

WATER ELECTROLYSIS DEVICE

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates to a water electrolysis device, and more
5 specifically, to a water electrolysis device that outputs hydrogen gas and
oxygen gas on the same side of the electrolyzer.

2. Description of the prior art

As people have always been paying much attention on health
developments, many developments in medical technology are often targeted
10 on treating diseases and prolonging human life. Most of the treatments in the
past are passive, which means that the disease is treated only when it occurs.
The treatments include operations, medication treatments, radiation therapies,
or even medical treatments for cancer. However, in recent years, most of the
researches from medical experts are gradually moving towards preventive
15 medical methods, such as research on healthy food, screening and the
prevention of inherited diseases, which actively prevents diseases from
occurring in the future. Due to the focus of the prolongation of human life,
many anti-aging and anti-oxidation technologies including skin care products
and anti-oxidation food/medicine are gradually being developed and have
20 becoming increasingly popular to the general public.

Studies have found that there are instable oxygen species (O⁺), also
known as free radicals, in the human body. The free radicals which are
usually generated due to diseases, diet, environment and one's lifestyle can be
excreted in the form of water by reacting with the inhaled hydrogen. With this
25 method, the amount of free radicals in the human body can be reduced,

thereby restoring the body condition from an acidic state to an alkaline state, achieving an anti-oxidation, anti-aging and beauty health effect, and even eliminating chronic diseases. Furthermore, there are also clinical experiments showing that patients who need to inhale a high concentration of oxygen for
5 an extended period of time would experience lung damage, but it could be ameliorated by inhaling hydrogen

In order to improve the effect of inhaling hydrogen gas, increasing the time of inhaling hydrogen gas is an effective way to improve the efficiency. In general, the conventional water electrolysis device is relatively bulky, and
10 it is hard for a person to have enough time to inhale hydrogen gas by staying next to the conventional water electrolysis device during daily activities. Therefore, inhaling hydrogen gas during sleep time could be an effective way. However, as mentioned above, the conventional water electrolysis device is relatively bulky, how to reduce the volume of the water electrolysis device
15 and to maintain sufficient hydrogen gas production are the problems that must be solved.

In addition to the health care mentioned above, the use of hydrogen gas can also be used to generate an oxyhydrogen flame for heating or combustion, and to remove engine carbon deposits and the like. In general, hydrogen gas is
20 generated by the electrolyzing water in the electrolyzer; however, it is easy to cause high temperature during the process of electrolyzing water. In order to avoid gas explosion, the traditional hydrogen-oxygen electrolyzer is mostly air-cooled; namely, using a fan to cool down. However, if a trouble occurs on the fan, it will cause the temperature of the hydrogen-oxygen electrolyzer to
25 rise and result in the danger of gas explosion. Furthermore, the hydrogen-oxygen mixed gas generated after electrolyzing water through the electrolysis device usually includes electrolyte, which is not suitable for human beings to inhale directly. At the same time, there is a problem of electrolyte consumption during the electrolysis process.

SUMMARY OF THE INVENTION

The present invention is to provide a water electrolysis device including a case, a power supplying unit and an ion-exchange membrane electrolyzer. The case includes a base and a side wall. A containing space is formed in the base and the side wall. The containing space includes a bottom space and a top space, and the bottom space is larger than the top space. The power supplying unit is configured in the bottom space of the case for supplying power to the water electrolysis device. The ion-exchange membrane electrolyzer is configured in a non-central position of the case, and includes a cathode. The cathode generates hydrogen gas during which the ion-exchange membrane electrolyzer electrolyzes water.

In one embodiment of the present invention, the ion-exchange membrane electrolyzer includes a first side, a second side, an ion-exchange membrane, an anode, an oxygen output tube and a hydrogen output tube. The ion-exchange membrane is configured between the anode chamber and the cathode chamber. When the ion-exchange membrane electrolyzer electrolyzes water, the anode generates oxygen gas. The oxygen output tube is used for outputting oxygen gas, and the cathode output tube is used for outputting hydrogen gas. The first side is close to the side wall, and both of the oxygen gas and the hydrogen gas are outputted from the second side of the ion-exchange membrane electrolyzer.

In one embodiment of the present invention, the anode is configured between the ion-exchange membrane and the second side, and the cathode is configured between the ion-exchange membrane and the first side. The oxygen output tube extends from the position between the ion-exchange membrane and the second side to the second side and passes through the second side. The hydrogen output tube extends from the position between the ion-exchange membrane and the first side to the second side and passes through the second side.

In one embodiment of the present invention, the anode is configured

between the ion-exchange membrane and the first side, and the cathode is configured between the ion-exchange membrane and the second side. The oxygen output tube extends from the position between the ion-exchange membrane and the first side to the second side and passes through the second side. The hydrogen output tube extends from the position between the ion-exchange membrane and the second side to the second side and passes through the second side.

In one embodiment of the present invention, the anode chamber includes an anode sealing plate, an anode conductive plate and an anode external plate. The oxygen output tube passes through the anode external plate, the anode conductive plate and the anode sealing plate. The cathode chamber includes a cathode sealing plate and a cathode conductive plate. The hydrogen output tube passes through the anode external plate, the anode conductive plate, the anode sealing plate and the cathode sealing plate, wherein oxygen gas and hydrogen gas are outputted on the same side of the ion-exchange membrane electrolyzer.

In one embodiment of the present invention, the ion-exchange membrane electrolyzer further includes a water supplying pipe which is configured on and passes through the anode external plate, the anode conductive plate and the anode sealing plate to connect the anode chamber and a water tank. The water from the water tank flows into the anode chamber through the water supplying pipe to replenish the water in the anode chamber.

In one embodiment of the present invention, the water electrolysis device further includes an air supplying tube, a fan and an air pump. The air supplying tube is connected to the hydrogen output tube to receive hydrogen gas. The fan draws air from the environment outside the water electrolysis device into the water electrolysis device. The air pump guides the air into the air supplying tube to mix the air with hydrogen gas to dilute the volume concentration of hydrogen gas in the air supplying tube.

In one embodiment of the present invention, the air pump is connected

with the air supplying tube by an air supplying interface. The air supplying tube has a first flow direction. The air supplying interface has a second flow direction. The first flow direction points to the upper portion of the water electrolysis device, and the second flow direction points to the air supplying tube. A lead angle is formed between the first flow direction and the second flow direction, wherein the lead angle is preferably between 25 to 45 degrees. The shape of the connecting position with the lead angle is made as an arc lead angle, so as to guide the air into the air supplying tube from the air supplying interface.

10 In one embodiment of the present invention, the water electrolysis device further includes an atomizing/volatile gas mixing tank which is connected to the air supplying tube and receives the diluted hydrogen gas. The atomizing/volatile gas mixing tank selectively generates an atomizing gas and mixes it with hydrogen gas to form a health gas, wherein the atomizing
15 gas is one or a combination selected from a group consisting of water vapor, atomizing potions and volatile essential oil.

In one embodiment of the present invention, the water electrolysis device further includes a hydrogen concentration detector which is coupled to the air supplying tube for detecting whether the volume concentration of
20 hydrogen gas in the air supplying tube is within a range from a first predetermined value to a second predetermined value. The hydrogen concentration detector generates a first warning signal when the detected volume concentration of hydrogen gas is higher than the first predetermined value. The water electrolysis device further includes a controller which is
25 coupled to the hydrogen concentration detector and the ion-exchange membrane electrolyzer. The controller generates a start command to start up the air pump when receiving the first warning signal.

In one embodiment of the present invention, the hydrogen concentration detector generates a second warning signal when the detected volume
30 concentration of the hydrogen gas is higher than the second predetermined

value; and, the controller generates a stop command to stop the ion-exchange membrane electrolyzer when receiving the second warning signal. The first predetermined value is 4%, the second predetermined value is 6%, and the range is 4%~6%.

5 In one embodiment of the present invention, the water electrolysis device further includes a water level detecting device for detecting the amount of water in the water tank.

 In one embodiment of the present invention, the volume of the water electrolysis device is less than 8.5L, and a hydrogen gas generating rate of the
10 water electrolysis device is located in a range between 120 ml/min and 600 ml/min.

 In one embodiment of the present invention, the power supplying unit of the water electrolysis device includes a high power output and a low power output, wherein the electric power outputted by the low power output is equal
15 to or less than half of that outputted by the high power output. The high power output outputs a first voltage and a first current. The low power output outputs a second voltage and a second current. The first voltage is less than the second voltage. The first current is greater than the second current.

 The present invention further provides another water electrolysis device
20 including a case and an ion-exchange membrane electrolyzer. The case includes a base and a side wall. The ion-exchange membrane electrolyzer includes a first side, a second side, an ion-exchange membrane, a cathode, an anode, an oxygen output tube and a hydrogen output tube. The ion-exchange membrane is configured between the anode and the cathode. When the ion-
25 exchange membrane electrolyzer electrolyzes water, the cathode generates hydrogen gas, and the anode generates oxygen gas. The oxygen output tube is configured for outputting oxygen gas. The hydrogen output tube is configured for outputting hydrogen gas. The first side is close to the side wall, and both of oxygen gas and hydrogen gas are outputted from the second side of the ion-
30 exchange membrane electrolyzer.

In another embodiment of the present invention, the anode is configured between the ion-exchange membrane and the second side, and the cathode is configured between the ion-exchange membrane and the first side. The oxygen output tube extends from the position between the ion-exchange
5 membrane and the second side to the second side and passes through the second side. The hydrogen output tube extends from the position between the ion-exchange membrane and the first side to the second side and passes through the second side.

In another embodiment of the present invention, the anode is configured
10 between the ion-exchange membrane and the first side, and the cathode is configured between the ion-exchange membrane and the second side. The oxygen output tube extends from the position between the ion-exchange membrane and the first side to the second side and passes through the second side. The hydrogen output tube extends from the position between the ion-
15 exchange membrane and the second side to the second side and passes through the second side.

Through the ion-exchange membrane electrolyzer with hydrogen gas and oxygen gas outputted on the same side, the water tank, the gas-water separation tank, and the air supplying tube and the like configured in a case
20 with a limited volume, the present invention uses the containing space in the case as much as possible while maintaining sufficient hydrogen gas production, and the use of the fan and the air pump are also based on low noise. Therefore, the present invention actually provides a water electrolysis device with effective space arrangement, small volume, low noise and
25 suitable for placement around the user.

BRIEF DESCRIPTION OF THE APPENDED DRAWINGS

FIG. 1A is a functional block diagram illustrating a water electrolysis device according to an embodiment of the present invention.

FIG. 1B is an appearance drawing illustrating the water electrolysis

device according to an embodiment of the present invention.

FIG. 1C is a schematic diagram of internal structure of the water electrolysis device in FIG. 1B.

FIG. 2A is a simple sectional schematic diagram illustrating anion-exchange membrane electrolyzer according to an embodiment of the present invention.

FIG. 2B is a simple sectional schematic diagram illustrating anion-exchange membrane electrolyzer according to another embodiment of the present invention.

FIG. 2C is a sectional schematic diagram illustrating the ion-exchange membrane electrolyzer according to the embodiment of FIG. 2A.

FIG. 3 is an exploded diagram illustrating an ion-exchange membrane electrolyzer according to an embodiment of the present invention.

FIG. 4 is an exploded diagram illustrating the ion-exchange membrane electrolyzer in FIG. 3 from another perspective according to an embodiment of the present invention.

FIG. 5A and FIG. 5B are assembly diagrams illustrating the ion-exchange membrane electrolyzer in Fig. 3 from different perspectives.

FIG. 6 is an exploded diagram illustrating the water electrolysis device according to an embodiment of the present invention.

FIG. 7A and FIG. 7B respectively are an exploded diagram and an assembly diagram illustrating the water electrolysis device in FIG. 6 from another perspective.

FIG. 8A is a top view diagram illustrating a water electrolysis device according to an embodiment of the present invention. FIG. 8B is a sectional view illustrating the water electrolysis device along the line D-D in FIG. 8A.

FIG. 9 is a sectional schematic diagram illustrating the water

electrolysis device along the line D-D in FIG. 8A.

FIG. 10 is a schematic diagram illustrating a water electrolysis device according to another embodiment of the present invention.

5 The advantages, spirits and features of the present invention will be explained and discussed in detail by way of the embodiments and with reference of the diagrams.

DETAILED DESCRIPTION OF THE INVENTION

For the sake of the advantages, spirits and features of the present invention can be understood more easily and clearly, the detailed descriptions and discussions will be made later by way of the embodiments and with
10 reference of the diagrams. It is worth noting that these embodiments are merely representative embodiments of the present invention, wherein the specific methods, devices, conditions, materials and the like are not limited to the embodiments of the present invention or corresponding embodiments.

15 Please refer to FIG. 1A to FIG. 1C. FIG. 1A is a functional block diagram illustrating a water electrolysis device 1 according to an embodiment of the present invention. FIG. 1B is an appearance drawing illustrating the water electrolysis device 1 in one embodiment of the present invention. FIG. 1C is a schematic diagram of internal structure of the water electrolysis
20 device 1 in FIG. 1B. In this embodiment, the water electrolysis device 1 including a case 100 and an operation panel 102. The case 100 includes a side wall 110 and a base 112. The case 100 includes a water tank 10 and an ion-exchange membrane electrolyzer 12 therein. The water tank 10 is configured for providing the water for electrolyzing of the ion-exchange membrane
25 electrolyzer 12, and is configured in a side of the case 100 opposite to the operation panel 102. The ion-exchange membrane electrolyzer 12 is configured between the operation panel 102 and the water tank 10, and in a non-central position of the case 100 for electrolyzing water to generate hydrogen gas. In one embodiment, the water can be, but not limited to,

deionized water, and high-purity hydrogen gas can be prepared. In practical applications, any kind of water available can be adopted. Moreover, the present invention is not limited to the ion-exchange membrane electrolyzer; other types of electrolyzer also can be adopted in the present invention.

5 Each of the components disclosed in FIG. 1A is contained in a containing space of the case **100**, such as the water tank **10**, the ion-exchange membrane electrolyzer **12**, an air pump **13**, a fan **15**, an atomizing/volatile gas mixing tank **16** and a power supplying unit **70**, wherein the fan **15** and the water tank **10** are configured on one side opposite to the operation panel **102**,
10 and the fan **15** is configured below the water tank **10** from the perspective of FIG. 1C. A part of the air pump **13** is covered by the operation panel **102**. As shown in FIG. 1B, a containing space formed by the case **100**, or by the side wall **110** and the base **112**, includes a bottom space and a top space, and the bottom space is larger than the top space. For example, when the principal
15 design of the water electrolysis device **1** of the present invention is circular, as shown in FIG. 1B, the longest section length of the circular base **112**, that is, the diameter, is larger than the longest section length of the top of the circular case **100**, so that the bottom space is larger than the top space. The case **100** presents a design of tapering from the bottom to the top. However,
20 the design of the present invention is not limited to the circular form. The shape of the water electrolysis device **1** can be other shapes. For example, the shape of the water electrolysis device can be ellipse, square or polygon form, as long as the bottom or the longest section length of the base **112** is larger than the longest section length of the top to conform to the design of tapering
25 from bottom to the top. In order to arrange the containing space, the inventor places the power supplying unit **70** in the bottom of the case **100**, and below the water tank **10**, the ion-exchange membrane electrolyzer **12** and the air pump **13**.

Please refer to FIG. 2A and FIG. 2B. FIG. 2A is a simple sectional
30 schematic diagram illustrating the ion-exchange membrane electrolyzer **12** according to an embodiment of the present invention. FIG. 2B is a simple

sectional schematic diagram illustrating the ion-exchange membrane electrolyzer **12** in another embodiment of the present invention. This paragraph will cooperate with FIG. 2A and FIG. 2B to briefly explain the main feature of the present invention. As shown in FIG. 2A, the ion-exchange membrane electrolyzer **12** substantially includes an ion-exchange membrane **120**, a cathode **123**, an anode **124**, a first side **S1**, a second side **S2**, a hydrogen output tube **21** and an oxygen output tube **22**. The ion-exchange membrane **120** is configured between the first side **S1** and the second side **S2**. The cathode **123** is configured between the ion-exchange membrane **120** and the first side **S1**. The anode **124** is configured between the ion-exchange membrane **120** and the second side **S2**. The area where the first side **S1** and the cathode **123** are located is referred as a cathode chamber **1201**, and the area where the second side **S2** and the anode **124** are located is referred as an anode chamber **1202**. In order to express the corresponding positions of the cathode chamber **1201** and the anode chamber **1202** more clearly, the positions are indicated by broken lines in FIG. 2A. The hydrogen output tube **21** extends from the position between the ion-exchange membrane **120** and the first side **S1** to the second side **S2** and passes through the second side **S2**. The oxygen output tube **22** extends from the position between the ion-exchange membrane **120** and the second side **S2** to the second side **S2** and passes through the second side **S2**. When the ion-exchange membrane electrolyzer **12** electrolyzes water, the cathode **123** generates hydrogen gas and the anode **124** generates oxygen gas. The main feature of the present invention is that the hydrogen gas and oxygen gas generated by electrolyzing water are outputted together from the second side **S2** of the ion-exchange membrane electrolyzer **12** respectively via the hydrogen output tube **21** and the oxygen output tube **22**. In this embodiment, the hydrogen output tube **21** is outputted together with the oxygen output tube **22** from one side of the anode chamber **1202** of the ion-exchange membrane electrolyzer **12**.

However, the positions of the hydrogen output tube **21** and the oxygen output tube **22** of the present invention are not limited to the foregoing

embodiments. Please refer to FIG. 2B. The ion-exchange membrane electrolyzer **12** shown by FIG. 2B has the same components as shown by FIG. 2A. The difference is that the configured positions of the first side **S1** and the second side **S2** in FIG. 2B are opposite to those in FIG. 2A, so that in FIG. 2B, the anode **124** is configured between the ion-exchange membrane **120** and the first side **S1**, and the cathode **123** is configured between the ion-exchange membrane **120** and the second side **S2**. The cathode chamber **1201** includes the second side **S2** and cathode **123**. The anode chamber **1202** includes the first side **S1** and the anode **124**. The hydrogen output tube **21** extends from the position between the ion-exchange membrane **120** and the second side **S2** to the second side **S2** and passes through the second side **S2**. The oxygen output tube **22** extends from the position between the ion-exchange membrane **120** and the first side **S1** to the second side **S2** and passes through the second side **S2**. When the ion-exchange membrane electrolyzer **12** electrolyzes water, the cathode **123** generates hydrogen gas and the anode **124** generates oxygen gas. The main feature of the present invention is that the hydrogen gas and oxygen gas generated by electrolyzing water are outputted together to the second side **S2** of the ion-exchange membrane electrolyzer **12** respectively via the hydrogen output tube **21** and the oxygen output tube **22**. In this embodiment, the hydrogen output tube **21** is outputted together with the oxygen output tube **22** from one side of the cathode chamber **1201** of the ion-exchange membrane electrolyzer **12**. That is to say, the hydrogen output tube **21** and the oxygen output tube **22** in the present invention can be configured on either side of the ion-exchange membrane electrolyzer **12** according to the practical requirement of the user.

Please refer to FIG. 2C. FIG. 2C is a sectional schematic diagram illustrating the ion-exchange membrane electrolyzer **12** according to the embodiment of FIG. 2A. As shown in FIG. 2C, the ion-exchange membrane electrolyzer **12** includes an ion-exchange membrane **120**, a cathode chamber **1201** and an anode chamber **1202**. The cathode chamber **1201** includes a cathode **123**. The anode chamber **1202** includes an anode **124**. The ion-

exchange membrane **120** is configured between the anode chamber **1202** and the cathode chamber **1201**, wherein when the ion-exchange membrane electrolyzer **12** electrolyzes water, the cathode **123** generates hydrogen gas, and the anode **124** generates oxygen gas. In one embodiment, the anode chamber **1202** is filled with water, and the water in the anode chamber **1202** can further penetrate through the ion-exchange membrane into the cathode chamber **1201**. In addition, FIG. 2A to FIG. 2C are only the sectional schematic diagrams for explaining the internal structure of the ion-exchange membrane electrolyzer, but not the actual internal structure of the ion-exchange membrane electrolyzer. The blank block in FIG. 2C indicates the external case of the ion-exchange membrane electrolyzer.

As shown in FIG. 2C, the ion-exchange membrane **120** includes an ion-exchange membrane body **1203**, a cathode catalytic layer **127** and an anode catalytic layer **128**. The ion-exchange membrane body **1203** can be a proton exchange membrane, and preferably a Nafion membrane. The cathode catalytic layer **127** can be selected from one or a combination from a group consisting of Pt, Ir, Pd and Pt alloy powders. The anode catalytic layer **128** can be selected from one or a combination from a group consisting of Pt, Ir, Pd, Pt alloy powders and Carbon. In one embodiment, the materials of the cathode catalytic layer **127** or the anode catalytic layer **128** can be respectively configured as slurry coatings on both sides of the ion-exchange membrane to form the cathode catalytic layer **127** and the anode catalytic layer **128**. In practical applications, the hydrogen gas can be generated on the catalytic layer, but not limited thereto. The hydrogen gas also can be generated on the electrode plate, or even between the ion-exchange membrane and the electrode plate. Therefore, compared with the conventional alkali-type electrolyzer, the ion-exchange membrane electrolyzer **12** used in the present invention can avoid the problems of corrosion of the tank body, environmental pollution, incomplete filtration and inhalation of the electrolyte-containing gas.

Please refer to FIG. 2A to FIG. 2C. The cathode chamber **1201** includes a

cathode external plate **121**, a cathode **123**, a cathode sealing plate **125** and a cathode catalytic layer **127**. The anode chamber **1202** includes an anode external plate **122**, an anode **124**, an anode sealing plate **126** and an anode catalytic layer **128**. As shown in FIG. 2A, the first side **S1** and the second side **S2** respectively correspond to the cathode external plate **121** and the anode external plate **122** in FIG. 2C. On the other hand, as shown in FIG. 2B, the first side **S1** and the second side **S2** of FIG. 2B respectively corresponds to the anode external plate **122** and the cathode external plate **121** of FIG. 2C. The ion-exchange membrane electrolyzer **12** includes a hydrogen output tube **21**, an oxygen output tube **22** and a water supplying pipe **24**. The oxygen output tube **22** is used for outputting oxygen gas, and the cathode output tube **21** is used for outputting hydrogen gas which is generated from the cathode chamber **1201**. As shown in FIG. 2C, the hydrogen output tube **21** passes through the cathode sealing plate **125**, the anode sealing plate **126**, the anode **124** and the anode external plate **122** (the second side **S2** in FIG. 2A) for connecting the cathode chamber **1201** and the external environment outside the ion-exchange membrane electrolyzer **12** and outputting hydrogen gas. The oxygen output tube **22** is used for outputting oxygen gas which is generated from the anode chamber **1202**. The oxygen output tube **22** passes through the anode **124** and the anode external plate **122** for connecting the anode chamber **1202** and the external environment outside the ion-exchange membrane electrolyzer **12** and outputting oxygen gas. The water supplying pipe **24** passes through the anode **124** and the anode external plate **122**, and is connected to the water tank **10** for guiding water from the water tank **10** to the anode chamber **1202** to replenish the water of electrolyzing of the ion-exchange membrane electrolyzer **12**. The oxygen output tube **21** and the hydrogen output tube **22** are both configured on the same side of the ion-exchange membrane electrolyzer **12**. In this embodiment, all of the oxygen output tube **21**, the hydrogen output tube **22** and water supplying pipe **24** pass through and are configured on the anode external plate **122**. However, the present invention is not limited to the aforementioned feature. For example,

the oxygen output tube **21**, the hydrogen output tube **22** and the water supplying pipe **24** also can pass through and be configured on the cathode external plate **121** in the similar structure, as shown in the second side **S2** of FIG. 2B.

5 Please refer from FIG. 3 to FIG. 4. Fig. 3 is an exploded diagram illustrating the ion-exchange membrane electrolyzer **12** according to an embodiment of the present invention. FIG. 4 is an exploded diagram of the ion-exchange membrane electrolyzer **12** different from another perspective according to an embodiment of the present invention. The ion-exchange
10 membrane **120** further includes an ion-exchange membrane external plate **1204** for fixing the relative positions of the ion-exchange membrane body **1203**, the cathode catalytic layer **127** and the anode catalytic layer **128** in the ion-exchange membrane electrolyzer. FIG. 3 and FIG. 4 show the relationship of the positions of the components in the ion-exchange membrane electrolyzer
15 **12** more clearly. The ion-exchange membrane electrolyzer **12** includes various components which can be assembled in the stacking sequence as shown in FIG. 3 and FIG. 4.

 Please continue to refer to FIG. 3 to FIG. 4. In one embodiment, the ion-exchange membrane external plate **1204**, the cathode sealing plate **125** and the
20 anode sealing plate **126** can be arranged around the electrode plate to achieve insulation and airtightness, wherein the material of the ion-exchange membrane external plate **1204**, the cathode sealing plate **125** and the anode sealing plate **126** may be silicone. However, the configuration and material of the cathode sealing plate **125** and the anode sealing plate **126** are not limited
25 to the above embodiment. In practice, any configuration and material with insulation and airtightness effect can be adopted for the cathode sealing plate and the anode sealing plate.

 As shown in FIG. 3 and FIG. 4, the hydrogen output tube **21** passes through the cathode sealing plate **125**, the ion-exchange membrane external
30 plate **1204**, the anode sealing plate **126**, the anode **124** and the anode external

plate **122**, so that the hydrogen gas generated in the cathode chamber **1201** can be outputted from the side of the anode external plate **122** via the hydrogen output tube **21** and the ion-exchange membrane external plate **1204**. The oxygen output tube **22** passes through the anode **124** and the anode external plate **122**, so that the oxygen gas generated in the anode chamber **1202** can be outputted from the side of the anode external plate **122** via the oxygen output tube **22**. The water supplying pipe **24** passes through the anode **124** and the anode external plate **122**, and connects to the water tank **10** for guiding water from the water tank **10** into the anode chamber **1202** to replenish the water of electrolyzing of the ion-exchange membrane electrolyzer **12**. O-ring **25** are configured between the hydrogen output tube **21**, the oxygen output tube **22** and the water supplying pipe **24** with the anode external plate **122** to seal the space between the hydrogen output tube **21**, the oxygen output tube **22** and the water supplying pipe **24** with the anode external plate **122**.

As shown in FIG. 3 and FIG. 4, the cathode **123** includes a cathode conductive plate **123-1** and a cathode electrode plate **123-2**, and the anode **124** includes an anode conductive plate **124-1** and an anode electrode plate **124-2**. In one embodiment, each electrode plate can be, but not limited to, a titanium powder die-casting sheet, and the material of each conductive plate can be, but not limited to, titanium. As shown in FIG. 3, in one embodiment, the cathode electrode plate **123-2** can be configured between the ion-exchange membrane **120** or ion-exchange membrane body **1203** and the cathode conductive plate **123-1**. The anode electrode plate **124-2** can be configured between the ion-exchange membrane **120** or ion-exchange membrane body **1203** and the anode conductive plate **124-1**. The ion-exchange membrane electrolyzer **12** can be connected to an outer power via the cathode conductive plate **123-1** and the anode conductive plate **124-1**. In one embodiment, the anode conductive plate **124-1** (as shown in FIG. 3) and the cathode conductive plate **123-1** (as shown in FIG. 4) have flow channels respectively. When the cathode conductive plate **123-1** and the cathode electrode plate **123-2** are stacked on each other, a plurality of cathode chambers **123-3** may be formed

in the cathode chamber **1201**. When the anode conductive plate **124-1** and the anode electrode plate **124-2** are stacked on each other, a plurality of anode chambers **124-3** may be formed in the anode chamber **1202**. The cathode chamber **123-3** and the anode chamber **124-3** can be used to circulate gas and water therein, wherein the anode chamber **124-3** is connected to the oxygen output tube **22**, and the cathode chamber **123-3** is connected to the hydrogen output tube **21**.

Please refer to FIG. 5A and FIG. 5B. FIG. 5A and FIG. 5B are assembly diagrams illustrating the ion-exchange membrane electrolyzer **12** in Fig. 3 from different perspectives. The cathode external plate **121** and the anode external plate **122** are configured respectively on both outer sides of the ion-exchange membrane electrolyzer **12** to fix and isolate the entire ion-exchange membrane electrolyzer **12**, wherein the materials of the cathode external plate **121** and the anode external plate **122** may be stainless steel. In one embodiment, after the ion-exchange membrane electrolyzer **12** is assembled, it may be locked with a locking component (as shown in FIG. 6), but the number, type and locking way of the locking components are not limited to those shown in the figure (FIG. 6). As shown in the figure, the volume of the ion-exchange membrane electrolyzer **12** is relatively small. Therefore, the water electrolysis device is also compact in the present invention.

Please refer to FIG. 1A, FIG. 6, and FIG. 7A to FIG. 7B. FIG. 6 is an exploded diagram illustrating the water electrolysis device according to an embodiment of the present invention. FIG. 7A and FIG. 7B are the exploded diagrams and assembly diagrams illustrating the water electrolysis device in FIG. 6 from another perspective. For illustration, only necessary elements are shown in FIG. 6, FIG. 7A and FIG. 7B. The water electrolysis device **1** of the present invention also includes an air supplying tube **11**, an air pump **13**, a fan **15**, an atomizing/volatile gas mixing tank **16**, a hydrogen concentration detector **18**, a controller **14**, a gas-water separation tank **30** and a water level detecting device **40** in addition to the aforementioned water tank **10** and ion-exchange membrane electrolyzer **12**. As shown in FIG. 6, the gas-water

separation tank **30** is contained in the isolated space of the water tank **10**, and its detailed structure will be described later. The water level detecting device **40** is configured for detecting the amount of water in the water tank **10**. In one embodiment, the water level detecting device **40** is a capacitive water level detecting device and is configured on the outer surface of the water tank **10**. The amount of water in the water tank **10** is measured by measuring the difference of capacitance between the water and the water-free area in the water tank **10**.

Please refer to FIG. 6, FIG. 8A and FIG. 8B. FIG. 8A is a top view diagram illustrating the water electrolysis device according to embodiment of the present invention. FIG. 8B is a sectional view diagram illustrating the water electrolysis device along to the line D-D of FIG. 8A. The hydrogen output tube **21** of the ion-exchange membrane electrolyzer **12** is connected and communicated with the gas-water separation tank **30** via a hydrogen interface **211**. The oxygen output tube **22** is connected and communicated with the water tank **10** via the oxygen interface **222**. The water tank **10** includes a sterilizer **50**. In this embodiment, the sterilizer **50** is a long-tube ultraviolet sterilizer which is configured in the water tank **10** away from the side where the gas-water separation tank **30** is located. The water supply pipe **24** directly communicates with the side of the water tank **10** near the sterilizer **50** via the water interface **242** to receive the sterilized water from the water tank **10** to replenish the water of electrolyzing of the ion-exchange membrane electrolyzer **12**.

The gas-water separation tank **30** includes a spring valve **32**, a bobber **34** and a hydrogen discharge tube **36**. The hydrogen gas generated by the electrolysis of the ion-exchange membrane electrolyzer **12** is guided to the gas-water separation tank **30** via the hydrogen output tube **21** and the hydrogen interface **211**. When the hydrogen gas in the gas-water separation tank **30** accumulates to a certain extent, the spring valve **32** will be opened due to the hydrogen gas pressure and allow hydrogen to be discharged to the filter **60** via the hydrogen discharge tube **36** to filter impurities in the hydrogen gas. Furthermore, when the hydrogen gas is outputted from the ion-exchange membrane electrolyzer **12**, a small amount of residual electrolyzed water may

be contained in the hydrogen gas, and the residual electrolyzed water may accumulate in the gas-water separation tank **30** to form liquid water, so as to cause bobber **34** to float due to the accumulated liquid water. At this time, a drain port (not shown) covered by the bobber **34** will be opened, and the
5 accumulated liquid water will be discharged into the water tank **10** through the drain port for recycling.

The oxygen gas generated by the electrolysis is directly discharged to the water tank **10** via the oxygen output tube **22** and the oxygen interface **222**. The oxygen gas will be discharged to the atmospheric environment from the
10 upper portion of the water tank **10**. When the oxygen gas is outputted from the ion-exchange membrane electrolyzer **12**, a small amount of residual electrolyzed water may be contained in the oxygen gas, and the residual electrolyzed water will be directly discharged into the water tank **10** for recycling.

15 Please refer to FIG. 7A, FIG. 7B, FIG. 8A and FIG. 9 together. FIG. 9 is a sectional view diagram illustrating the water electrolysis device along the line D-D of the FIG. 8A. As mentioned in the previous paragraph, the hydrogen gas is discharged to the filter **60** via the hydrogen discharge tube **36**, and then a filter core **602** of the filter **60** filters the impurities in the hydrogen gas. The
20 filtered hydrogen gas is further guided into the air supplying tube **11** for dilution and then guided into the atomizing/volatile gas mixing tank **16**. The air supplying tube **11** is connected to the filter **60** to receive the filtered hydrogen gas, and the air supplying tube **11** is connected to the air pump **13**. The fan **15** draws air from the external environment into the water electrolysis device **1** to dilute
25 the hydrogen gas in the air supplying tube **11**. The case **100** is set with a plurality of small holes. The fan **15** draws air from the external environment into the water electrolysis device **1** through the small holes on the case **100**. The drawn air is guided into the air supplying tube **11** by the air pump **13**. In this embodiment, the air pump **13** is a vortex fan, and the air drawn by the fan
30 **15** is drawn into the air pump **13** through a drawing port **134** of the air pump **13**, so as to guide air into the air supplying tube **11**. As shown in FIG. 7B and

FIG. 9, a duct **132** of the air pump **13** is connected with an air supplying interface **112** of the air supplying tube **11**. The air supplying tube **11** has a first flow direction **D1**, and the air supplying interface **112** has a second flow direction **D2**. The first flow direction **D1** points to the atomizing/volatile gas mixing tank **16**, as indicated by the arrow on the indication line representing the first flow direction **D1**, and the arrow on the indication line also points to the position above the water electrolysis device. The second flow direction **D2** points to the air supply tube **11**, as indicated by an arrow on the indication line representing the second flow direction **D2**, so that the air from the duct **132** through the air supplying interface **112** is guided into the air supplying tube **11**. A lead angle **A** is formed between the first flow direction **D1** and the second flow direction **D2**. The lead angle **A** is an acute angle of less than 90 degrees, and preferably, between 25 to 45 degrees. At the connecting position of the air supplying tube **11** and the air supplying interface **112** where the lead angle **A** is located, the shape of the connecting position can be made as an arc lead angle. The air in the duct **132** and the air supplying interface **112** may be guided into the air supplying tube **11** by the design of the lead angle **A** to dilute the hydrogen gas in the atomizing/volatile gas mixing tank **16**.

Please continue to refer to FIG. 9. The atomizing/volatile gas mixing tank **16** is connected with the air supplying tube **11**, and receives the filtered and diluted hydrogen gas to generate an atomizing gas and mix it with the hydrogen gas to form a health gas, wherein the atomizing gas is one or a combination selected from a group consisting of water vapor, atomizing potions and volatile essential oil. The atomizing/volatile gas mixing tank **16** includes an oscillator **162**. The oscillator **162** atomizes water, atomizing potions or volatile essential oil added to the atomizing/volatile gas mixing tank **16** by oscillation to generate the atomizing gas, and then mixes the hydrogen gas with the atomizing gas to form a health gas. The atomizing/volatile gas mixing tank **16** can be selectively opened or closed according to user's requirements. That is to say, the atomizing/volatile gas mixing tank **16** can be activated by actuating the oscillator to provide the

hydrogen gas mixing with the atomizing gas for the user, or the atomizing/volatile gas mixing tank **16** can be closed by stopping the oscillator to provide the filtered and diluted hydrogen without mixing with the atomizing gas for the user. The means for user to inhale the filtered and diluted hydrogen or the health gas includes that the atomizing/volatile gas mixing tank **16** directly releases the hydrogen or health gas into the atmosphere, or provides for the user inhaling via a conduit and a mask.

The hydrogen concentration detector **18** is connected with the atomizing/volatile gas mixing tank **16** to detect the hydrogen concentration in the atomizing/volatile gas mixing tank **16**. The controller **14** is connected to the hydrogen concentration detector **18**, the air pump **13** and the ion-exchange membrane electrolyzer **12**. In one embodiment, the hydrogen concentration detector **18** can be connected to the hydrogen output tube **21** or the hydrogen interface **211** to detect the volume concentration of the hydrogen gas which is outputted from the ion-exchange membrane electrolyzer **12** to the atomizing/volatile gas mixing tank **16**. The hydrogen concentration detector **18** detects whether the hydrogen volume concentration is within a range from a first predetermined value to a second predetermined value. For example, the first predetermined value is 4%, the second predetermined value is 6%, and the hydrogen concentration detected by the hydrogen concentration detector **18** ranges from 4% to 6%. The first predetermined value and the second predetermined value can be adjusted through the operation panel **102** according to the requirement of the user. In this embodiment, when the hydrogen concentration detector **18** detects that the volume of hydrogen gas in the hydrogen output tube **21** or the hydrogen interface **211** is higher than the first predetermined value by 4%, a first warning signal is generated to the controller **14**. When the controller **14** receives the first warning signal, a start command is generated to the air pump **13** to start up the air pump **13** to draw air into the air supplying tube **11** to dilute the hydrogen gas in the air supplying tube **11**. When the hydrogen concentration detector **18** detects that the volume of hydrogen gas in the hydrogen output tube **21** or the hydrogen

interface **211** is higher than the second predetermined value by 6%, a second warning signal is generated to the controller **14**. When the controller **14** receives the second warning signal, a stop command is generated to stop the ion-exchange membrane electrolyzer **12** by the means such as cutting off the power input to the ion-exchange membrane electrolyzer **12**, and then the gas explosion due to the excessive hydrogen concentration can be avoided, thereby improving the overall safety.

Please refer to FIG. 10. FIG. 10 is a sectional view diagram illustrating the water electrolysis device 1 according to another embodiment of the present invention. In another embodiment of present invention, a preheating water tank **17** is further connected between the water tank **10** and the ion-exchange membrane electrolyzer **12**. The preheating water tank **17** is substantially cylindrical or circular. Although the preheating water tank **17** is larger than the water tank **10** in FIG. 10, in other embodiments, the volume of the preheating water tank **17** can be smaller than that of the water tank **10**. The preheating water tank **17** includes a preheating water tank water filling port **172** which is connected to the lower port **10-2** of the water tank **10**, an electrolyzed water inlet **174** which is connected to the water supplying pipe **24** of the ion-exchange membrane electrolyzer **12**, an oxygen receiving tube **176** which is connected to the oxygen output tube **22** and an oxygen discharge tube **178** which is connected to the upper port **10-1** of the water tank **10**. The preheating water tank **17** is configured between the water tank **10** and the ion-exchange membrane electrolyzer **12**. The electrolyzed water in the water tank **10** flows into the preheating water tank **17** via the lower port **10-2** first, and then flows into the ion-exchange membrane electrolyzer **12** through the electrolyzed water inlet **174** for electrolysis. The oxygen gas generated during the process of electrolyzing water and a portion of the residual electrolyzed water are discharged into the preheating water tank **17** via the oxygen receiving tube **176**, wherein the part of the residual electrolyzed water will remain in the preheating water tank **17**. The oxygen gas generated by the electrolysis will be discharged to the water tank **10**

through the upper port **10-1** via the oxygen discharge tube **178**, and then discharged to the outside of the water electrolysis device.

Due to the process of electrolyzing water, the temperature of the ion-exchange membrane electrolyzer**12** will increase, and the temperature of the electrolyzed water is also related to the electrolysis efficiency. The temperature of electrolyzed water about 55 to 65 ° C can improve the electrolysis efficiency. Thus, the preheating water tank **17** of the present invention recovers the higher temperature residual electrolyzed water discharged from the oxygen output tube **22** of the ion-exchange membrane electrolyzer**12** to preheat the electrolyzed water entering the ion-exchange membrane electrolyzer**12** in the preheating water tank **17** to an appropriate temperature, for example, between 55 and 65 °C. In order to control the temperature of the electrolyzed water in the preheating water tank **17** to be maintained between 55 and 65 ° C, the preheating water tank **17** further includes a plurality of cooling fins **171** and a second fan **173**. The plurality of cooling fins **171** are configured on the outer wall of the preheating water tank **17** in a radial pattern. The second fan **173** is configured at one end of the preheating water tank **17** and is matched with the plurality of cooling fins **171** to dissipate the preheating water tank **17** by forced convection. For the sake of simplicity, the cooling fins **171** are drawn only on a part of the outer wall of the preheating water tank **17**. In other embodiments, the cooling fins **171** can be distributed on the whole outer wall of the preheating water tank **17**.

One of the purposes of the present invention is to reduce the volume of the water electrolysis device and the noise while maintaining sufficient hydrogen production, so that the user can use it during sleeping. Therefore, the applicant firstly reduced the volume of the water electrolysis device as the main purpose. In one embodiment, the water electrolysis device of the present case is roughly cylindrical. The longest section length at the bottom, that is, the diameter, is at least 200 mm, and the height of the device is up to 270 mm, so the volume is at most about 8,500 cubic centimeters, or 8.5 liters. However, the shape of the water electrolysis device of the present invention is not

limited to the cylindrical type, and the shape of the water electrolysis device can be other shapes. For example, the water electrolysis device can be elliptical, square or polygonal, as long as the bottom or the longest sectional side of the base **112** is longer than the longest sectional side of the top to conform to the design of tapering from the bottom to the top. The effective use of the containing space defined by the case of the water electrolysis device is utilized as much as possible to maintain sufficient hydrogen production for the user. For example, the water electrolysis device has a total of six output settings for the hydrogen generating rates, including the hydrogen generating rate for the water electrolysis device outputting the health gas which mixes the air, the hydrogen gas and the atomizing gas: 120 ml/min, 240 ml/min, 360 ml/min, respectively corresponding to three corresponding settings of the health gas outputting rate of the water electrolysis device: 2 L/min, 4 L/min and 6 L/min; and including the hydrogen generating rates for the water electrolysis device outputting the pure hydrogen gas: 400 ml/min, 500 ml/min, 600 ml/min. The user is allowed to adjust the hydrogen generation rate of the water electrolysis device **1** and the type of gas outputted through the operation panel. This device also reduces the noise, so that the user can place the present invention close to the user's head while sleeping.

Please refer to FIG. 1A. In one embodiment, the present invention provides a water electrolysis device **1** including a power supplying unit **70** for converting supply mains to output 240 watts of direct current to supply power of the water electrolysis device **1**. The power supplying unit **70** includes a high power output **701** and a low power output. The high power output **701** is connected to the ion-exchange membrane electrolyzer **12** to supply the electric power required for the electrolysis reaction. The low power output is suitable for supplying electrical power to other non-electrolysis components in the water electrolysis device **1**, such as the air pump **13**, the controller **14**, the fan **15**, and the hydrogen concentration detector **18**. In order to simplify the content of the drawing, only the power supplying unit **70** and the high

power output **701** are depicted in FIG.1A. One of ordinary skills in the art should be able to know the configuration of the low power output in the water electrolysis device to supply the power required for the operation of the water electrolysis device.

5 In the 240 watts of direct current supplied by the power supplying unit **70**, 172 watts are outputted from the high power output **701** to the ion-exchange membrane electrolyzer **12**. The high power output **701** outputs a first voltage and a first current, wherein the range of the first voltage is between 3 volts and 6.3 volts and the output of the first current is in a range
10 from 10 amps to 27.3 amps. The low power output outputs 60 watts of direct current to supply the power required to operate the water electrolysis device. The low power output outputs a second voltage and a second current, wherein the second voltage is a DC voltage of 24 volts, and a second current is up to 2.5 amps. In another one embodiment, the second voltage can also be reduced
15 down from 24 volts to 5 volts and output a second current up to 0.5 amps. Comparing the power parameters outputted by the high power output with the low power output, the first voltage is lower than the second voltage, but the first current is higher than the second current. Therefore, the high power output outputs high-current low-voltage DC power, and the low power output
20 outputs low-current high-voltage DC power.

With the examples and explanations mentioned above, the present invention provides a water electrolysis device including an ion-exchange membrane electrolyzer with the hydrogen gas and the oxygen gas outputted from the same side, an air supplying tube, an air pump, and an
25 atomizing/volatile gas mixing tank. The ion-exchange membrane electrolyzer electrolyzes water to generate hydrogen gas. After the hydrogen gas is inputted to the air supplying tube, the air pump draws in air, and the air is unidirectionally inputted into the air supplying tube through a air supplying interface having a lead angle with the air supplying tube to dilute the
30 hydrogen gas in the air supplying tube, and the air supplying tube then introduces the diluted hydrogen into the atomizing/volatile gas mixing tank

and mixes with an atomizing gas for the user.

Through the ion-exchange membrane electrolyzer with the hydrogen gas and the oxygen gas outputted from the same side, and the water tank, the gas-water separation tank, and the air supplying tube configured in a case within a defined volume, the water electrolysis device of the present invention employs the containing space in the case as much as possible while maintaining sufficient hydrogen production, and the fan and the air pump of water electrolysis device are also based on low noise. Therefore, this present invention actually provides a water electrolysis device with effective space arrangement, small volume and low noise, and suitable for placing around the user.

The features and spirits of the present invention are hopefully described more clearly by the above detailed description of the preferred embodiments, and the scope of the present invention is not limited by the preferred embodiments disclosed above. On the contrary, the purpose is to cover a variety of changes and equivalence arrangements within the scope of the patent application to be applied for by the creative institute. Although the present invention has been disclosed in the above embodiments, it is not intended to limit the present invention, and anyone skilled in the art can make various changes and refinements without departing from the spirit and scope of the present invention. Therefore, the scope of protection of this present invention is subject to the definition of the scope of the patent application attached.

What is claimed is:

1. A water electrolysis device, comprising:

a case comprising a base, a side wall and a containing space;

5 a power supplying unit configured in the containing space of the case;

an ion-exchange membrane electrolyzer electrically coupled to the power supplying unit, the ion-exchange membrane electrolyzer comprising an ion-exchange membrane, a cathode, and an anode, the ion-exchange membrane being configured between the anode and the cathode;
10 wherein when the ion-exchange membrane electrolyzer electrolyzes water, the cathode generates hydrogen gas to be outputted and the anode generates oxygen gas to be outputted;

an atomizing/volatile gas mixing tank coupled to the power supplying unit, the atomizing/volatile gas mixing tank selectively
15 generating an atomizing gas and mixing it with the hydrogen gas to form a health gas, wherein the atomizing gas is water vapor, atomizing potions or volatile essential oil; and

an integrated pathway module coupled to the ion-exchange membrane electrolyzer to receive the hydrogen gas and the oxygen gas,
20 and coupled to the and the atomizing/volatile gas mixing tank to deliver the hydrogen gas to the atomizing/volatile gas mixing tank.

2. The water electrolysis device of claim 1, wherein the power supplying unit further comprises a high power output and a low power output, the ion-exchange membrane electrolyzer is electrically coupled to the high
25 power output and the atomizing/volatile gas mixing tank is electrically coupled to the low power output.

3. The water electrolysis device of claim 1, wherein the ion-exchange membrane electrolyzer further comprises a first side, a second side, a

- hydrogen output tube, and an oxygen output tube; the anode is configured between the ion-exchange membrane and the second side; the cathode is configured between the ion-exchange membrane and the first side; the oxygen output tube extends from the position between the ion-exchange membrane and the second side to the second side and passes through the second side to output the oxygen gas; and the hydrogen output tube extends from the position between the ion-exchange membrane and the first side to the second side and passes through the second side to output the hydrogen gas.
- 10 4. The water electrolysis device of claim 1, wherein the ion-exchange membrane electrolyzer further comprises a first side, a second side, a hydrogen output tube, and an oxygen output tube; the anode is configured between the ion-exchange membrane and the first side; the cathode is configured between the ion-exchange membrane and the second side; the hydrogen output tube extends from the position between the ion exchange membrane and the second side to the second side and passes through the second side; and the oxygen output tube extends from the position between the ion exchange membrane and the first side to the second side and passes through the second side.
- 15 5. The water electrolysis device of claim 2, wherein the high power output outputs a first voltage and a first current; the low power output outputs a second voltage and a second current; the first voltage is less than the second voltage; and the first current is greater than the second current.
- 20 6. The water electrolysis device of claim 1, wherein the first side faces the side wall, the hydrogen output tube and the oxygen output tube are positioned on the second side of the ion-exchange membrane electrolyzer.
- 25 7. The water electrolysis device of claim 2, wherein the electric power outputted by the low power output is equal to or less than half of that outputted by the high power output.

8. The water electrolysis device of claim 1, wherein the ion-exchange membrane electrolyzer further comprises a hydrogen output tube for outputting the hydrogen gas, an oxygen output tube for outputting the oxygen gas, and a water supplying pipe for receiving a supplemental water,
5 the hydrogen output tube, the oxygen output tube and the water supplying pipe extend outward from the same side of the ion-exchange membrane electrolyzer.
9. The water electrolysis device of claim 8, wherein the integrated pathway module comprises a hydrogen interface, an oxygen interface, and a water
10 interface, the hydrogen interface, an oxygen interface, and a water interface are configured on the same side of the integrated pathway module and respectively corresponding to the hydrogen output tube, the oxygen output tube and the water supplying pipe of the ion-exchange membrane electrolyzer.
- 15 10. The water electrolysis device of claim 1, wherein the integrated pathway module further comprises a water tank and a gas-water separation tank isolated from the water tank, the gas-water separation tank is configured to receive the hydrogen gas from the ion-exchange membrane electrolyzer, the water tank is configured to receive the oxygen gas from the ion-
20 exchange membrane electrolyzer and to provide a supplemental water to the ion-exchange membrane electrolyzer.
- 25 11. The water electrolysis device of claim 1, further comprising a pump fluidly coupled to the integrated pathway module, the pump is configured to supply air into the integrated pathway module to dilute the hydrogen gas in the integrated pathway module.

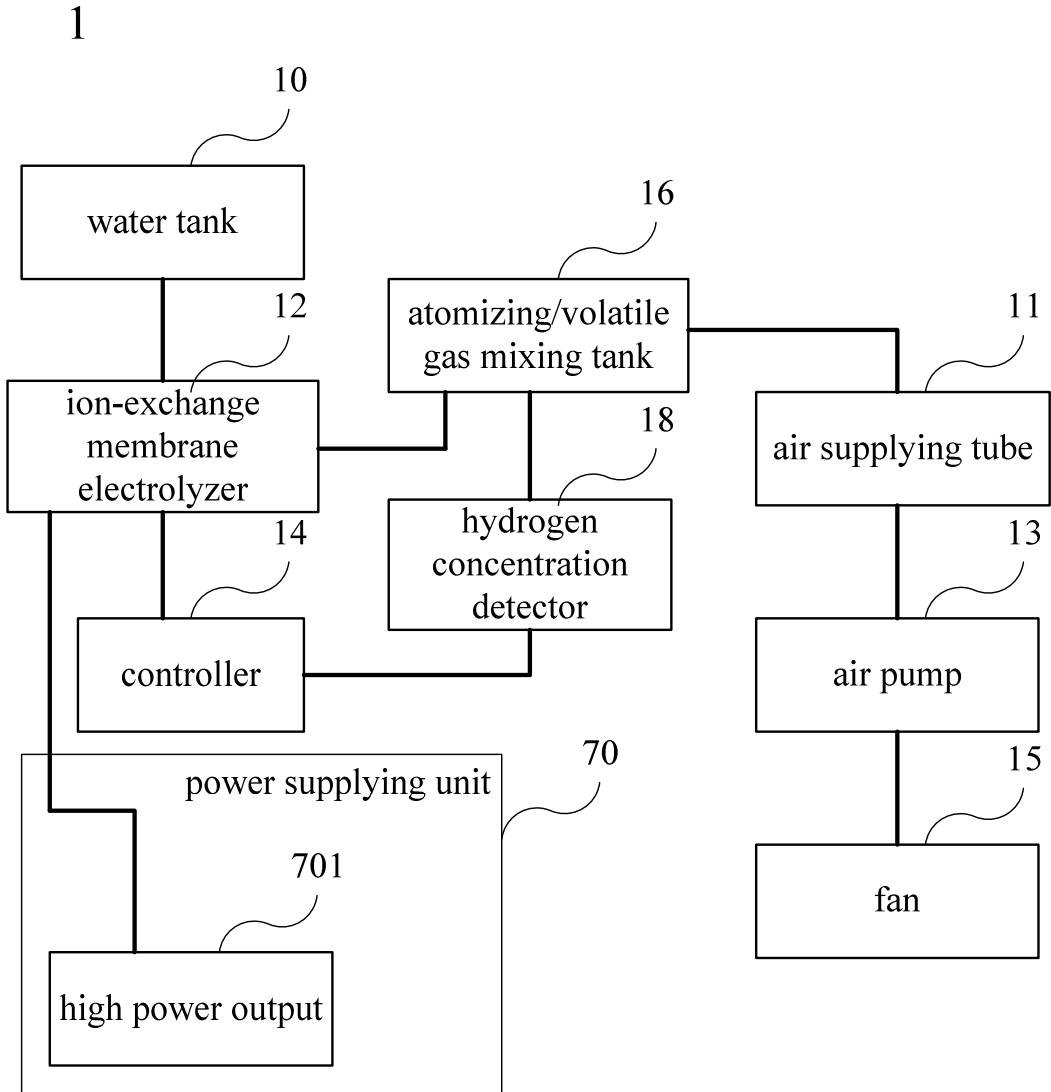


FIG. 1A

1

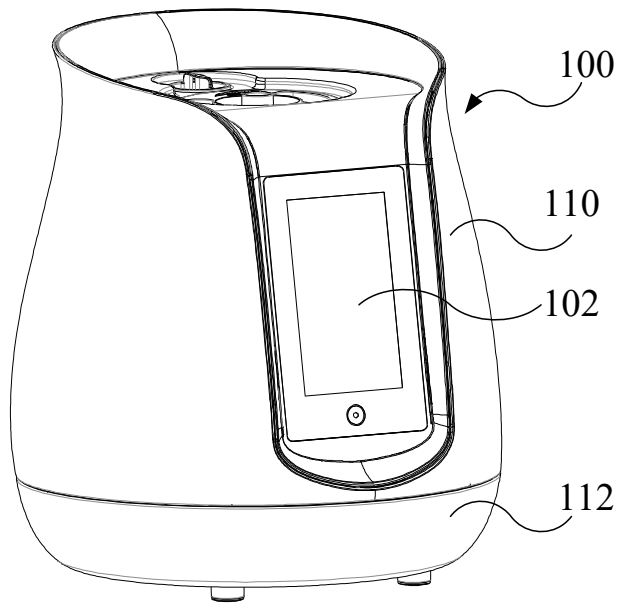


FIG. 1B

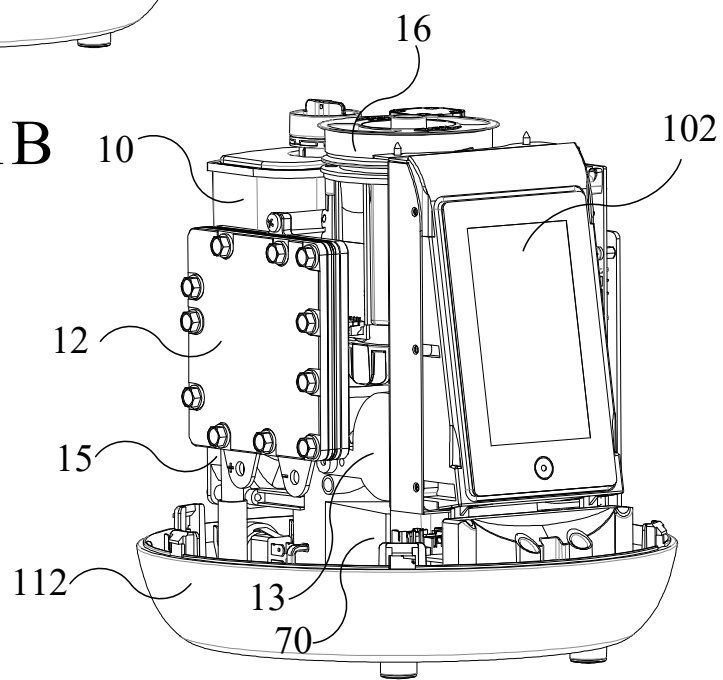


FIG. 1C

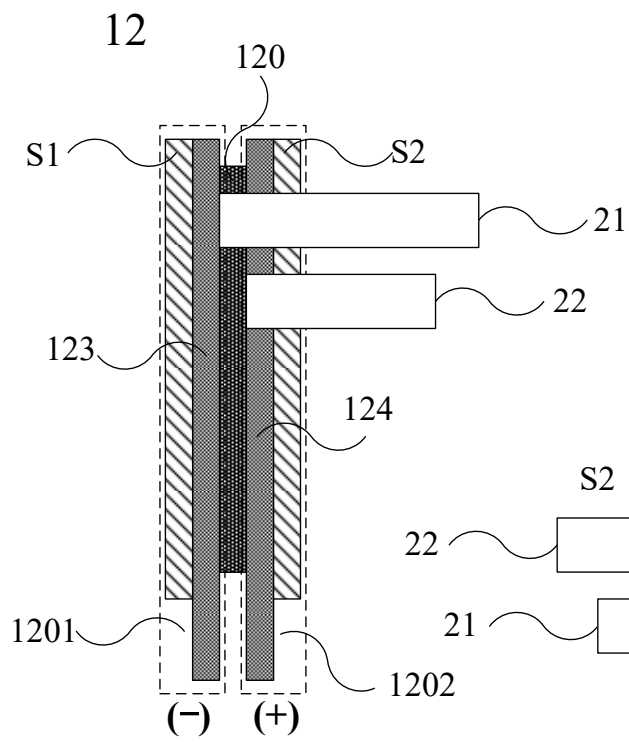


FIG. 2A

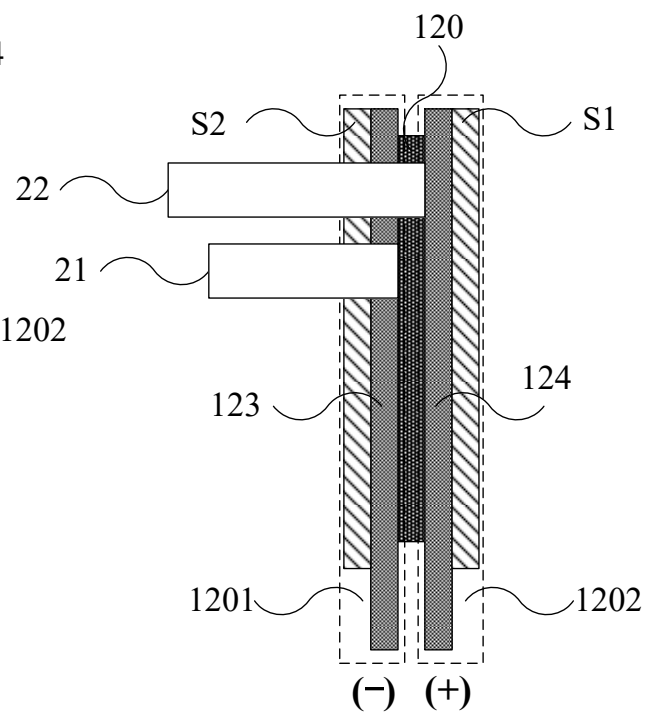


FIG. 2B

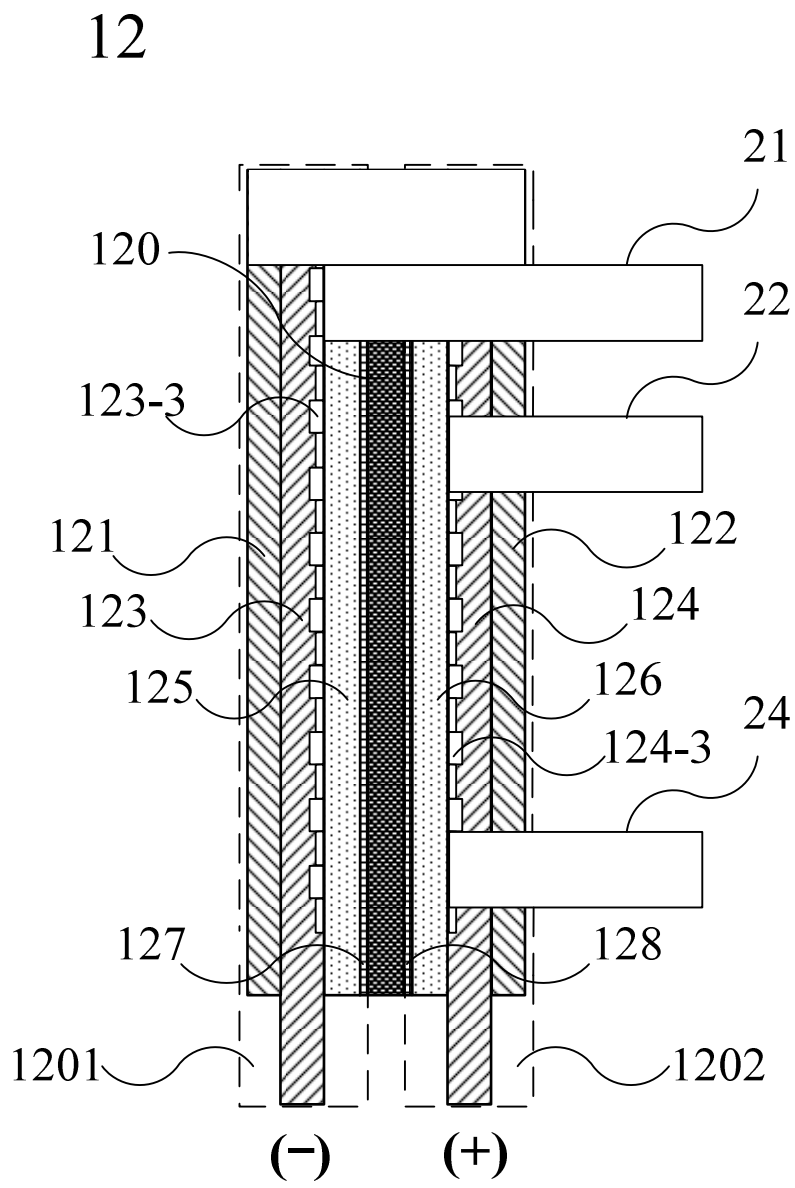


FIG. 2C

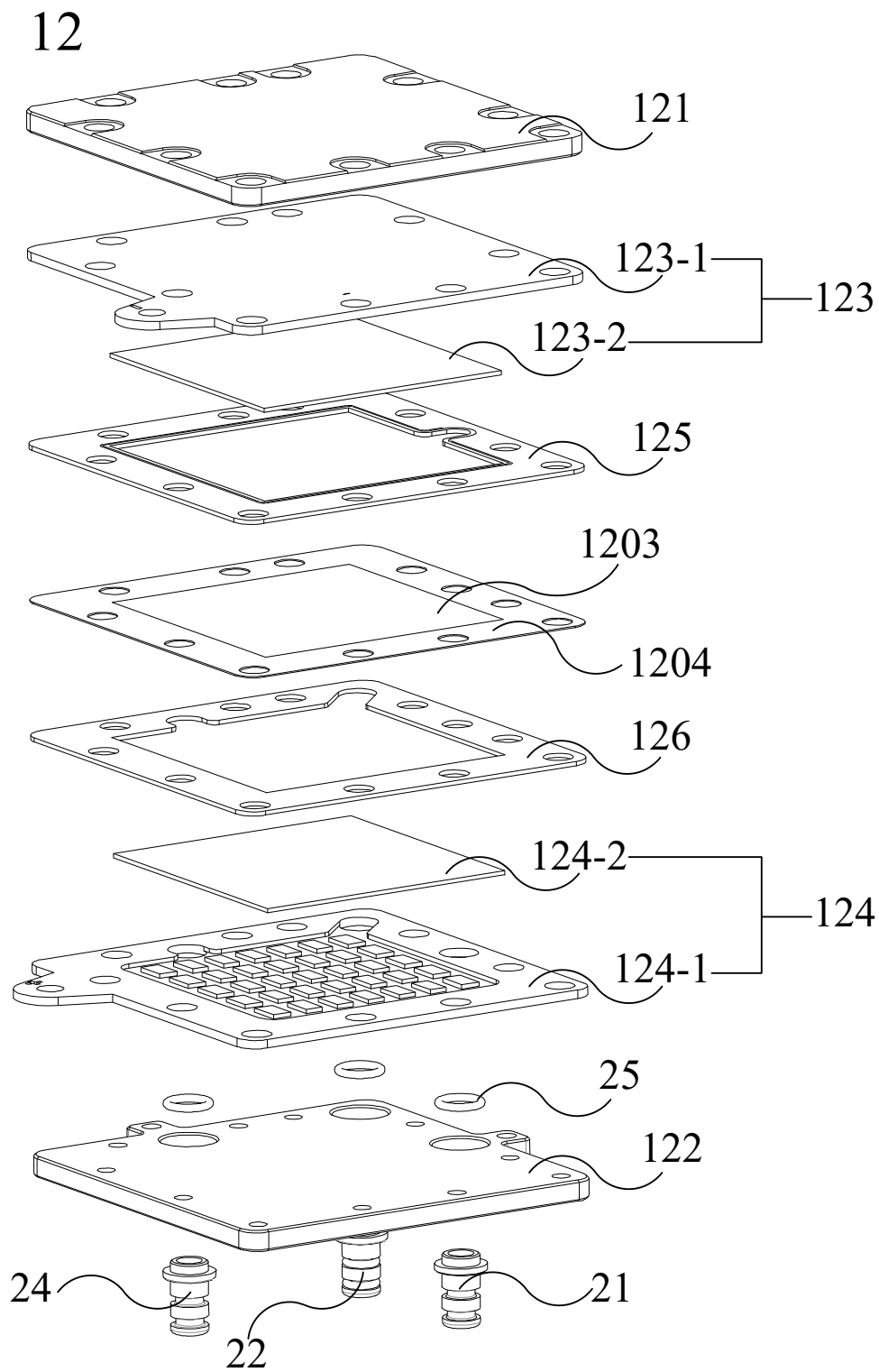


FIG. 3

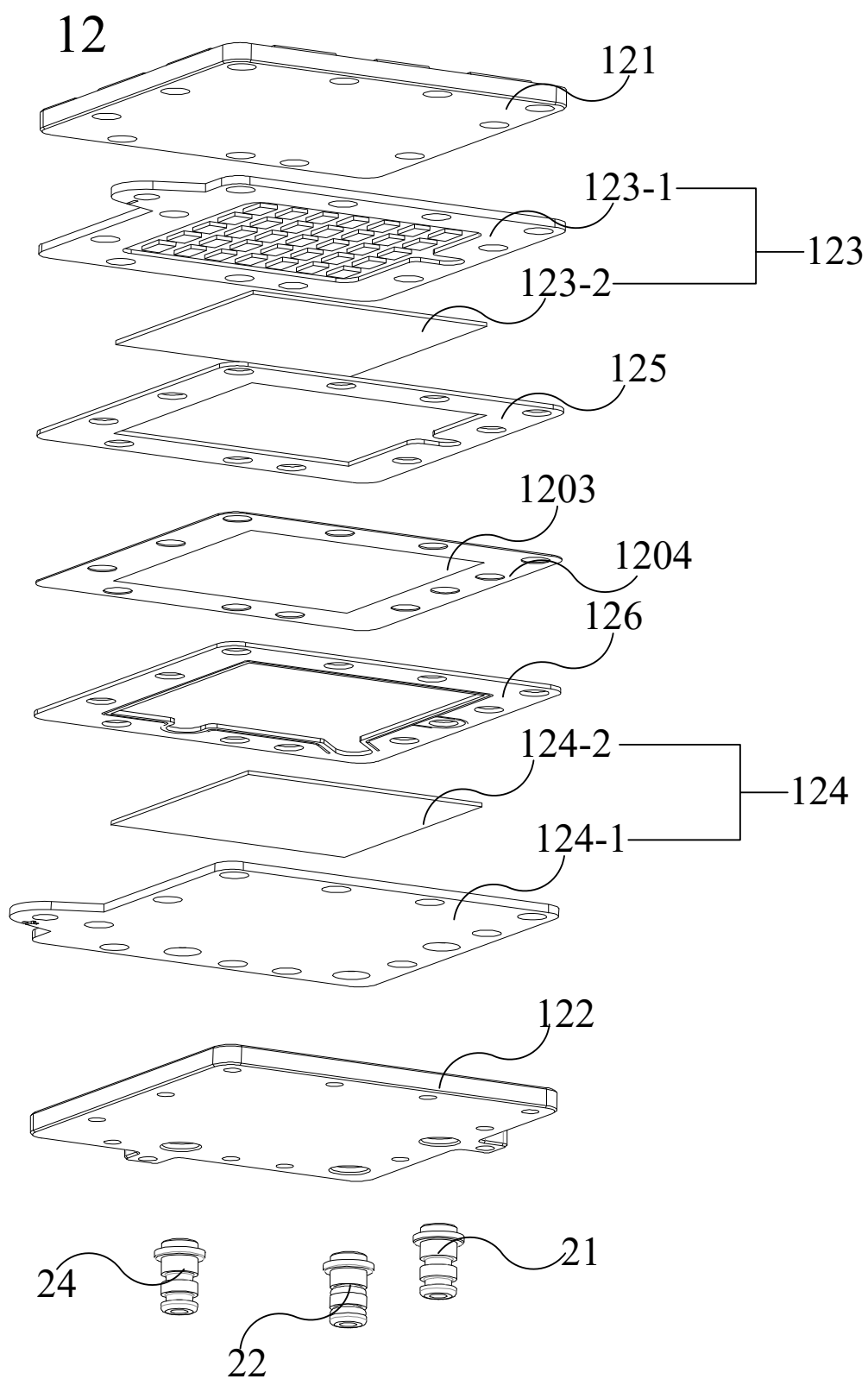


FIG. 4

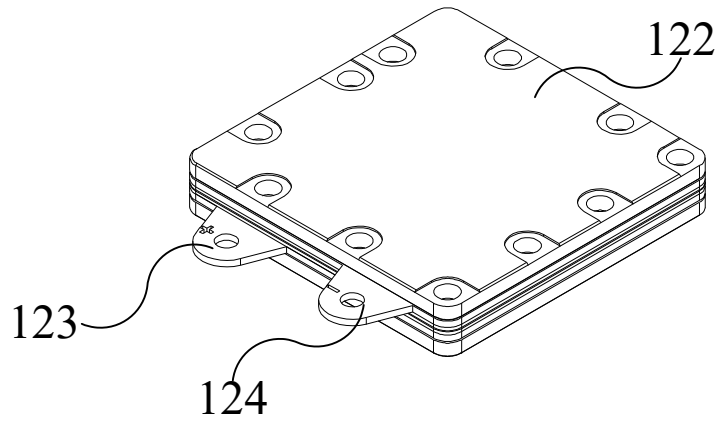


FIG. 5A

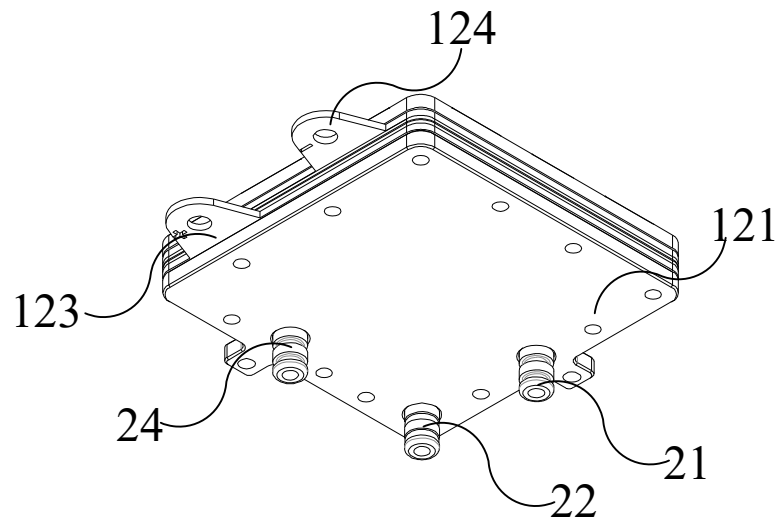


FIG. 5B

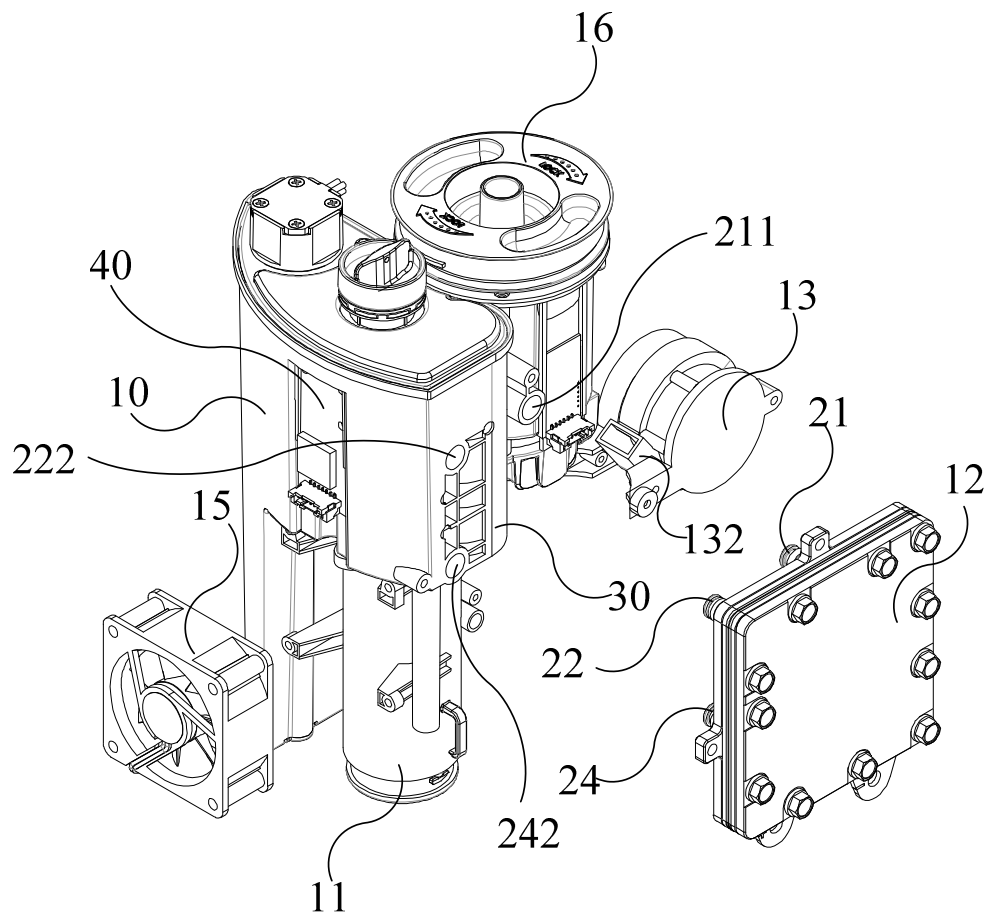


FIG. 6

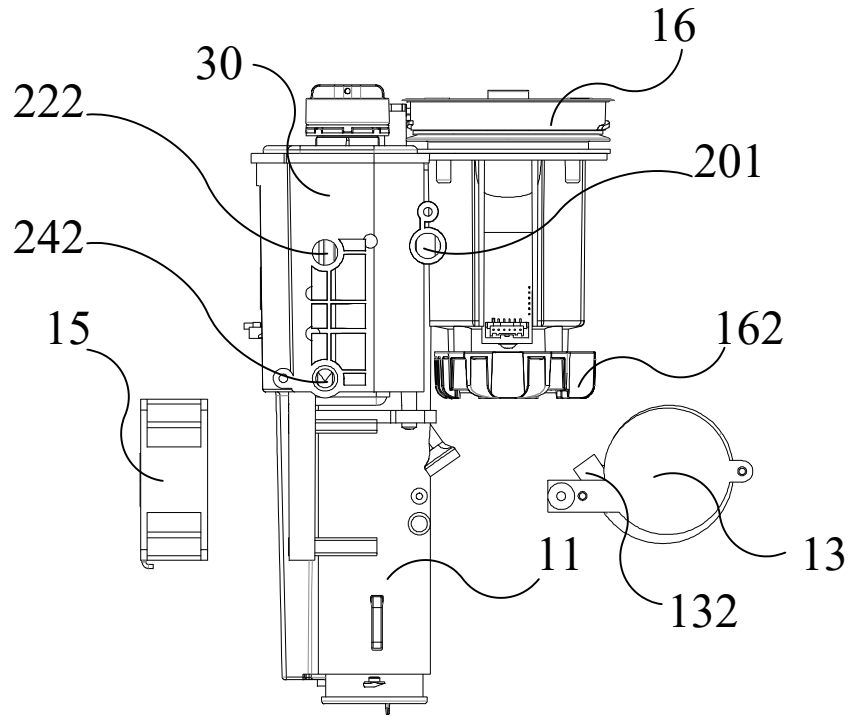


FIG. 7A

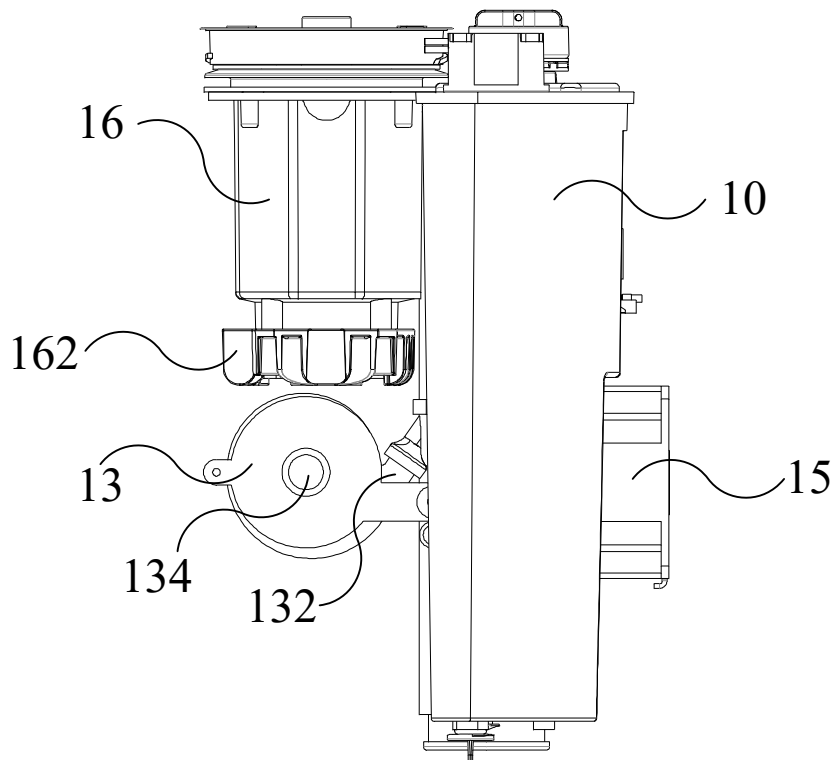


FIG. 7B

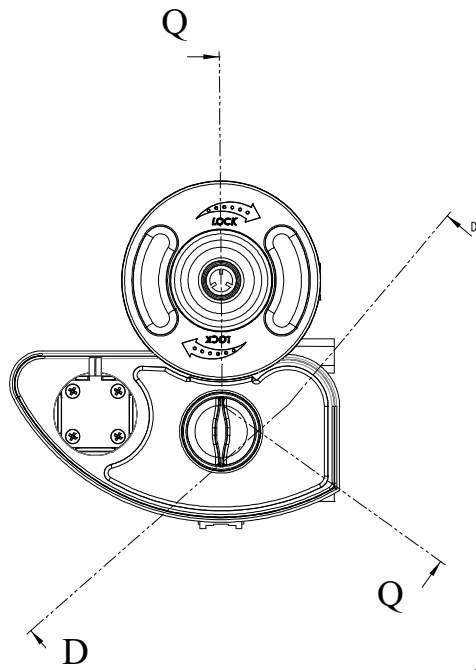


FIG. 8A

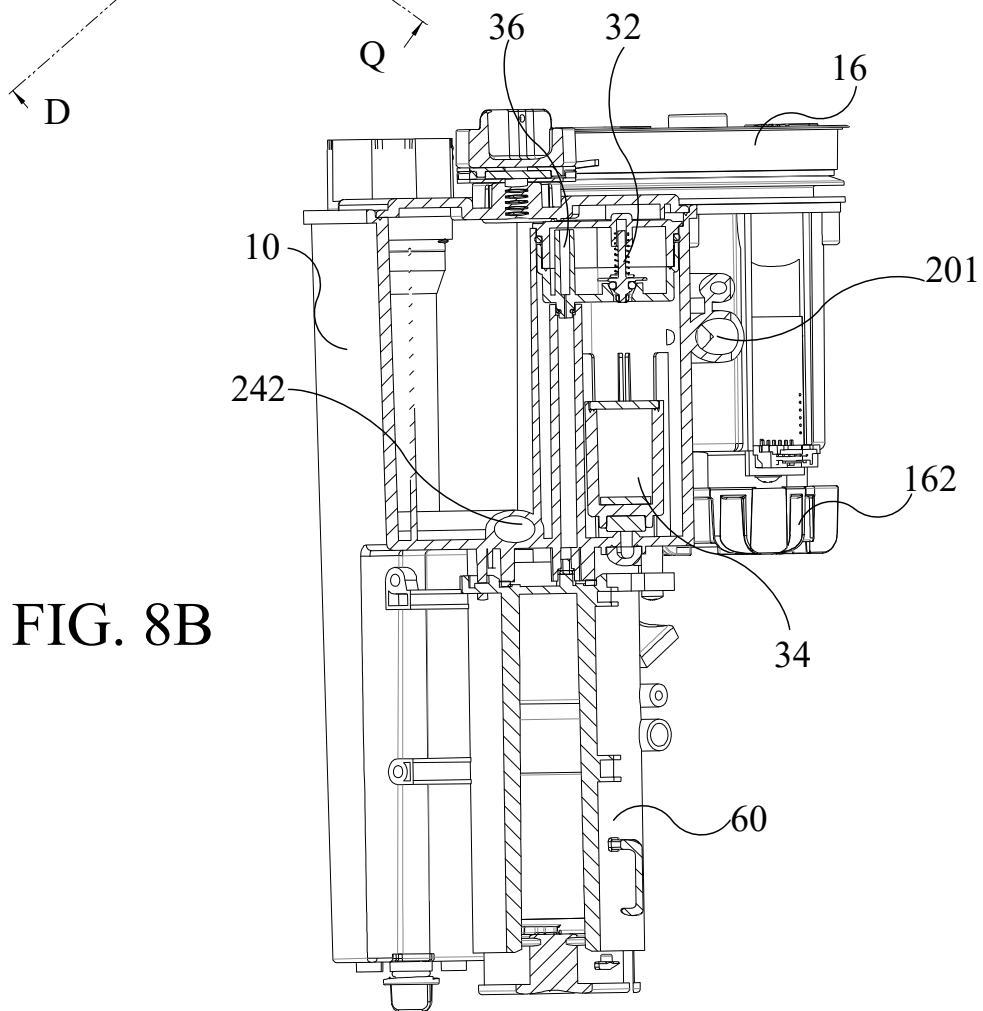


FIG. 8B

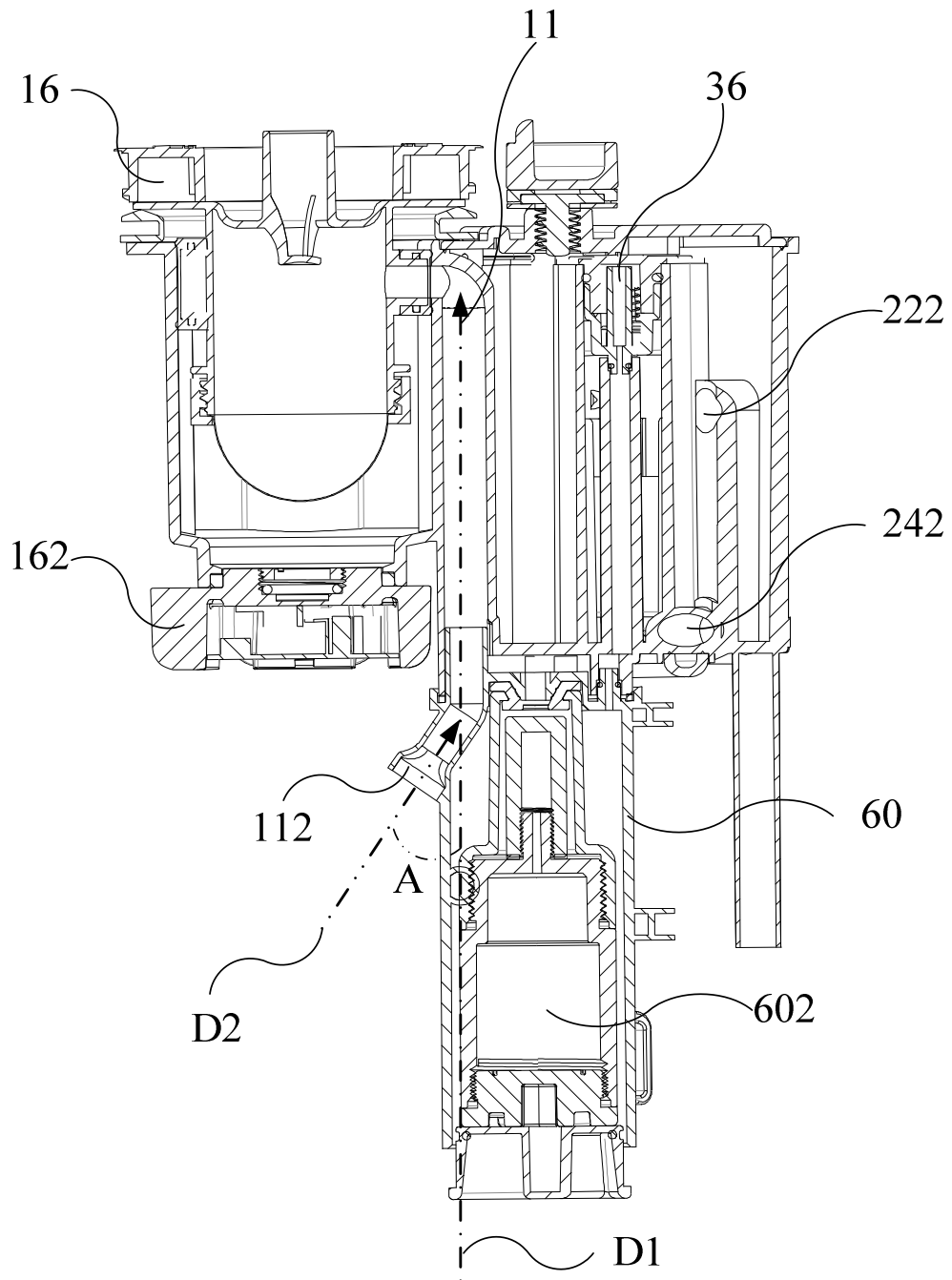


FIG. 9

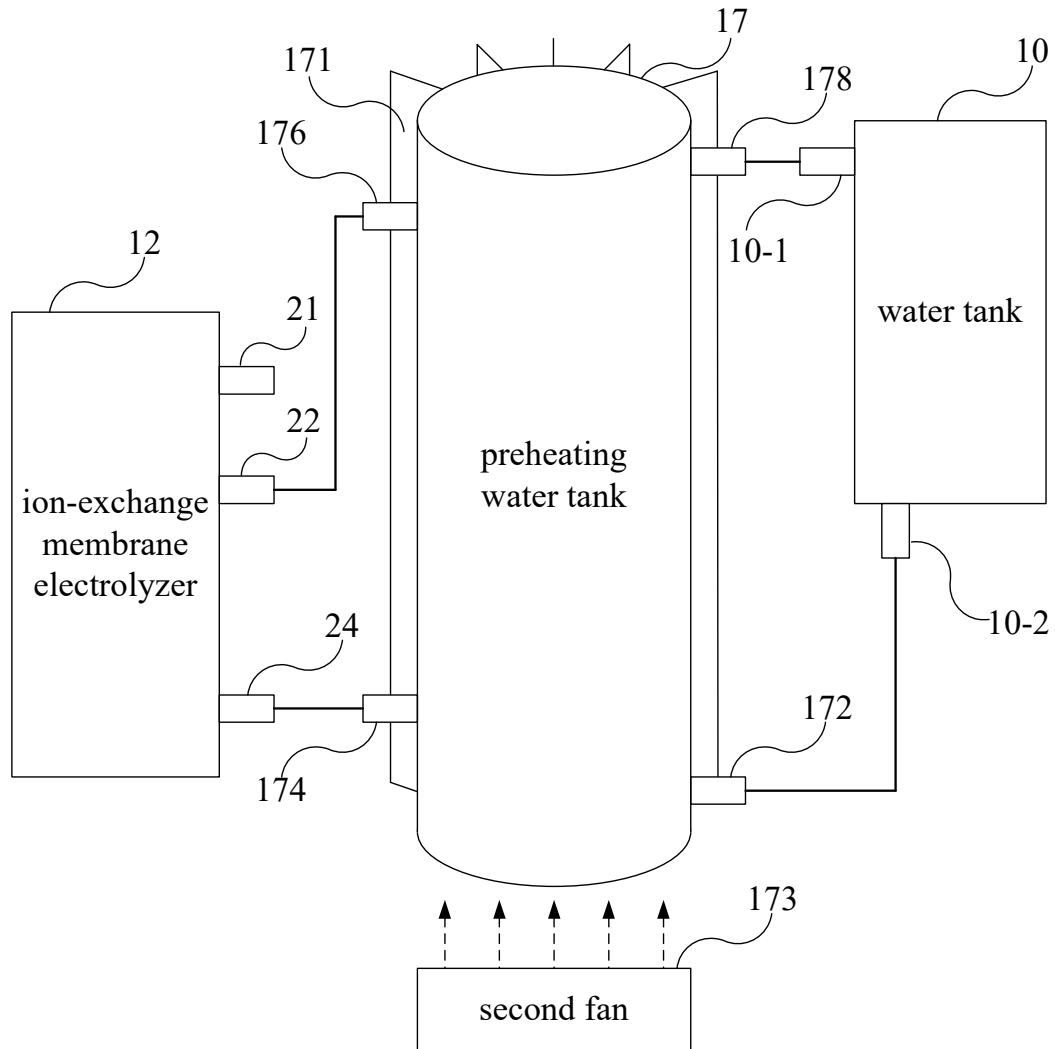


FIG. 10