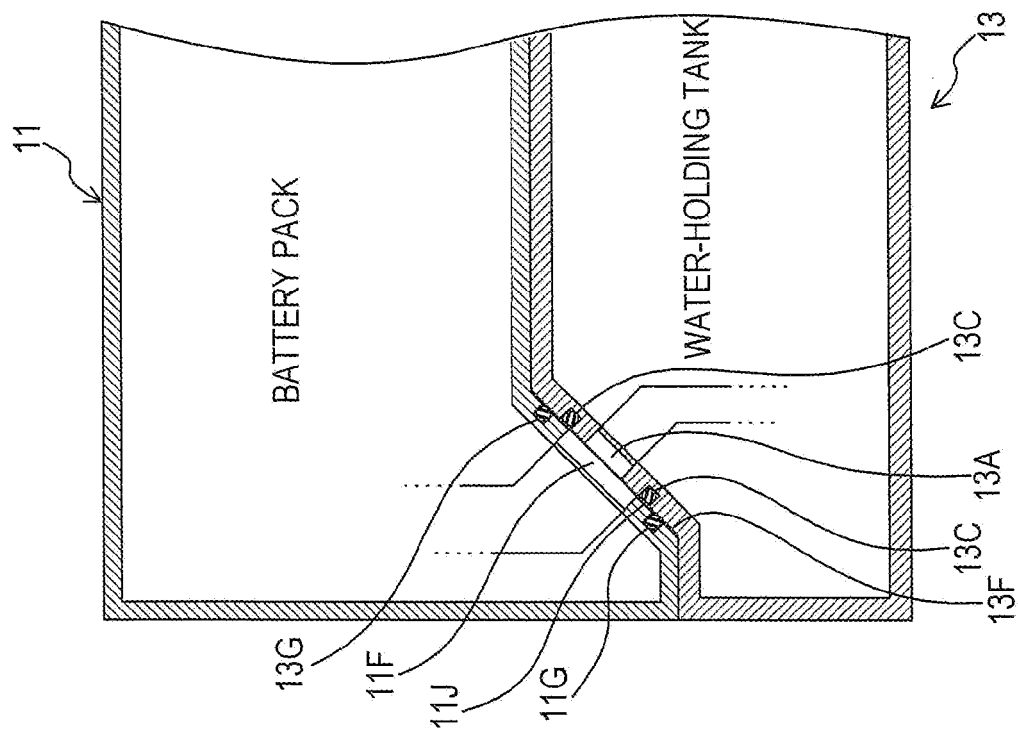


FIG.8A

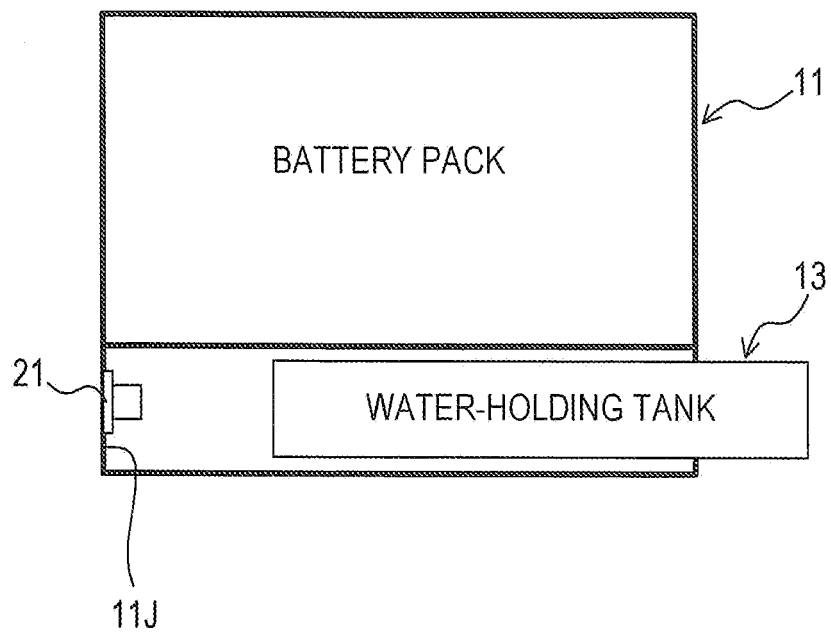


FIG.8B

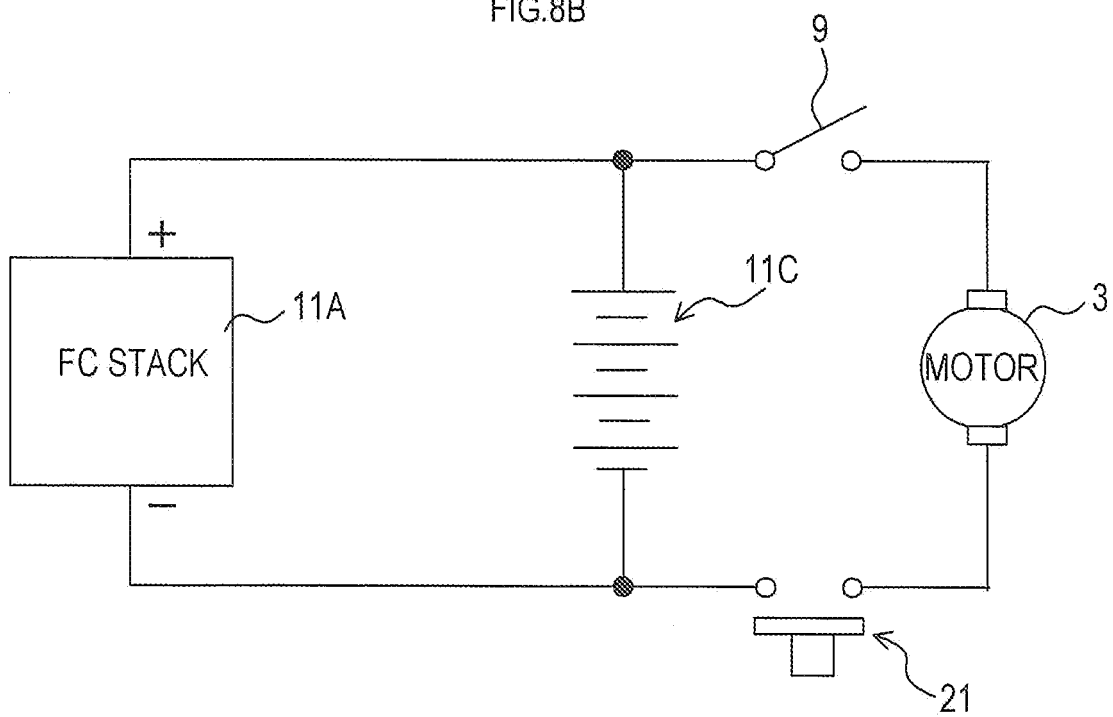


FIG.9

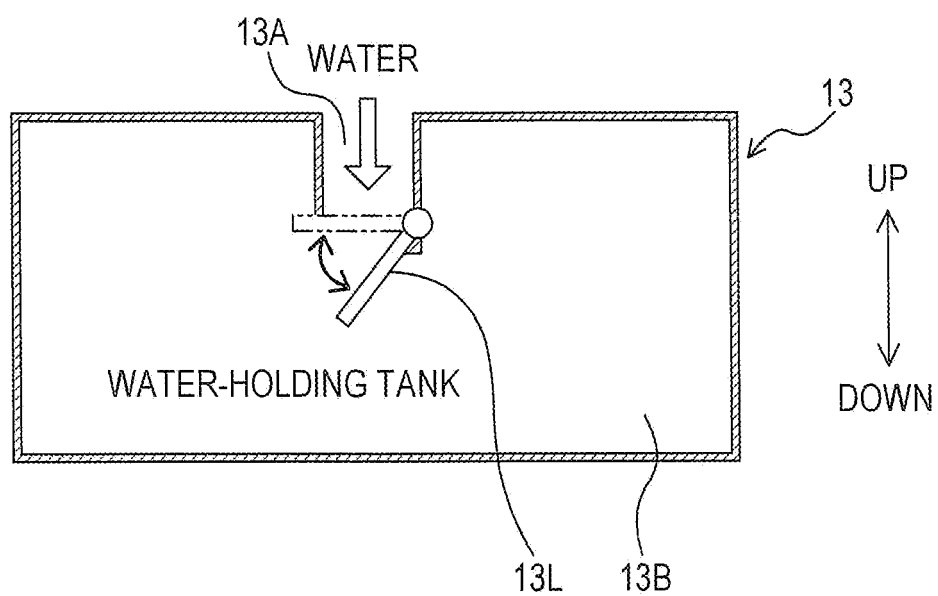


FIG.10

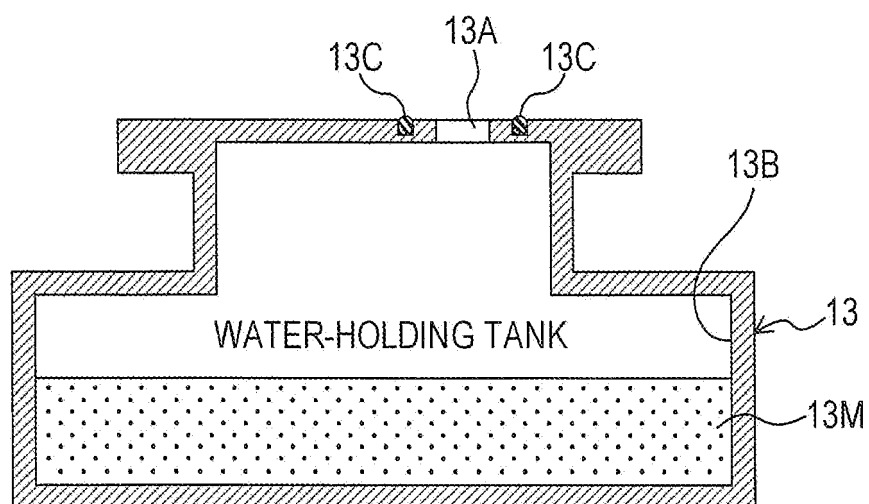


FIG.11

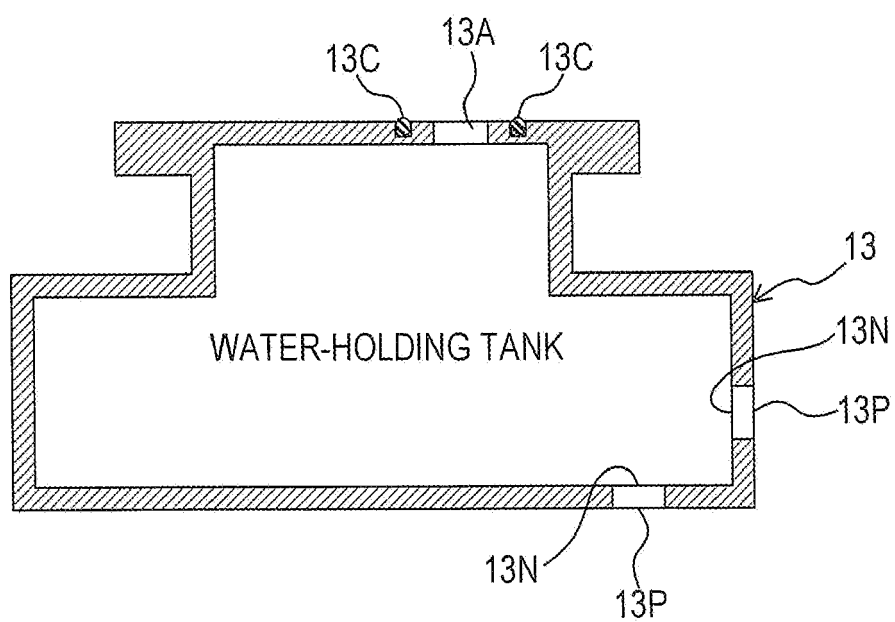


FIG.12

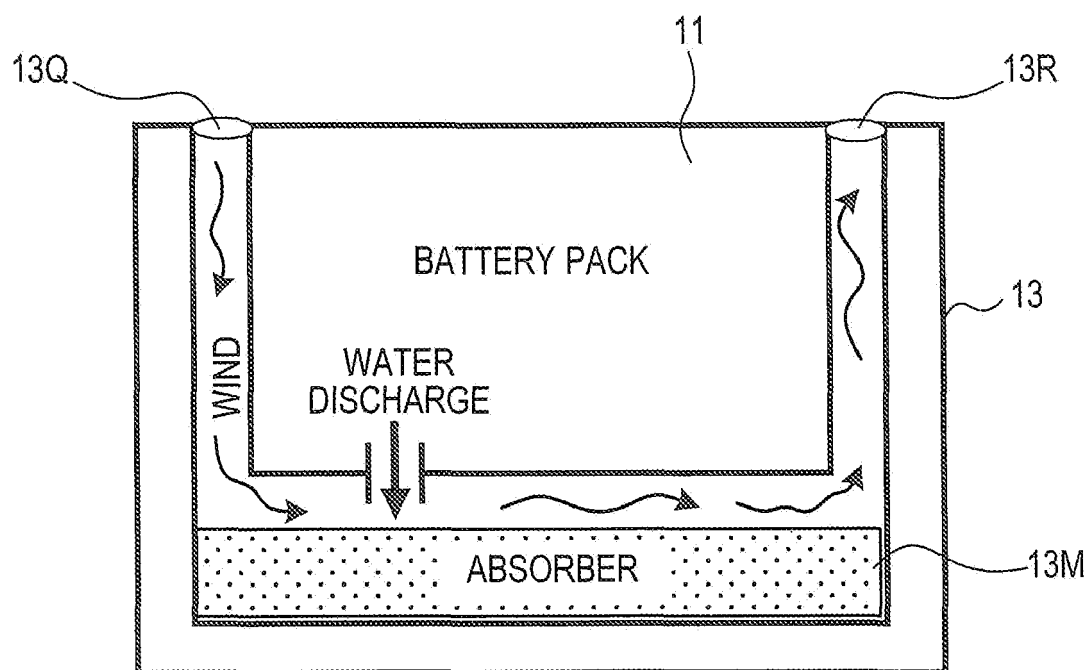


FIG.13

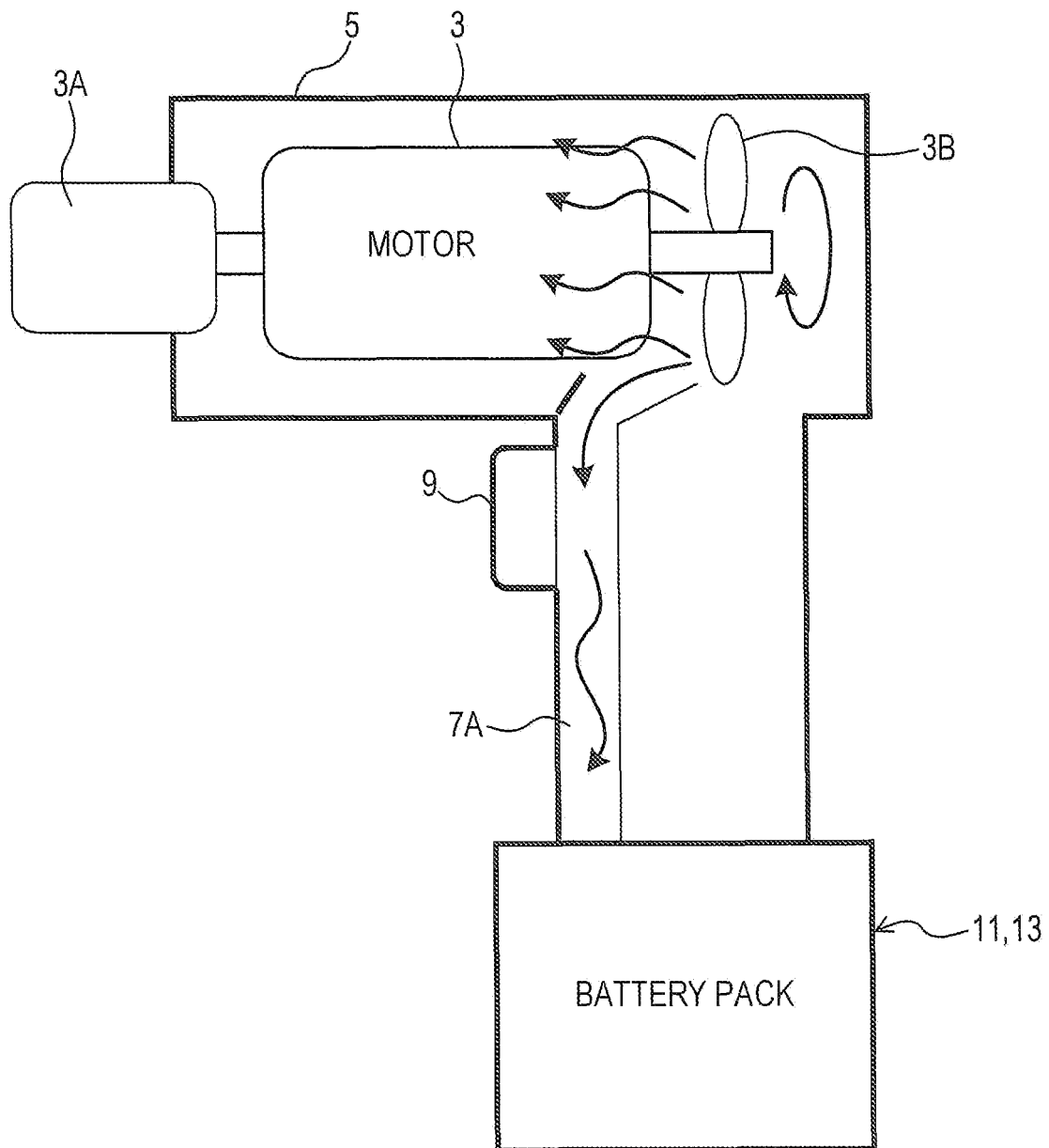


FIG.14A

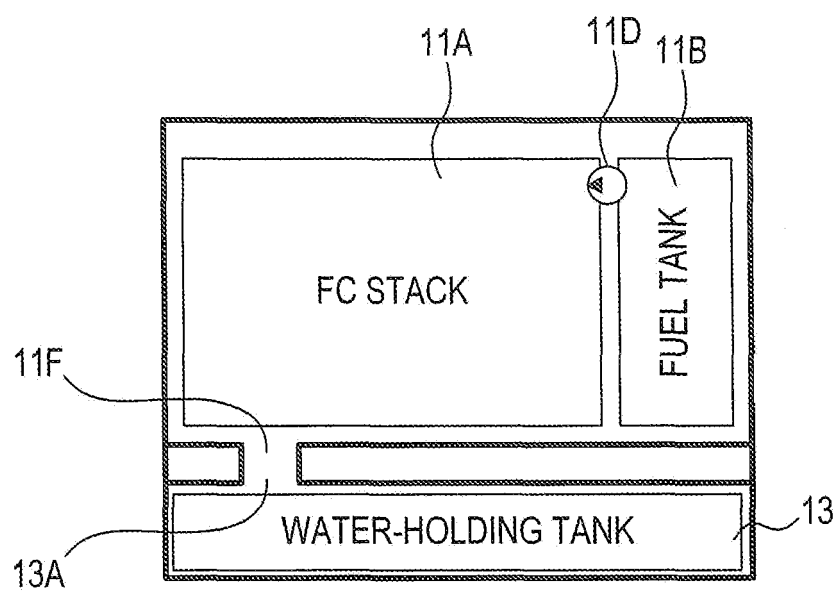


FIG.14B

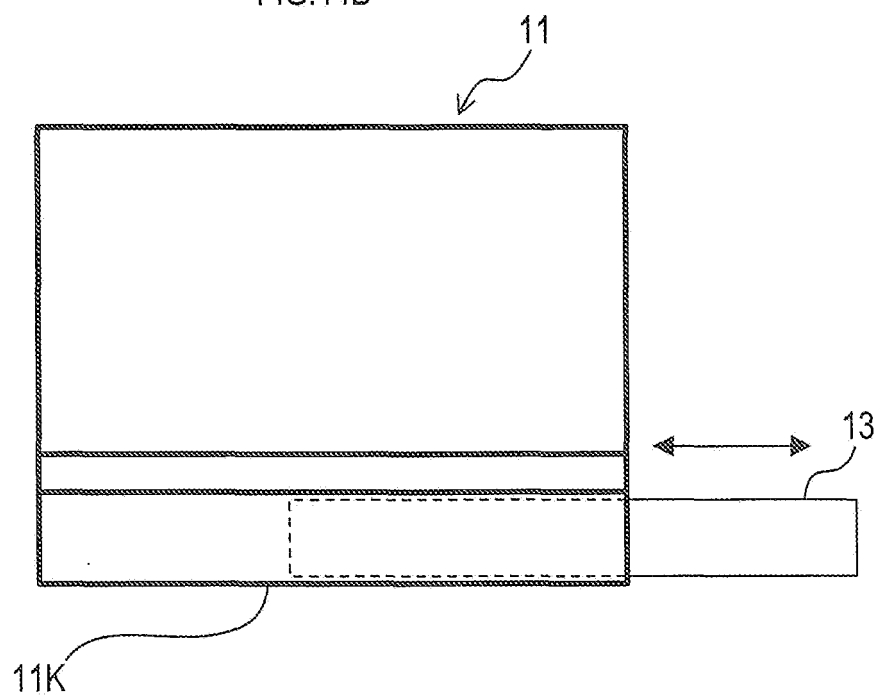


FIG.15

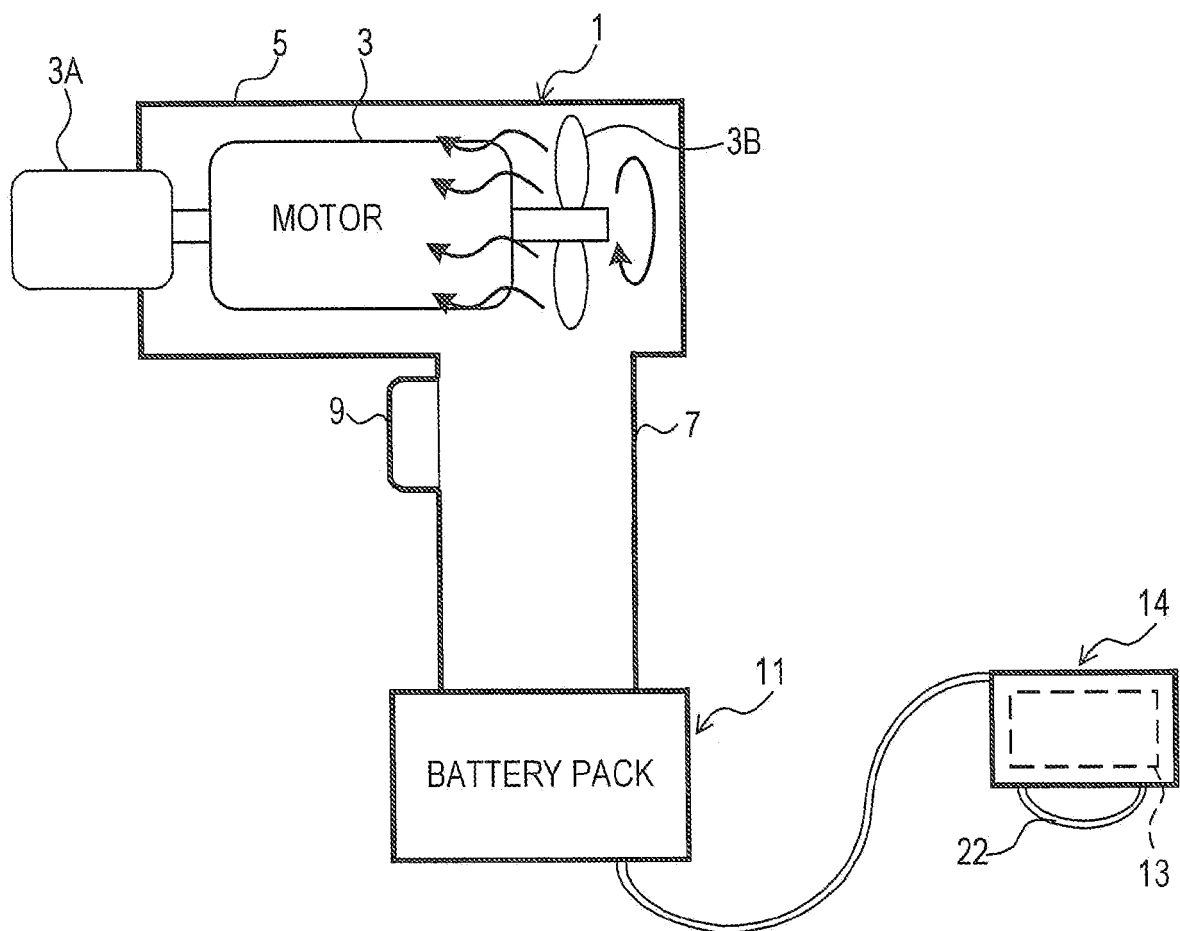
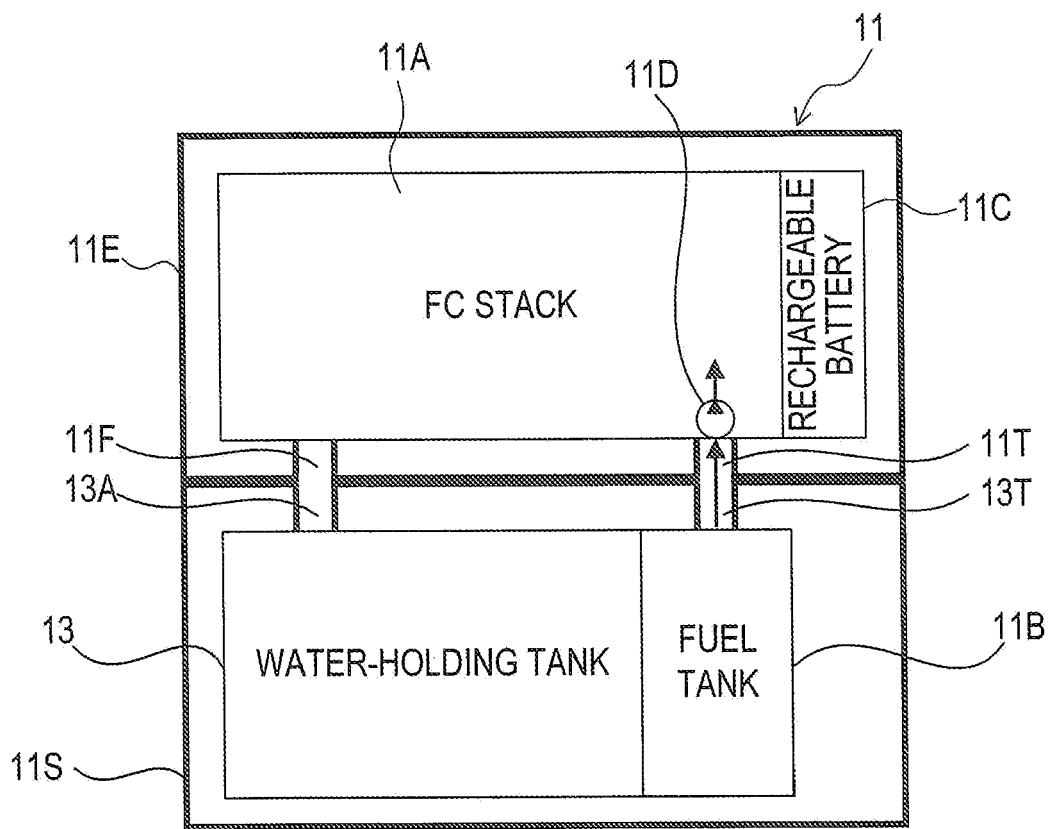


FIG.16



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008132551 A [0002]