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(54) **Title:** ELECTROLYZER, SYSTEMS AND USES THEREOF

(57) **Abstract:** The technology subject of the present application concerns an electrolyzer comprising a plurality of electrolysis cells and a method of generating hydrogen and oxygen gases.

ELECTROLYZER, SYSTEMS AND USES THEREOF

TECHNOLOGICAL FIELD

The invention generally contemplates an electrolyzer and systems implementing same.

BACKGROUND OF THE INVENTION

Electrolyzers are electrochemical devices that are used to separate water into hydrogen and oxygen. Construction of an electrolyzer as a cell stack operating in an electrical series arrangement typically requires presence of bipolar elements. As the electrolyte solution is a good electrical conductor, some of the electrical current applied to the stack may follow a path through the fluid rather than through the electrolytic cells, resulting in a reduction in the electrolyzer efficiency. These undesired currents are called “stray currents” or “shunt currents”. The reduced efficiency of the electrolyzer can be enhanced by current flow between the conductive electrodes through the moving fluid streams in contact with the electrodes, from each respective cell and into a reservoir into which all flows are combined. Such currents can give rise to local corrosion and water electrolysis causing generation of both hydrogen and oxygen gases.

Various solutions have been proposed for reducing shunt currents in flow-based systems such as electrolyzers, fuel cells and flow batteries. A bipolar plate forming a physical barrier between cells is one of the means used to serve as means to reduce the shunt or stray currents.

A way to avoid use of a bipolar plate has been implemented in a system [**1**] configured such that an electrolyte is allowed to flow uninterruptedly through a connector that is not a bipolar plate, positioned between any two electrochemical cells, or any two stacks of electrochemical cells, while maintaining a cell activity in terms of totally avoiding or minimizing leakage currents.

BACKGROUND PUBLICATIONS

[1] International Application No. PCT/IL2022/050657

GENERAL DESCRIPTION

The inventors of the technology disclosed herein have developed a novel gravitational electrolyzer that minimizes shunt currents and provides a better management of thermal losses by providing electrical isolation in the gas phase. The flow configuration involves generation of drops that prevent continuous uninterrupted flow of the electrolyte solution, thereby ensuring electrical isolation.

An electrolyzer of the invention is structured of a plurality of electrolysis cells, which may be vertically stacked or horizontally arranged, with each of the cells being independently designed to receive an electrolyte solution through a top plate, which may be a perforated top plate positioned for each cell separately as a top wall. Fluid from each of the cells cascades into a bottom plate and is compartmentalized therein, thereby avoiding mixing of excess fluids from other cells. This permits an interruption of the flow path of the electrolyte solution and causes an increase in the resistance of the path. By feeding the electrolyte solution through the perforated top plate of each cell, a cascaded gravitational flow of drops of the solution is achieved, ensuring gas isolation and minimization or elimination of the shunt currents.

Electrolyte solution is introduced into the electrolyzer through one or more supply tubes. The flow of electrolyte solution into and out of the supply tubes may be assisted by means such as an external pump that pushes the solution into the supply tubes. The solution can enter either from the top or the bottom of the electrolyzer. However, once the solution enters the supply tubes, fluid outlets provided on the supply tubes allow the solution to flow onto the electrolysis cells and subsequently flow gravitationally downward through top perforated plates.

Thus, in a first of its aspects, the invention provides an electrolyzer (or an electrolysis apparatus) comprising a plurality of electrolysis cells (or cells- which may be vertically stacked) and one or more electrolyte solution supply tubes passing through said plurality of electrolysis cells and configured to receive and flow an electrolyte solution, the one or more supply tubes having a plurality of fluid outlets configured to discharge the electrolyte solution from said one or more electrolyte supply tubes to each of said plurality of electrolysis cells; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution introduced into said electrolysis cells via said outlets.

In some embodiments, the one or more supply tubes being configured to receive and flow the electrolyte solution is/are configured to receive the electrolyte solution from a top end or a bottom end thereof. In some embodiments, where two or more supply tubes are present, each may receive the electrolyte solution from same end(s) or from opposite end(s). In some embodiments, an electrolyzer of the invention is provided with a plurality of electrolysis cells (or cells- which may be vertically stacked) and one or more electrolyte solution supply tubes passing through said plurality of electrolysis cells and configured to receive an electrolyte solution from a top end thereof, the one or more supply tubes having a plurality of fluid outlets configured to discharge the electrolyte solution from said one or more electrolyte supply tubes to each of said plurality of electrolysis cells.

In some embodiments, the number of electrolysis cells in a given electrolyzer, or a given stack, is unlimited and may be determined based on practical considerations. The number of cells in the plurality of cells may vary. In some cases, the number of cells may be between 1 and more than 100 in each electrolyzer unit. in some embodiments, the number of cells may be between 1 and 100, or 1 and 80, or 1 to 70, or 1 to 60, or 1 to 50 or 10 to 100, or 20 to 100, or 30 to 100, or 40 to 100, or 50 to 100, or 60 to 100, or 70 to 100, or 80 to 100, or 90 to 100, or 30 to 90, or 40 to 80, or 50 to 70 or any other number of cells per electrolyzer unit.

The invention further provides an electrolyzer (or an electrolysis apparatus or a reactor) comprising a plurality of vertically stacked electrolysis cells and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and configured to receive an electrolyte solution from a top or bottom end of the one or more supply tubes, the one or more supply tubes having a plurality of fluid outlets configured to discharge the electrolyte solution from said one or more electrolyte supply tubes to each of said plurality of electrolysis cells having a perforated top wall to permit gravitational flow of the electrolyte solution therethrough and into a bottom fluid chamber; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution introduced into said electrolysis cells via said outlets.

The invention further provides an electrolyzer (or an electrolysis apparatus or a reactor) comprising a plurality of vertically stacked electrolysis cells, each being configured to independently receive an electrolyte solution from one or more electrolyte supply tubes passing through each of said plurality of electrolysis cells and configured to receive and flow an electrolyte solution from a top or bottom end thereof, the one or more supply tubes having a plurality of fluid outlets each configured to discharge the electrolyte solution to each of said plurality of electrolysis cells, wherein a perforated top wall of each one of the plurality of electrolysis cells permits gravitational flow of the solution from a top electrolysis cell to bottom fluid chamber; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution introduced into said electrolysis cells via said outlets.

The number of fluid outlets provided in each supply tube may vary. In some cases, each of the one or more of the electrolyte supply tubes may have between 1 and 5 fluid outlets that directionally flow the electrolyte solution into each of the electrolysis cells. The size and shape of the outlets may differ in the various tubes or may differ based on the position of the outlet along the supply tube. An outlet may be in the shape of a tube that has several sub outlets. The size of the outlet holes may be adjustable to deliver a similar flow of electrolyte to other cells that are either above or below a given cell. In some cases, each one of the electrolyte supply tubes having a single fluid outlet that is configured to flow the solution into a respective cell. In other words, the number of outlets making up the plurality of fluid outlets is equal or greater than the number of electrolysis cells. The outlets of the supply tubes may be designed in a way that the liquid flow onto the top cell is similar to the flow into the bottom fluid chamber in the stack, thus taking into account the hydrostatic pressure difference between them.

The electrolyzer, apparatus or system of the invention is typically provided in a housing that is configured to accommodate the plurality of the electrolysis cells. The cells connected in series (in some embodiments, stacked one on top of the other, or in horizontal fashion) and provided with one or more, in some embodiments, one electrolyte supply tube that passes through a bore or an opening provided in each of the electrolysis cells and separately supplies each of the cells with the electrolyte solution. One or more or all of the electrolysis cells is/are provided with an electrode assembly that at least partially encircles a portion of the electrolyte supply tube inside each of the electrolysis cells.

Each of the cells is provided with a top wall which may be a perforated top wall. In other words, the electrolyte solution exiting the supply tubes through the fluid outlets is delivered onto the perforated top wall, such that each of the cells receives the electrolyte solution by gravity and in a form of drops. Thus, in some embodiments, a top wall of each of the plurality of electrolysis cells is or comprises a perforated pod or tray that is configured to receive the electrolyte solution discharged from a fluid outlet of the electrolyte supply tube and gravitationally discharge the electrolyte solution through its perforations as a plurality of drops.

Each electrolysis cell is provided with one or more respective fluid outlet(s) that is/are positioned immediately above the top wall or perforated tray.

The electrolyte solution cannot flow into the cells in any other way. Flow through the perforated wall is gravitational.

In some embodiments, the top wall of each one of the cells in the plurality of electrolysis cells comprises a plurality of circumferential apertures arranged about the surface of the perforated tray and configured for discharging the electrolysis products, e.g., gases, from each of the electrolysis cells into a product chamber defined above said top wall or above the stacked cells in communication, e.g., gaseous communication, with one or more discharge apertures that are not fluid apertures. Unlike the apertures used for communication of products of electrolysis, e.g., gases, from each of the cells into a common product chamber, each of the cells may be additionally provided with one or more fluid apertures. Fluid or excess fluid from each of the cells may be regulated in each of the cells through a level-regulating side-aperture that is configured to allow electrolyte overflow thereinside. A flow-regulating side-aperture may also be provided in each of the cells to guarantee a desired outflow of the electrolyte solution therefrom. The fluid side apertures permit flow of fluid from within each of the cells into a bottom fluid chamber, that is compartmentalized or sectioned. The flow from each cell into a respective sectioned chamber ensures that solutions from different cells are not mixed.

The flow is through a plurality of vertical fluid channels that extend the full length of the apparatus. The vertical fluid channels are configured to direct fluid from each cell into a respective compartment or section of the bottom fluid chamber. In some embodiments, this may be achieved in a configuration wherein each of the plurality of electrolysis cells defines a plurality of vertical fluid channels that extend a long a length of said apparatus, wherein each of said plurality of electrolysis cells is in fluid communication with one or more respective vertical fluid channel(s) from said plurality of vertical fluid channels via its respective side-apertures.

In some embodiments, the number of vertical fluid channels is equal to or greater than the number of electrolysis cells in said apparatus.

In some embodiments, one or more additional vertical channels are provided which are not configured to receive or flow a fluid therethrough. Each of the plurality of electrolysis cells is thus configured to define a plurality of discharge apertures for passage of electrolysis products, typically gaseous products, from each of said electrolysis cell into a respective plurality of the vertical channels that are not in fluid communication with the side-apertures; namely that are not designed nor configured to permit flow of excess fluid therethrough.

In some embodiments of an apparatus of the invention, a collector tube is provided that is in communication, e.g., gaseous communication, with at least some of the vertical channels for discharging the electrolysis products, e.g., gases, from said apparatus.

It should be stated that unlike existing electrolyzers, the gas pressure generated by the evolving gaseous products, within the assembly of cells is uniform throughout. The gases generated in the different cells at the same pressure rise in the electrolyte solution within each cell and flow outward. In other words, each of the electrolysis cells maintains a gas phase that is at the same pressure.

In some embodiments, for managing thermal loses, the plurality of vertical channels, i.e., both those configured for discharging electrolyte fluid and those configured for discharging the electrolysis products, are formed or defined between external wall surfaces of the electrolysis cells and internal wall surfaces of the housing.

As noted herein, fluid or excess fluid flowing from each of the cells is collected in a bottom fluid chamber that is a compartmentalized fluid collector cell, provided or located at the bottom of the apparatus, under the plurality of electrolysis cells, and which is in fluid communication with the respective vertical fluid channels that are in fluid communication with the side-apertures of the electrolyte cells, for receiving the electrolyte discharged into said vertical fluid channels via the side-apertures. In some embodiments, the fluid collector cell comprises a plurality of compartments each configured to receive electrolyte from a respective one (or a set) of the vertical fluid channels that are in fluid communication with the side-apertures of the electrolyte cells. In some embodiments, the bottom wall of the fluid collector cell comprises a plurality of openings for discharging the electrolyte from said apparatus.

An electrolyzer of the invention may implement one to many electrolysis cells. Each cell may be configured to receive an electrolyte solution from one or more electrolyte supply tubes passing therethrough and may comprise an electrode assembly that is connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution present in the cell. As the cell arrangement dictates, the electrode assembly (comprising an anode and a cathode) is fully contained within the cell, at least partially or fully encircling at least one of the supply tubes. In some configurations, each cell may be configured to receive an electrolyte solution from a single electrolyte supply tube and the electrode assembly (comprising an anode and a cathode) is fully contained within the cell, at least partially or fully encircling the single supply tube.

Each of the cells may be shaped as a cup or a vessel or a tray and have a size and shape dictated by the dimensions of the apparatus or system or by the volume of electrolyte it is configured to contain.

In some embodiments, an electrolysis cell comprises:

-a cup-shaped vessel having a bore or a plurality of bores (that are formed through the surface of the vessel and may be positioned centrally or in any other pattern), each configured for receiving or for passage of an electrolyte supply tube(s) therethrough;

-one or more electrodes connectable to one or more electrical power sources and configured to pass electric current through electrolyte introduced into said electrolysis cell via one or more fluid outlets provided in said electrolyte supply tube(s); and

-a cover element having a bore (or a plurality of bores, e.g., centrally positioned) configured for passage of the electrolyte supply tube(s) therethrough and for covering a top opening of said cup-shaped vessel,

wherein said cover element comprises an optionally perforated pod or tray or top wall configured to receive the electrolyte discharged from said one or more fluid outlets of the electrolyte supply tube for passage (e.g., through its perforations) into said cup-shaped vessel by gravity (wherein the electrolyte passes through the perforations to provide a plurality of drops).

Thus, in some embodiments, an apparatus of the invention comprises one or more stacked electrolysis cells (or cells associated in series) arranged around a common (and at times central) electrolyte supply tube, wherein each of the one or more stacked electrolysis cells is a cup-shaped vessel having a bore (optionally a central bore) configured for passage of the electrolyte supply tube therethrough; one or more electrodes connectable to one or more electrical power sources and configured to pass electric current through electrolyte introduced into said electrolysis cell via one or more fluid outlets provided in said electrolyte supply tube; and a cover element having a bore (optionally a central bore) configured for passage of the electrolyte supply tube therethrough and for covering a top opening of said cup-shaped vessel, wherein said cover element comprises a perforated pod, tray or surface configured to receive the electrolyte discharged from said one or more fluid outlets of the electrolyte supply tube for passage through its perforations in a form of drops into said cup-shaped vessel by gravity.

In some embodiments, the electrodes are configured to at least partially encircle a portion of the electrolyte supply tube passing through the cup-shaped vessel.

In some embodiments, an apparatus of the invention comprises one or more stacked electrolysis cells arranged around a common and optionally central electrolyte supply tube (or plurality of tubes), wherein each of the one or more stacked electrolysis cells is a cup-shaped vessel having a bore (optionally a central bore) configured for passage of the electrolyte supply tube therethrough; one or more electrodes at least partially encircling a portion of the electrolyte supply tube and connectable to one or more electrical power sources and configured to pass electric current through electrolyte introduced into said electrolysis cell via one or more fluid outlets provided in said electrolyte supply tube(s); and a cover element having a bore (optionally a central bore) configured for passage of the electrolyte supply tube(s) therethrough and for covering a top opening of said cup-shaped vessel, wherein said cover element comprises a perforated pod/tray or surface configured to receive the electrolyte discharged from said one or more fluid outlets of the electrolyte supply tube for passage through its perforations into said cup-shaped vessel by gravity.

In some embodiments, the electrode(s) may be configured in a variety of forms, shapes and sizes. In some configurations, the electrode(s) may be in a form of a flat electrode, a rolled electrode, or may be provided such that each cell contains a different type of electrode. In some configurations, the system of the invention comprises a stacked arrangement of electrodes.

In some embodiments, the cover element comprises a plurality of circumferential apertures arranged about the perforated pod/tray or surface and configured to discharge electrolysis products, e.g., gases, from said cup-shaped vessel.

In some embodiments, the cup-shaped vessel comprises a level-regulating side-aperture configured to prevent electrolyte overflow. In some embodiments, the cup-shaped vessel comprises a flow-regulating side-aperture configured to guarantee a desired outflow of the electrolyte therethrough.

In some embodiments, the system may be equipped with a flow-regulating valve that is configured and operable to completely prevent or stop outflow of the electrolyte solution.

In some embodiments, the electrolysis cell comprises a bottom lip. In some embodiments, said electrolysis cell is configured to define a fluid chamber between its cover element, a bottom wall and the bottom lip of a cup-shaped vessel of another such electrolysis cell placed thereabove.

In some embodiments, the electrolysis cell is configured to define a plurality of vertical fluid channels extending a long a length thereof, at least one of said plurality of vertical fluid channels is in fluid communication with the side-apertures of the cup-shaped vessel of said electrolysis cell.

In some embodiments, the electrolysis cell comprises a plurality of discharge apertures provided in the bottom lip to fluidly communicate between a plurality of the vertical channels thereof that are not in fluid communication with the side-apertures and a fluid chamber defined between a bottom wall and the bottom lip of the cup-shaped vessel of said electrolysis cell and a cover element of another such electrolysis cell placed therebelow. In some embodiments, each of the plurality of the vertical fluid channels that are not in fluid communication with the side-apertures comprises top and bottom apertures fluidly communicating to such plurality of vertical fluid channels that are not in fluid communication with side-apertures of other such electrolysis cells placed above and/or below said electrolysis cell.

In some embodiments, the electrolysis cell comprises one or more electrode supports formed on inner surfaces of a bottom wall of the cup-shaped vessel.

The invention further provides a system according to the invention comprising a plurality of electrolyzers or electrolyzer units, each being an electrolyzer as disclosed herein. Systems of the invention may comprise one or more electrolyzer units. The number of units may vary and be modified. The system may be arranged such that some of the units are configured and operable for generating one type of an electrolysis product, while others are configured and operable for generating another type of an electrolysis product. Alternatively, the system may be configured and operable to generate a single type of electrolysis product. For example, the system comprising a plurality of electrolyzer units may be configured to generate hydrogen and oxygen gases. In some configurations, some units are operable for generating hydrogen gas and others operable for generating oxygen gas.

In some embodiments, a system of the invention is configured for generating hydrogen gas and oxygen gas in spatially and/or temporally separated production steps. In other words, the system of the invention may be configured and operated to generate hydrogen gas and oxygen gas in separate electrolyzer units, simultaneously; or generate hydrogen gas and oxygen gas sequentially in the same units. The generation of hydrogen and oxygen gases, namely as a mixture or combination of gases, in the same units and at the same time, is not safe and is thus not within the scope of the invention.

A system is provided for generating hydrogen gas and oxygen gas in spatially (different cells) and/or temporally (different times) separated production steps, the system comprising a plurality of electrolyzer units, each electrolyzer unit comprises a plurality of electrolysis cells (or cells) connected serially or provided as a stack of cells; and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and having a plurality of fluid outlets configured to discharge an electrolyte solution (or an electrolyte) from said one or more electrolyte supply tubes to each of said plurality of electrolysis cells; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution introduced into said electrolysis cells via said outlets, wherein

the system is configured and operable to generate hydrogen gas in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas in one or more different electrolyzer units of the plurality of electrolyzer units; or wherein

the system is configured and operable to generate hydrogen gas in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas in the same one or more of the plurality of electrolyzer units at a different time point.

The system or electrolysis apparatus of the invention may be configured as any purpose-constructed or purpose-oriented electrochemical system. In some configuration, the electrochemical system may be fully electrochemical (for both hydrogen and oxygen generation), or an electrochemical thermally activated chemical cell (E-TAC), or a mixed system, where some of the O_2 is generated thermally and some electrochemically, or a system comprising a plurality of electrochemical cells, as disclosed herein. Each of the cells is configured to allow generation of electrolysis products in a form of hydrogen gas and/or oxygen gas in spatially and/or temporally separated steps, with or without changing the polarity of the system. Cells and/or systems of the invention and methods described herein for operating these cells and/or systems permit control not only on the type of gases that would be produced, i.e., hydrogen gas or oxygen gas, but also on the ability to produce either one or both of the gases in a continuous, uninterrupted fashion.

The invention therefore also provides an electrochemical thermally activated chemical cell (E-TAC) system for generating hydrogen gas and oxygen gas in spatially and/or temporally separated production steps, the system comprising a plurality of electrolyzer units, each unit comprises a plurality of electrolysis cells (or cells) connected serially or provided as a stack of cells; and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and having a plurality of fluid outlets configured to discharge an electrolyte solution (or an electrolyte) from said one or more electrolyte supply tubes to each of said plurality of electrolysis cells; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution introduced into said electrolysis cells via said outlets, wherein

the system is configured and operable to generate hydrogen gas in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas in one or more different electrolyzer units of the plurality of electrolyzer units; or wherein

the system is configured and operable to generate hydrogen gas in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas in the one of more of the plurality of electrolyzer units at a different time point.

As stated herein, the plurality of electrolyzer units may include between 1 and several units, e.g., between 1 and 100 electrolyzer units, 1 and 50, 1 and 10 electrolyzer units or between 1 and 12 electrolyzer units. Each electrolyzer unit may have a duplicate unit that is hydraulically connected to it in parallel, and electrically connected to it in parallel or in series. Such a multiplicity of electrolyzer units connected hydraulically in parallel would be called a set.

An exemplary system of the invention may comprise a stack of 50 trays, each tray including 4 electrolysis cells. The total number of cells is 200 in a single electrolyzer unit.

Such a unit where the cells are connected in series operates at 400 V. Each system may include a minimum of eight separate electrolyzer units.

An arrangement of systems may be provided, wherein each system in the arrangement may be electrically connected in series and filled and drained at the same time. In such a case the voltage of the power supply can be 800 volts, and the total number of electrolyzer units may be doubled, i.e. 16, 20 or 24 or more.

In some embodiments, the number of electrolyzer units in a system of the invention is at least 2.

Thus, systems of the invention may comprise between 1 and 100 (or between 2 and 100) electrolyzer units, each being as defined herein; wherein the electrolyzer units are operated in spatially (different cells) and/or temporally (different times) production steps to generate hydrogen and oxygen gases.

The invention further provides a method of water electrolysis, the method comprises:

-flowing an electrolyte solution (comprising water and electrolytes, as known in the art) into one or more electrolysis cells connected in series (or stacked one on top of the other or in parallel one besides each other);

-passing electric current through the electrolyte solution in each of said one or more electrolysis cells;

-flowing from each one of said one or more electrolysis cells: a level-regulated stream of the electrolyte solution for continuous circulation of said electrolyte solution in said electrolysis cell; and a level-regulated stream of the electrolyte solution whenever a level of the electrolyte solution in said electrolysis cell exceeds a defined permissible level value, wherein said streams of the electrolyte solutions are flown downwardly by gravity via a respective fluid channel of each one of said one or more electrolysis cells; and

-allowing electrolysis products, e.g., gases (hydrogen or oxygen) from each of one of said one or more electrolysis cells to propagate via one or more channels other than the fluid channels.

The gases may propagate via a space between the cells and the inner wall of the electrolyzer. Since the electrolyte solution continuously flows downwardly by gravity, the bottom section of the electrolyzer may be configured to allow the electrolysis products, namely gases, to emerge either from the bottom section, or from the top section of the electrolyzer.

In some embodiments, the method is for generating hydrogen gas and oxygen gas in spatially and/or temporally separated production steps.

In some embodiments, the method is carried out in an electrolyzer according to the invention.

In some embodiments, the electrolyzer is an electrolyzer unit of a system comprising a plurality of electrolyzer units.

In some embodiments, for generating hydrogen gas and oxygen gas, wherein hydrogen gas is generated in one or more electrolyzer unit of a plurality of electrolyzer units and oxygen gas is generated in one or more different electrolyzer unit of the plurality of electrolyzer units; or wherein hydrogen gas is generated in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas generated in the same one of more electrolyzer units of the plurality of electrolyzer units at a different time point.

For the sake of brevity only, embodiments disclosed herein are not repeated for every system and method of the invention. As such, any of the embodiments disclosed herein with regard to cells, electrolyzers and systems of the invention is relevant without limitation, unless otherwise stated, to any system and method of the invention. Any system-dependent embodiment is applicable to any method of the invention.

As used herein, the term "***plurality***" refers to a number of elements or features or units, which may be between 1 and several. The actual number, unless specifically indicated, is unlimited. Typically, the term encompasses between 1 and 100, 1 and 80, 1 and 10, 1 and 5, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to better understand the subject matter that is disclosed herein and to exemplify how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Figs. 1A-B depict an arrangement of electrolysis cells in an apparatus implementing three cells. **Fig. 1A** depicts an apparatus, not showing an external housing; **Fig. 1B** depicts a cross-section of the apparatus according to some embodiments of the invention.

Figs. 2A-B depict top (**A**) and side (**B**) views of a cell according to some embodiments of the invention

Fig. 3 depicts a perforated pod according to some embodiments of the invention.

Figs. 4A-B depict top (**A**) and bottom (**B**) views of a fluid collector cell according to some embodiments of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

As disclosed herein, the invention provides an arrangement of electrolysis cells in an apparatus implementing such one or more cells. **Figs. 1A** and **1B** generally depict an electrolysis apparatus (30) and a cross-section of the apparatus, respectively. The apparatus (30) comprises a plurality of electrolysis cells (33) vertically stacked one on top of the other. In the configuration shown, three stacked cells are depicted. An electrolyte supply tube (31) is configured to introduce an electrolyte solution into the electrolysis cells from a top end of the stack. The solution may be pumped in or introduced under pressure. Once in the tube (31), the solution is gravitationally flown through the cells. The tube (31) passes through said plurality of electrolysis cells (33) and has a plurality of fluid outlets (1u) configured to discharge the electrolyte solution from said electrolyte supply tube (31) to each of said plurality of electrolysis cells (33). The tube (31) passes through a bore (11, **Fig. 2A**) that is provided in the depicted embodiment at the center of each cell (33). In other configurations (not shown), multiple tubes may be present, each passing through a respective bore formed in the cells.

Each of the cells (33) is configured to receive one or more electrodes (not shown) that are connectable to one or more electrical power sources and configured to pass electric current through electrolyte introduced into said electrolysis cells via said outlets.

The apparatus (30) may be provided within a housing (35) configured to accommodate the plurality of electrolysis cells (33).

As further shown in **Figs. 2A** and **2B**, each of the cells making up a plurality of electrolysis cells (33) according to the invention comprises a level-regulating side-aperture (14, **Fig. 1A**; 14a, **Figs. 2A-B**) configured to allow a desired electrolyte flow thereinside. Each of the plurality of electrolysis cells further comprises a flow-regulating side-aperture (14b) that is configured to guarantee a desired outflow of the electrolyte therefrom.

The plurality of electrolysis cells (33) is configured to define a plurality of vertical channels (13 and 14, **Figs. 1** and **2**) extending a long a length of said apparatus, and wherein each of said electrolysis cells is in fluid communication with a respective vertical fluid channel (13) from said plurality of vertical channels (13 and 14) via its respective side-apertures (14a and 14b). Each one of the electrolysis cells is further configured to define a plurality of channels (13) and discharge apertures (13e), shown in **Fig. 2B**, for passage of electrolysis products, e.g., gases, therethrough, from said electrolysis cell into a respective number of vertical channels (13) that are not in fluid communication with the side-apertures.

A top wall of each of the plurality of electrolysis cells (33) comprises a perforated pod (23, **Fig. 1B** and **Fig. 3**) that is configured to receive the electrolyte discharged from one or more of the plurality of fluid outlets (1u, **Fig. 1B**) of the electrolyte supply tube (31) for passage through its perforations (23r) into said electrolysis cell by gravity, as shown in **Fig. 1B** and **Fig. 3**. The top wall of each one of the electrolysis cells (33) comprises a plurality of circumferential apertures (20q, **Fig. 1A** and **Fig. 3**) arranged about the perforated pod (23) and configured for discharging the electrolysis products from the electrolysis cell into a chamber (29) defined above said top wall in fluid communication with said fluid discharge apertures (13e, **Fig. 2B**). A collector tube (32, **Fig. 1**) through which electrolysis products, typically gases, are collected, is provided in communication with the at least some of the vertical fluid channels (13) for discharging the electrolysis products.

As noted in **Figs. 1A**, **1B** and more specially in **Figs. 4A** and **4B**, the apparatus or system of the invention further comprises a fluid collector cell (34) that is located under the plurality of electrolysis cells (33) and which is in fluid communication with the respective vertical fluid channels (14) that are in fluid communication with the side-apertures (14a and 14b) of the electrolyte cells for receiving the electrolyte discharged into said vertical fluid channels (13) via the side-apertures (14a and 14b). The fluid collector cell (34) comprises a plurality compartments (34p), each configured to receive electrolyte from a respective one of the vertical fluid channels (14) that are in fluid communication with the side-apertures (14a and 14b) of the electrolyte cells. A bottom wall of the fluid collector cell (34) comprises a plurality of openings (34i) or holes or perforations for discharging the electrolyte solution from said apparatus.

As noted herein and depicted in **Figs. 2A** and **2B**, the electrolysis cell (33) may comprise:

a cup-shaped vessel (10) having a central bore (11) that is configured for passage of an electrolyte supply tube (31 shown in **Fig. 1**) therethrough;

one or more electrodes (not shown) connectable to one or more electrical power sources and configured to pass electric current through electrolyte introduced into said electrolysis cell via one or more fluid outlets (1u shown in **Fig. 1**) provided in said electrolyte supply tube (31); and

a cover element (20) as exemplified in **Fig. 3**, which has a central bore (22) configured for passage of the electrolyte supply tube (31) therethrough and for covering a top opening of said cup-shaped vessel (10), wherein said cover element (20) comprises a perforated pod (23) configured to receive the electrolyte discharged from said one or more fluid outlets (1u) of the electrolyte supply tube (31) for passage through its perforations (23r) into said cup-shaped vessel (10) by gravity.

The cover element (20) comprises a plurality of circumferential apertures (20q) arranged about the perforated pod (23) and configured to discharge electrolysis products, e.g., gases, from said cup-shaped vessel (10).

The cup-shaped vessel (10) comprises a level-regulating side-aperture (14a) configured to prevent electrolyte overflow thereinside and a flow-regulating side-aperture (14b) configured to guarantee a desired outflow of the electrolyte therethrough.

Each of the electrolysis cells comprises a bottom lip (10m). The electrolysis cell is configured to define a chamber (29) between its cover element (20), a bottom wall and the bottom lip (10m shown in **Fig. 2B**) of a cup-shaped vessel (10) of another such electrolysis cell (33) placed thereabove. Each of the plurality of the vertical fluid channels (13) that are not in fluid communication with the side-apertures (14a and 14b) comprises top and bottom apertures (13q) communicating to such plurality of vertical channels (13) that are not in fluid communication with side-apertures (14a and 14b) of other such electrolysis cells placed above and/or below said electrolysis cell.

The electrolysis cell further comprises one or more electrode supports (12 shown in **Fig. 2A**) formed on inner surfaces of a bottom wall of the cup-shaped vessel (10).

CLAIMS:

1. An electrolyzer comprising a plurality of electrolysis cells and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and configured to receive and flow an electrolyte solution, the one or more supply tubes having a plurality of fluid outlets configured to discharge the electrolyte solution to each of said plurality of electrolysis cells; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution introduced into said electrolysis cells via the outlets of said supply tubes.

2. The electrolyzer according to claim 1, comprising a plurality of electrolysis cells and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and configured to receive an electrolyte solution from a top or bottom end thereof, the one or more supply tubes having a plurality of fluid outlets configured to discharge an electrolyte solution to each of said plurality of electrolysis cells having each a perforated top wall to permit gravitational flow of the solution from each of the electrolysis cell to a bottom fluid chamber; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution gravitationally introduced into said electrolysis cells via said outlets.

3. The electrolyzer according to claim 1 or 2, for generating gaseous electrolysis products at a uniform pressure.

4. The electrolyzer according to claim 1 or 2, wherein the electrolyzer comprises a gas phase at a uniform pressure.

5. The electrolyzer according to claim 3, wherein the gaseous products comprise hydrogen gas and oxygen gas.

6. The electrolyzer according to any one of claims 1 to 5, wherein each of the electrolysis cells is provided with a performed top wall, wherein the top wall of each one of the plurality of electrolysis cells comprises a plurality of circumferential apertures arranged about a surface of a perforated pod and configured for discharging electrolysis products from the electrolysis cells into a product chamber defined above said top wall in communication with one or more discharge apertures that are not fluid apertures.

7. The electrolyzer according to any one of claims 1 to 6, wherein a flow-regulating side-aperture is provided in each of the cells to guarantee a desired outflow of the electrolyte therefrom.

8. The electrolyzer according to claim 7, wherein the side-aperture permits flow of fluid from within each of the cells through a plurality of vertical fluid channels that extend the full length of the apparatus into the bottom fluid chamber being compartmentalized or sectioned.

9. The electrolyzer according to claim 8, wherein the vertical fluid channels are configured to direct fluid from each cell into a respective compartment or section of the bottom fluid chamber.

10. The electrolyzer according to any one of the preceding claims, wherein each of the plurality of electrolysis cells defines a plurality of vertical fluid channels that extend along a length of said electrolyzer, wherein each of said plurality of electrolysis cells is in fluid communication with one or more respective vertical fluid channel(s) from said plurality of vertical fluid channels via its respective side-apertures.

11. The electrolyzer according to claim 10, wherein the number of vertical fluid channels is equal or greater than the number of electrolysis cells in said apparatus.

12. The electrolyzer according to any one of claims 8 to 11, wherein one or more additional vertical channels are provided which are not configured to receive or flow a fluid therethrough.

13. The electrolyzer according to claim 12, wherein each of the plurality of electrolysis cells is configured to define a plurality of discharge apertures for passage of electrolysis products from each of said electrolysis cell into a respective plurality of the additional vertical channels that are not in fluid communication with the side-apertures.

14. The electrolyzer according to any one of claims 8 to 13, wherein a collector tube is provided that is in communication with the at least some of the additional vertical channels for discharging gaseous electrolysis products from said electrolyzer.

15. The electrolyzer according to any one of the preceding claims, wherein the electrolyzer is arranged as a plurality of electrolyzer units.

16. The electrolyzer according to any one of the preceding claims, wherein each electrolysis cell comprises:

a cup-shaped vessel having a central bore configured for receiving or for passage of an electrolyte supply tube therethrough;

one or more electrodes connectable to one or more electrical power sources and configured to pass electric current through electrolyte introduced into said electrolysis cell via one or more fluid outlets provided in said electrolyte supply tube; and a cover element having a central bore configured for passage of the electrolyte supply tube therethrough and for covering a top opening of said cup-shaped vessel,

wherein said cover element comprises a perforated pod or perforated top wall configured to receive the electrolyte discharged from said one or more fluid outlets of the electrolyte supply tube for passage into said cup-shaped vessel by gravity.

17. The electrolyzer according to any one of the preceding claims, comprising one or more stacked electrolysis cells arranged around a common and central electrolyte supply tube, wherein each of the one or more stacked electrolysis cells is a cup-shaped vessel having a central bore configured for passage of the electrolyte supply tube therethrough; one or more electrodes connectable to one or more electrical power sources and configured to pass electric current through electrolyte introduced into said electrolysis cell via one or more fluid outlets provided in said electrolyte supply tube; and a cover element having a central bore configured for passage of the electrolyte supply tube therethrough and for covering a top opening of said cup-shaped vessel, wherein said cover element comprises a perforated pod configured to receive the electrolyte discharged from said one or more fluid outlets of the electrolyte supply tube for passage through its perforations into said cup-shaped vessel by gravity.

18. The electrolyzer according to claim 16 or 17, wherein the electrodes are configured to at least partially encircle a portion of the electrolyte supply tube passing through the cup-shaped vessel.

19. The electrolyzer according to claim 16 or 17, comprising one or more stacked electrolysis cells arranged around a common and central electrolyte supply tube, wherein each of the one or more stacked electrolysis cells is a cup-shaped vessel having a central bore configured for passage of the electrolyte supply tube therethrough; one or more electrodes at least partially encircling a portion of the electrolyte supply tube and connectable to one or more electrical power sources and configured to pass electric current through an electrolyte solution introduced into said electrolysis cell via one or more fluid outlets provided in said electrolyte supply tube; and a cover element having a central bore configured for passage of the electrolyte supply tube therethrough and for covering a top opening of said cup-shaped vessel, wherein said cover element comprises a perforated pod configured to receive the electrolyte discharged from said one or more fluid outlets of the electrolyte supply tube for passage through its perforations into said cup-shaped vessel by gravity.

20. The electrolyzer according to claim 19, wherein the cover element comprises a plurality of circumferential apertures arranged about the perforated pod and configured to discharge gaseous electrolysis products from said cup-shaped vessel.

21. The electrolyzer according to claim 19, wherein the cup-shaped vessel comprises a level-regulating side-aperture configured to allow electrolyte overflow thus regulating the maximum electrolyte level in the cell.

22. The electrolyzer according to claim 21, wherein the cup-shaped vessel comprises a flow-regulating side-aperture configured to guarantee a desired outflow of the electrolyte therethrough.

23. The electrolyzer according to any one of the preceding claims, configured to define a fluid chamber between its cover element, a bottom wall and a bottom lip of a cup-shaped vessel of another such electrolysis cell placed thereabove.

24. The electrolyzer according to any one of the preceding claims, configured to define a plurality of vertical fluid channels extending a long a length thereof, at least one of said plurality of vertical fluid channels is in fluid communication with the side-apertures of the cup-shaped vessel of said electrolysis cell.

25. The electrolyzer according to any one of the preceding claims, comprising a plurality of discharge apertures provided in a bottom lip to fluidly communicate between a plurality of the vertical channels thereof that are not in fluid communication with the side-apertures and a fluid chamber defined between a bottom wall and the bottom lip of the cup-shaped vessel of said electrolysis cell and a cover element of another such electrolysis cell placed therebelow.

26. The electrolyzer according to any one of the preceding claims, comprising one or more electrode supports formed on inner surfaces of a bottom wall of the cup-shaped vessel.

27. The electrolyzer according to any one of the preceding claims, for generating hydrogen gas and oxygen gas in spatially or temporally separated production steps.

28. An electrolyzer system for generating hydrogen gas and oxygen gas in spatially and/or temporally separated production steps, the system comprising a plurality of electrolyzer units, each unit comprising a plurality of electrolysis cells connected serially or provided as a stack of cells; and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and having a plurality of fluid outlets configured to discharge an electrolyte solution from said one or more electrolyte supply tubes to each of said plurality of electrolysis cells; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution introduced into said electrolysis cells via said outlets, wherein

the system being configured and operable to generate hydrogen gas in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas in one or more different electrolyzer units of the plurality of electrolyzer units; or wherein

the system being configured and operable to generate hydrogen gas in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas in the same one or more of the plurality of electrolyzer units at a different time point.

29. The system according to claim 28, wherein each electrolyzer unit comprises a plurality of electrolysis cells and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and configured to receive an electrolyte solution from a top or bottom end thereof, the one or more supply tubes having a plurality of fluid outlets configured to discharge an electrolyte solution to each of said plurality of electrolysis cells having each a perforated top wall to permit gravitational flow of the solution from each of the electrolysis cell to a bottom fluid chamber.

30. The system according to claim 28 or 29 configured as an electrochemical thermally activated chemical cell (E-TAC) system comprising a plurality of electrolyzer units.

31. An electrochemical thermally activated chemical cell (E-TAC) system for generating hydrogen gas and oxygen gas in spatially and/or temporally separated production steps, the system comprising a plurality of electrolyzer units, each unit comprising a plurality of electrolysis cells connected serially or provided as a stack of cells; and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and having a plurality of fluid outlets configured to discharge an electrolyte solution from said one or more electrolyte supply tubes to each of said plurality of electrolysis cells; and a plurality of electrodes connectable to one or more electrical power sources and configured to pass electric current through the electrolyte solution introduced into said electrolysis cells via said outlets, wherein

the system being configured and operable to generate hydrogen gas in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas in one or more different electrolyzer units of the plurality of electrolyzer units; or wherein the system being configured and operable to generate hydrogen gas in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas in the one of more of the plurality of electrolyzer units at a different time point.

32. The system according to claim 31, wherein each electrolyzer unit comprises a plurality of electrolysis cells and one or more electrolyte supply tubes passing through said plurality of electrolysis cells and configured to receive an electrolyte solution from a top or bottom end thereof, the one or more supply tubes having a plurality of fluid outlets configured to discharge an electrolyte solution to each of said plurality of electrolysis cells having each a perforated top wall to permit gravitational flow of the solution from each of the electrolysis cell to a bottom fluid chamber.

33. A method of water electrolysis, the method comprises:

-flowing an electrolyte solution into one or more electrolysis cells connected in series or stacked one on top of the other;

-passing electric current through the electrolyte solution in each of said one or more electrolysis cells;

-flowing from each one of said one or more electrolysis cells: a level-regulated stream of the electrolyte solution for continuous circulation of said electrolyte solution in said electrolysis cell; and a level-regulated stream of the electrolyte solution whenever a level of the electrolyte solution in said electrolysis cell exceeds a defined permissible level value, wherein said streams of the electrolyte solutions are flown downwardly by gravity via a respective fluid channel of each one of said one or more electrolysis cells; and

-allowing electrolysis products from each of one of said one or more electrolysis cells to propagate via one or more channels other than the fluid channels and via the space between the cells and the inner containing cylinder walls.

34. The method according to claim 33, wherein the electrolysis products are gaseous products.

35. The method according to claim 34, wherein the gaseous products are hydrogen gas and oxygen gas.

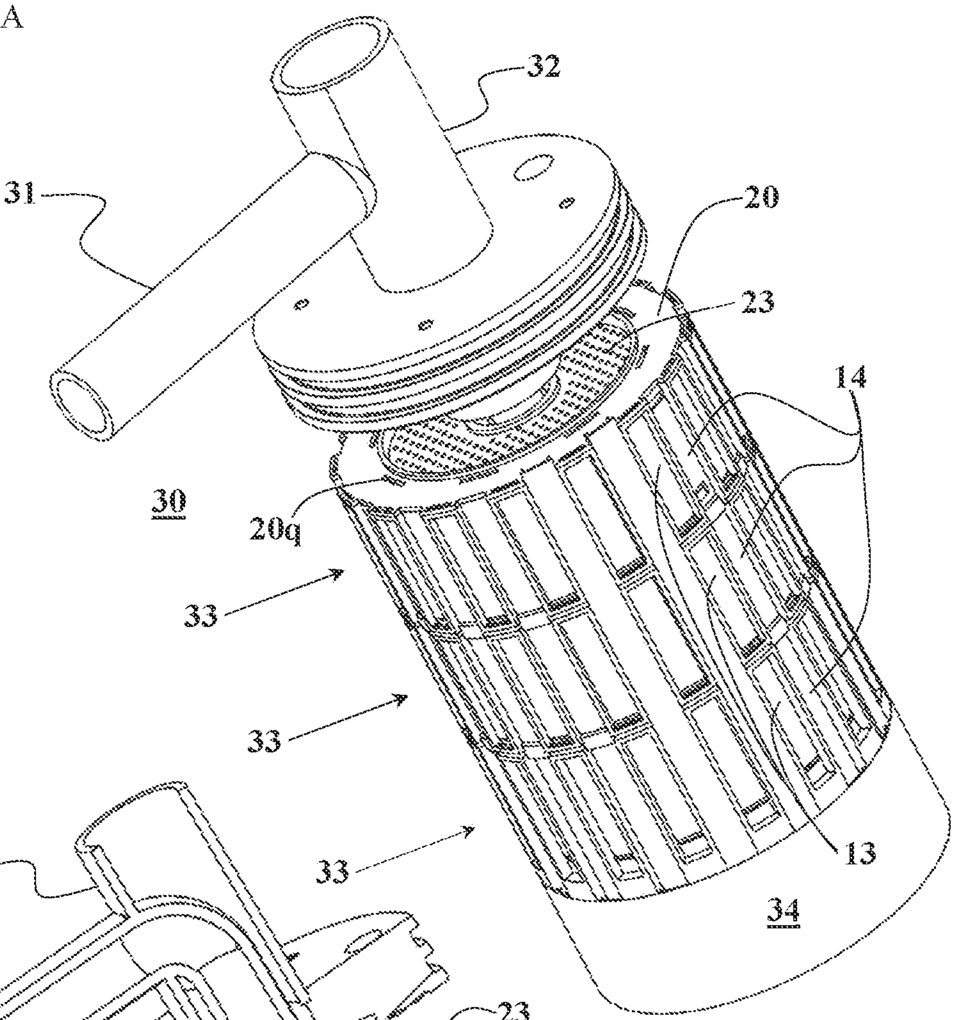
36. The method according to claim 33, for generating hydrogen gas and oxygen gas in spatially and/or temporally separated production steps.

37. The method according to any one of claims 33 to 36, when carried out in an electrolyzer according to any one of claims 1 to 27.

38. The method according to claim 37, wherein the electrolyzer is an electrolyzer unit or a system comprising a plurality of electrolyzer units.

39. The method according to claim 37, wherein hydrogen gas is generated in one or more electrolyzer unit of a plurality of electrolyzer units and oxygen gas is generated in one or more different electrolyzer unit of the plurality of electrolyzer units; or wherein hydrogen gas is generated in one or more electrolyzer units of the plurality of electrolyzer units and oxygen gas generated in the same one of more electrolyzer units of the plurality of electrolyzer units at a different time point.

Fig. 1A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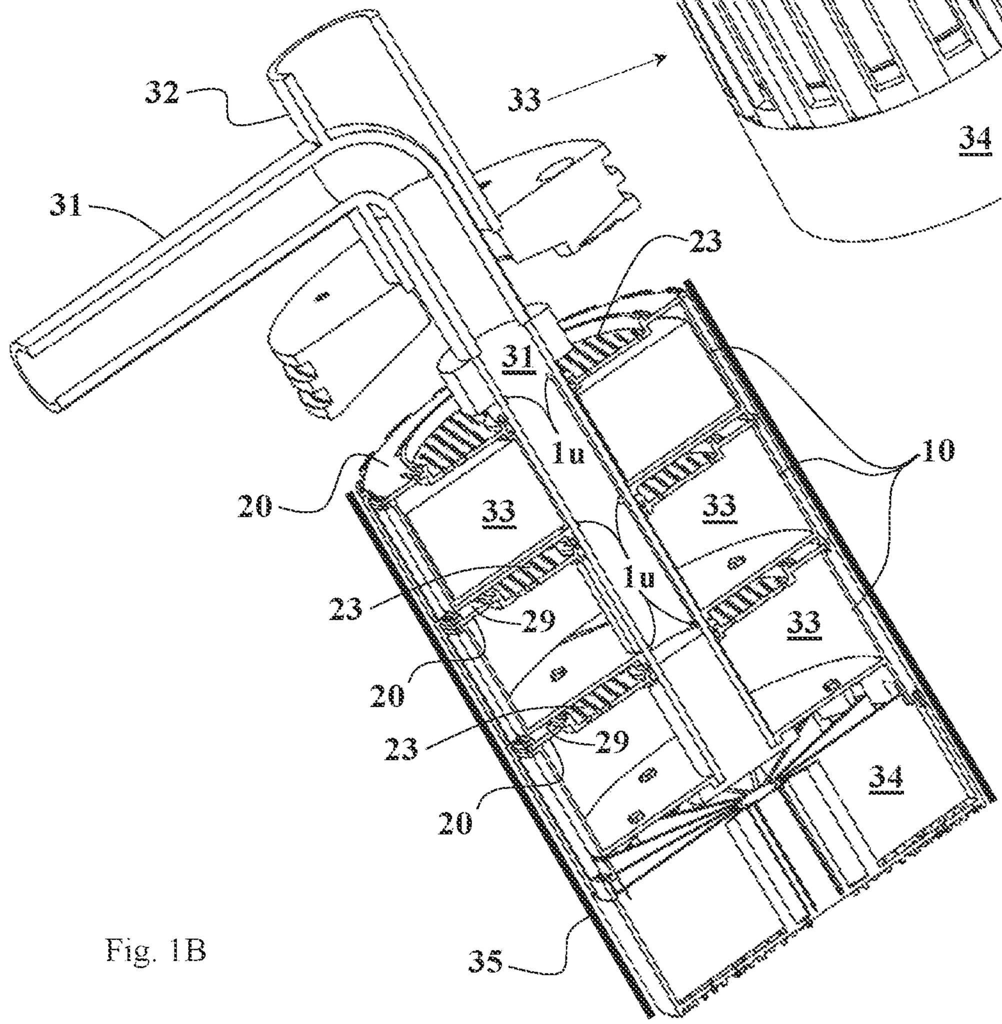
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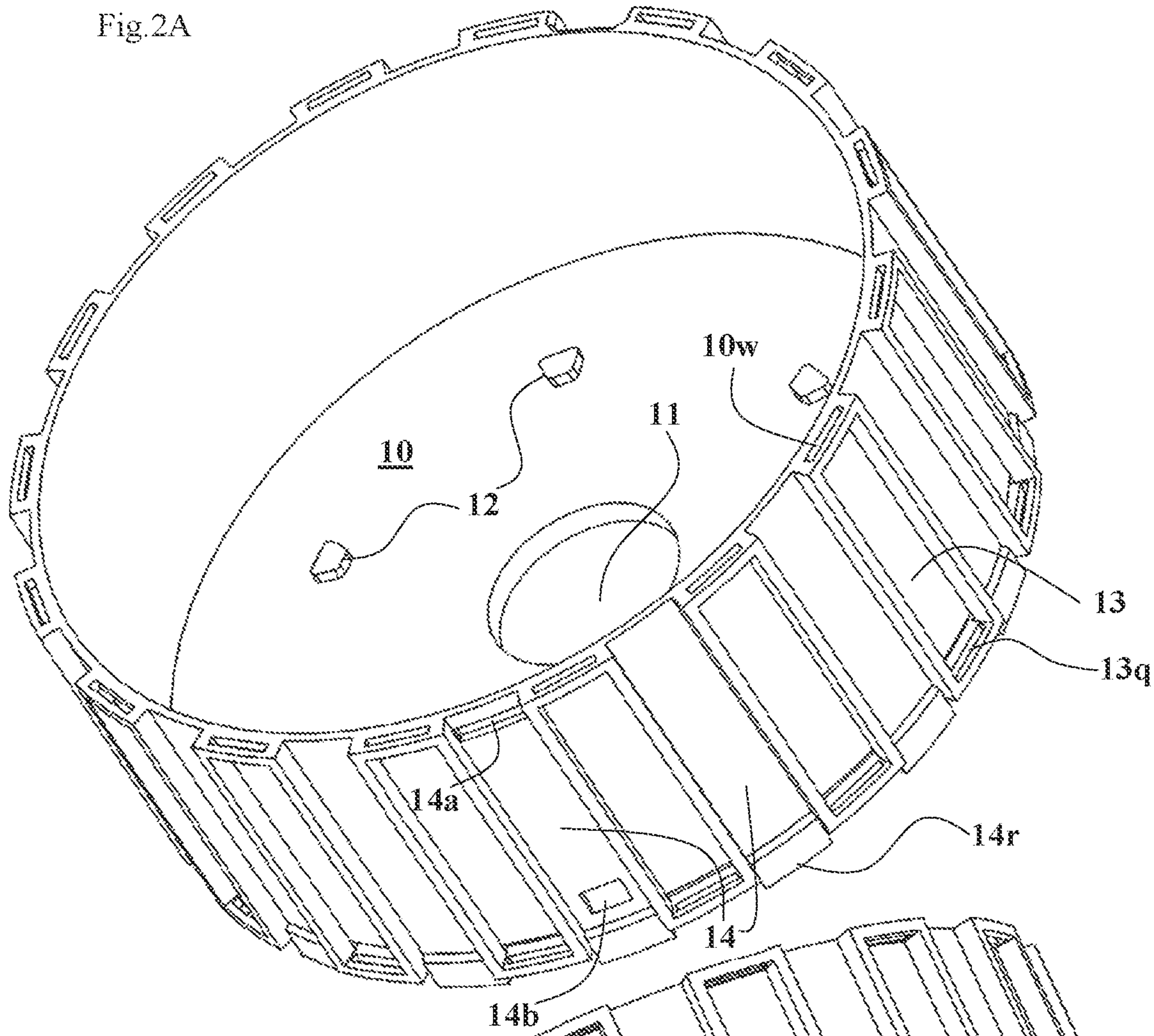
Fig. 1B

Fig.2A



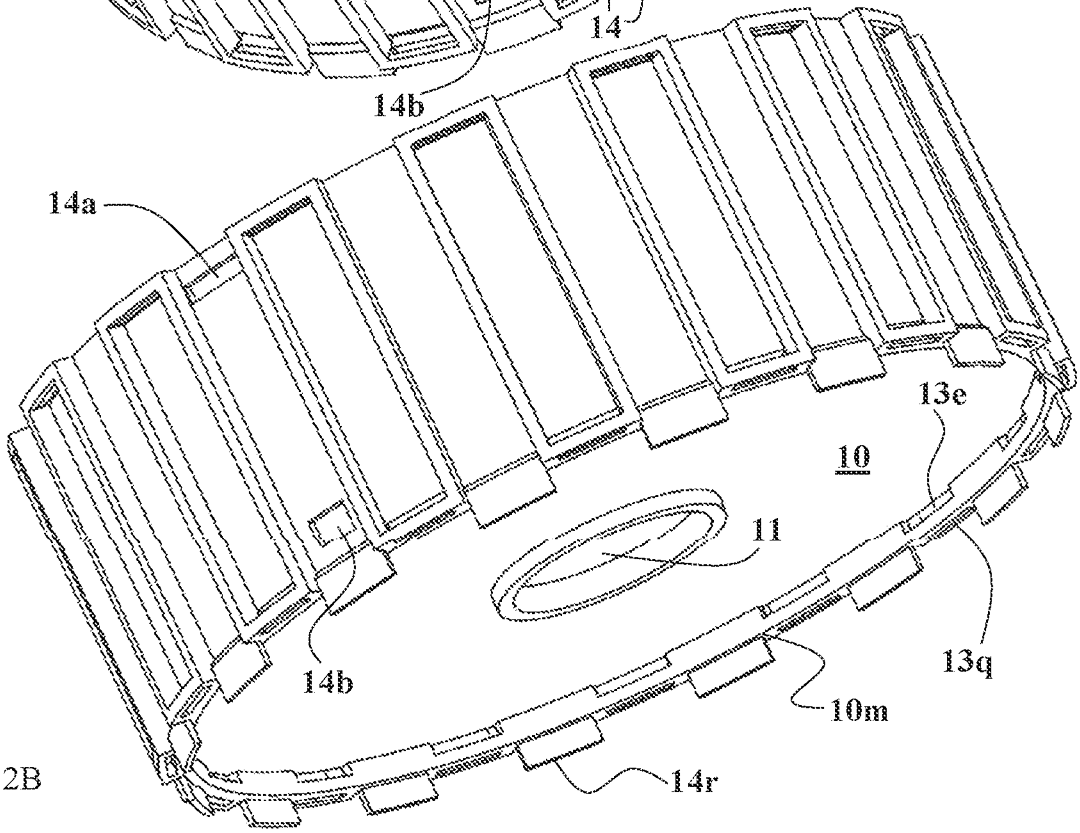


Fig. 2B

Fig. 3

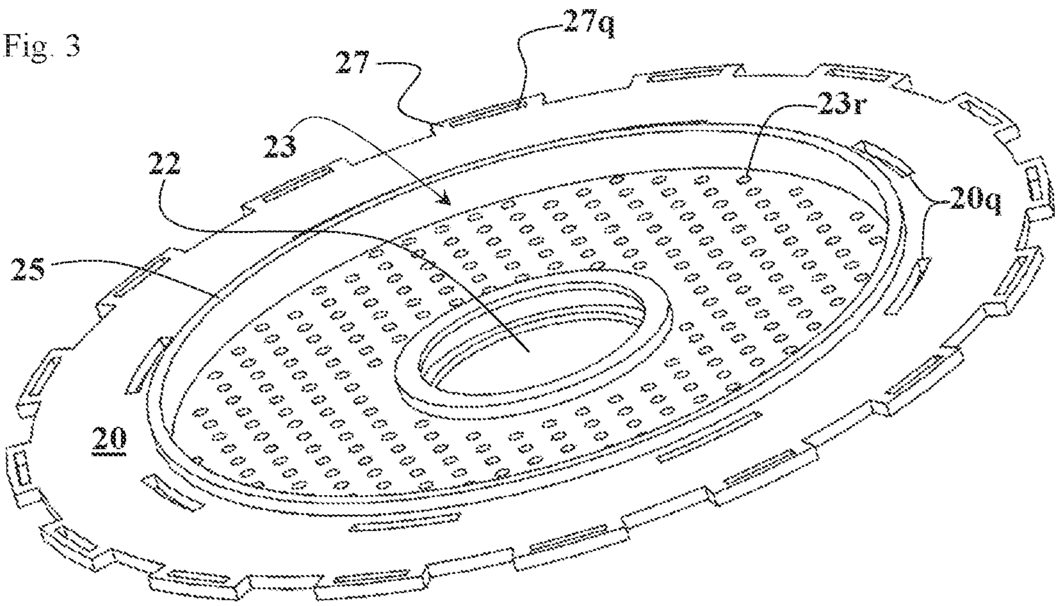
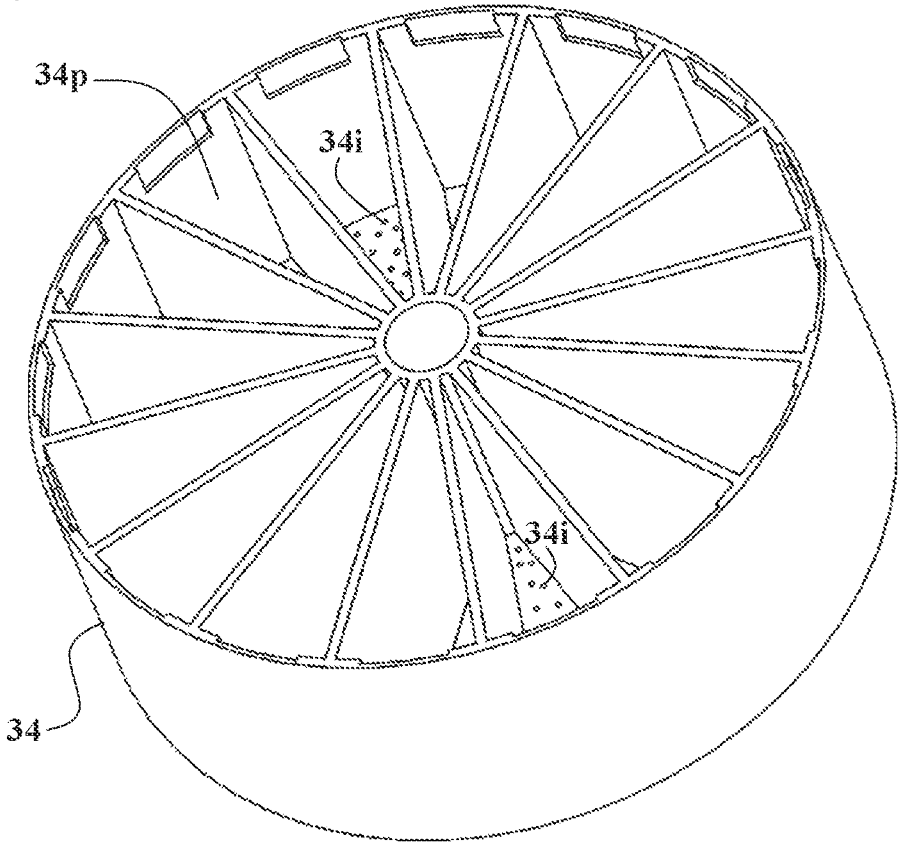


Fig. 4A



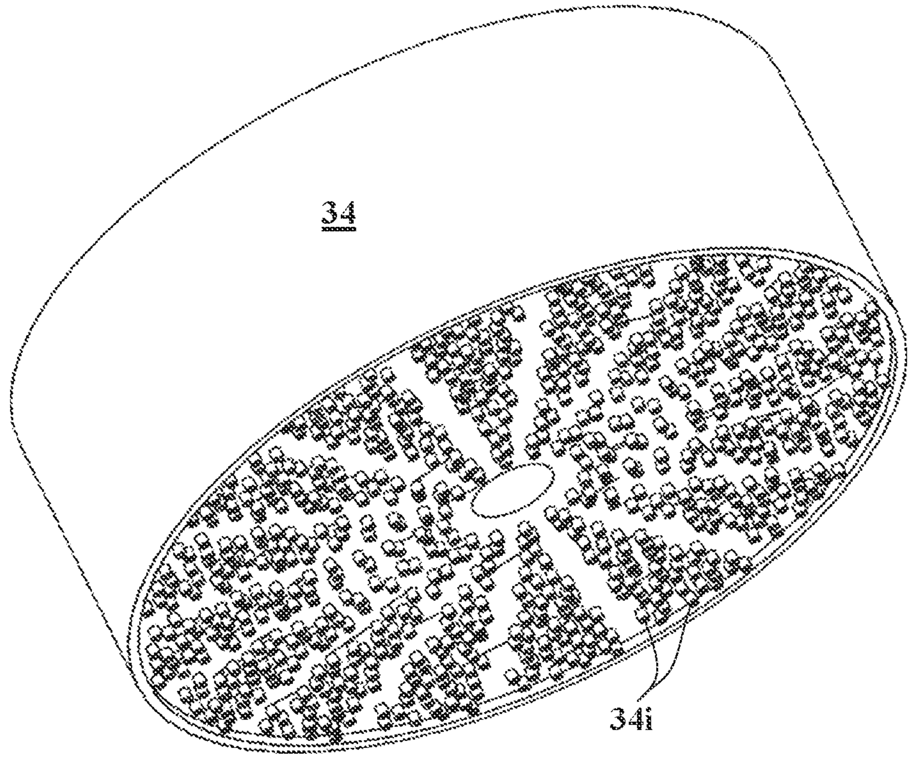


Fig. 4B

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2024/050571

A. CLASSIFICATION OF SUBJECT MATTER
INV. C25B1/04 C25B9/70
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 111 139 496 A (ZHANGJIAGANG INDUSTRY TECH RESEARCH INSTITUTE CO LTD DALIAN INSTITUTE) 12 May 2020 (2020-05-12) paragraph [0068]; claim 1; figures 1, 2, 4, 6	1-7,10, 16,18, 23,24
X	US 2017/271706 A1 (JEHAN MICHEL [FR] ET AL) 21 September 2017 (2017-09-21) paragraph [0001]; figures 1, 2, 5 paragraph [0017] paragraph [0062] paragraph [0064]	1-12, 14-16,18

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[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 September 2024	04/12/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Telias, Gabriela

2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2024/050571

C(Continuation). **DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 258 779 B2 (CASEY ALAN PATRICK [AU] ET AL) 21 August 2007 (2007-08-21) column 1, line 44 - column 2, line 35; figures 3, 7, 8 column 3, line 14 - column 4, line 13 -----	1,13,17, 19-22, 25, 33-35, 37,38

2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2024/050571

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims;; it is covered by claims Nos.:

2-25, 34, 35, 37, 38(completely); 1, 33(partially)

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 2-25, 34, 35, 37, 38(completely); 1, 33(partially)

   Electrolyzer comprising a plurality of electrolysis cells and one or more electrolyte supply tubes passing through said plurality of electrolysis cells, wherein each of said plurality of electrolysis cells comprises a perforated top wall to permit gravitational flow of the solution from each of the electrolysis cell to a bottom fluid chamber.

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2. claims: 26-32, 36, 39(completely); 1, 33(partially)

   Electrolyzer system for generating hydrogen gas and oxygen gas in spatially and/or temporally separated production steps.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IL2024/050571

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
CN 111139496	A	12-05-2020	NONE			
US 2017271706	A1	21-09-2017	AU	2015305072	A1	09-03-2017
			CA	2958474	A1	25-02-2016
			CN	107004929	A	01-08-2017
			EP	3183770	A1	28-06-2017
			FR	3025055	A1	26-02-2016
			JP	6744306	B2	19-08-2020
			JP	2017532750	A	02-11-2017
			KR	20170100475	A	04-09-2017
			US	2017271706	A1	21-09-2017
			WO	2016027031	A1	25-02-2016
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			EP	1444383	A1	11-08-2004
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			KR	20050044324	A	12-05-2005
			MX	PA04003360	A	23-07-2004
			US	2005029119	A1	10-02-2005
			WO	03042431	A1	22-05-2003