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(54) **Apparatus and method for removal of ions.**

(57) An apparatus for removal of ions provided with a plurality of capacitive electrode stacks. Each capacitive electrode stack may have:
a plurality of first electrodes provided with a plurality of first current collectors;
a plurality of second electrodes provided with a plurality of second current collectors;
and,
a spacer between the first and second electrodes for allowing water to flow in between the electrodes.
The second current collectors of a first of the plurality of capacitive electrode stacks may be connected to the first current collectors of a second of the plurality of capacitive electrode stacks.

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Title: Apparatus and method for removal of ions

Field of the invention

The invention relates to an apparatus for removal of ions provided with a plurality of capacitive electrode stacks, each electrode stack comprising:

a first electrode provided with a first current collector;

a second electrode provided with a second current collector; and,

a spacer between the first and second electrodes for allowing water to flow in between the electrodes.

Background prior art

In recent years one has become increasingly aware of the impact of human activities on the environment and the negative consequences this may have. Ways to reduce, reuse and recycle resources are becoming more important. In particular, clean water is becoming a scarce commodity. Therefore, various methods and devices for purifying water have been published.

A method for water purification is by capacitive deionisation, using an apparatus provided with a flow through capacitor (FTC) for removal of ions in water. The FTC functions as an electrically regenerable cell for capacitive deionisation. By charging electrodes, ions are removed from an electrolyte and are held in electric double layers at the electrodes. The electrodes may be charged with a voltage between 0,5 to 2 Volts. The electrodes may be (partially) electrically regenerated to desorb such previously removed ions without adding chemicals.

The apparatus for removal of ions comprises one or more pairs of spaced apart electrodes (a cathode and an anode) and a spacer, separating the electrodes and allowing water to flow between the electrodes. The electrodes are provided with current collectors or backing layers that are generally adjacent to or very near the electrodes and a material to store the ions. Current collectors are electrically conductive and transport charge in and out of the electrodes.

The apparatus may be provided with a housing comprising a water inlet for letting water into the housing and a water outlet for letting water out of the housing. In the housing of the apparatus for removal of ions the layers of electrodes and spacers are stacked in a "sandwich" fashion by compressive force, normally by mechanical fastening.

A problem with the apparatus for removal of ions is that the charging voltages may be low causing high electrical currents within the apparatus which may lead to increased energy

loss or which may require the use of thick expensive metal connectors, or expensive power supplies that may handle high currents at low voltage.

Summary of the invention

It is an object of the invention to provide an improved apparatus for removal of ions.

Accordingly, the present invention provides an apparatus for removal of ions provided with a plurality of capacitive electrode stacks, each capacitive electrode stack comprising:

a first electrode provided with a first current collector;

a second electrode provided with a second current collector; and,

a spacer between the first and second electrode for allowing water to flow in between the electrodes, wherein the second current collector of a first of the plurality of capacitive electrode stacks is connected to the first current collector of a second of the plurality of capacitive electrode stacks.

According to a further embodiment of the invention an apparatus for removal of ions is provided with a plurality of electrode stacks, each electrode stack comprising:

a first electrode provided with a first current collector;

a second electrode provided with a second current collector; and,

a spacer between the first and second electrode for allowing water to flow in between the electrodes, wherein the apparatus comprises a power connector for connecting a power source to a plurality of capacitive electrode stacks in electrical serial connection with each other and the resistivity in each of the capacitive electrode stacks is substantially equal so as to divide the potential difference of the power source substantially equally over all capacitive electrode stacks.

According to yet a further embodiment a method is provided for removal of ions the method comprising:

providing a plurality of capacitive electrode stacks, each capacitive electrode stack manufactured by:

providing a first electrode provided with a first current collector;

providing a second electrodes provided with a second current collectors; and,

providing a spacer between the first and second electrodes for allowing water to flow in between the electrodes,

wherein the method comprises connecting the first current collectors of a first of the plurality of capacitive electrode stacks to the second current collectors of a second of the plurality of capacitive electrode stacks.

These and other aspects, features and advantages will become apparent to those of ordinary skill in the art from reading the following detailed description and the appended

claims. For the avoidance of doubt, any feature of one aspect of the present invention may be utilised in any other aspect of the invention. It is noted that the examples given in the description below are intended to clarify the invention and are not intended to limit the invention to those examples per se. Similarly, all percentages are weight/weight percentages unless otherwise indicated. Numerical ranges expressed in the format "from x to y" are understood to include x and y. When for a specific feature multiple preferred ranges are described in the format "from x to y", it is understood that all ranges combining the different endpoints are also contemplated.

Brief description of the figures

Embodiments of the invention will be described, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, and in which:

Figure 1 shows a schematic cross-section of an apparatus for removal of ions according to an embodiment;

Figure 2 shows a schematic cross-section along the line Y-Y of the apparatus of figure 1;

Figure 3 shows a schematic three dimensional figure of an apparatus for removal of ions according to a further embodiment;

Figure 4 depicts a connector according to an embodiment;

Figure 5 depicts the connector of figure 4 provided in a ring of a housing;

Figure 6 shows a full ring for the housing of an apparatus for removing ions with two connectors of figure 4;

Figure 7 depicts the stack of figure 3 wherein stack A, B are provided in a tray

Figure 8 depicts the apparatus after a first housing portion and the ring of figure 5 is provided;

Figure 9 shows a cross section of the apparatus of figure 3 to 7;

Figures 10a to 10b disclose a pressure plate according to a second embodiment; and,

Figures 11a to 11d show a top view of a tray 113a for use in an embodiment.

Detailed description of the invention

Figure 1 shows a schematic cross-section of an apparatus for removal of ions according to an embodiment, which comprises two capacitive electrode stacks of first electrodes and second electrodes separated by spacers 11. The apparatus may have a housing comprising a first housing part 1 and a second housing part 3 made of a relatively

hard material e.g. a hard plastic. By pressing the first and second housing parts onto each other, for example with a bold and nut (not shown) the housing may be made water tight. Adhesive, seals or O-rings may be used to improve the water tightness of the housing.

The housing is provided with a water inlet 7 and a water outlet 9. During ion removal from the water, the water will flow from the inlet 7 to the outlet 9 through the spacers 11 which separates the first electrode and the second electrode from each other. In the example the current collectors of the electrodes of two different stacks are clamped together inside the housing. In principle the current collectors can be clamped either inside or outside the housing. Nevertheless, clamping the current collectors inside the housing may have the advantage that stacks can be placed electrically in series without the need to make holes in the housing which helps to provide a water leakage free apparatus. By creating an electrical potential difference between the first and second electrode, for example by applying a positive voltage to the first electrode (the anode) 13 and a negative voltage to the second electrode (cathode) 15, anions in the water flowing through the spacer 11 are attracted to the first electrode and cations are attracted to the second electrode. In this way the ions (anions and cations) can be removed from the water flowing through the spacer 11. The electrical potential difference can also be created by e.g. applying a positive voltage to the first electrode (the anode) 13 and a lower positive voltage to the second electrode (cathode) 15. Also in this way the ions (anions and cations) can be removed from the water flowing through the spacer 11. In the example of figure 1 the two capacitive electrode stacks are electrically placed in series, whereas the flow paths, which are determined by the spacers 11 are placed parallel, which means that the water may flow from the water inlet 7 to the water outlet 9 via any of the flow path of either the first or the second stack, which is placed in the same housing.

The electrical potential differences between the first and second electrode of the first capacitive electrode stack may be rather low, for example lower than 2 Volt, preferably lower than 1,7 Volt and even more preferably lower than 1,4 Volt. The advantage of placing FTC stacks electrically in series is that the potential difference over multiple capacitive electrode stacks may be higher than that between the first and the second electrode. For example, the potential difference over two capacitive electrode stacks A and B, provided with a first and second electrode 13A, 13B, 15A, 15B and a spacer 11, which are electrically connected in series may be twice as high than the potential difference over one single capacitive electrode stack or two capacitive electrode stacks A and B which are placed in a parallel electrical circuit. The current collectors of the first electrode 13A of a first capacitive electrode stack may be connected to an electrical power source PS for example and the current collector of the second electrode 15A of the first capacitive electrode stack may be connected to the current collector of the first electrode 13B of the second capacitive electrode stack. The

connection may be directly, and may, for example, be accomplished by clamp 17, which may preferentially be made from a non-electrically conductive material since its function is to press the conductive current collectors of the second and first electrode 15A, 13B together so that the current is directly transported between the two current collectors. Alternatively clamp 17 may be made from an electrically conductive material or may contain parts that are electrically conductive. The second electrode 15A of a first capacitive electrode stack may substantially have the same potential as the first electrode 13B of the second capacitive electrode stack. The current collectors of the second electrode 15B may also be connected to the electrical power source PS in order to complete the electrical circuit.

The current collectors of the first electrode 13A are clamped between clamp portions 19. The clamp portions 19 may be made from plastic, but could also be made from carbon, for example graphite blocks. The clamp portions 19 may be provided with a ratchet mechanism to secure the clamp portions 19 with respect to each other and to optimize the contact surface between the current collector 13A and the clamp portions 19 to optimize electrical conductivity. To make the first connector, two clamp portions 19 may be pressed against multiple current collectors of the first electrode 13A so as to press the current collectors together and provide an electrical connection, subsequently an adhesive may be used to permanently fix the clamp portions 19 with the current collectors in a watertight manner. Alternatively a screw 21 may be used to press the current collectors 13 together with the clamp portions 19 and at the same time avoiding water metal contact of the connector. For a low electrical resistance it is advantageous to make the contact surface of the current collector and the connector of the same or similar material, for example carbon. An advantage of carbon is that it does not corrode in the water and that it is relatively cheap compared to other non-corrosive materials and metals.

The pressure to clamp the current collector onto the connector may be at least 0.1 Bar, preferably at least 0.5 Bar and less than 15 Bar preferably less than 10 Bar and most preferably less than 5 Bar. The connector 18 may be glued against the housing so as to avoid contact of the water in the housing with the screw 21 which may be made out of metal. In this way corrosion of the screw may be prevented. In a similar way the current collector of the second electrode 15B of the second stack may be connected to the power source PS with a second connector 20. The potential difference delivered by the power source PS between the current collectors of the first electrode 13A of the first capacitive electrode stack via first cable 23 and the current collector of the second electrode 15B of the second capacitive electrode stack via second cable 22 may be, for example lower than 4 Volt, preferably lower than 3,4 Volt and even more preferably lower than 2,8 Volt.

A potential problem of the relatively high potential difference between the first and second connector, 18, 20 may be a potential leak current between the first and the second

connector. This may be prevented by placing an insulator between the two connectors. This insulator 24 may also be placed between the two connectors as well as the first and second stack. The insulator 24 may be an insulator to prevent electrical and/or ionic transport. By placing the capacitive electrode stacks electrically in series, the applied potential difference between the first and second connector, 18, 20 may be increased or even doubled, whereas at the same time the current through the cables 22, 23 may be reduced by as much as 50%. The energy efficiency of the FTC apparatus may therefore be improved and the need for very thick expensive cables may be reduced. At the same time cheaper PS may be used that transport less current at higher voltages.

By assuring that the electrical resistance of the first and second capacitive electrode stacks A and B are substantially the same, the potential difference as delivered by the PS may be equally divided over the first and second capacitive electrode stack A, B. As a consequence the potential difference between the first electrode 13A and second electrode 15A of the first capacitive electrode stack A may be substantially the same as the potential difference between the first electrode 13B and second electrode 15B of the second capacitive electrode stack B. This potential difference may for example be lower than 2 Volt, preferably lower than 1,7 Volt and even more preferably lower than 1,4 Volt.

A feed through or opening may be provided through the housing at a position where the first and second connector 18, 20 are positioned against the housing 1,3. The feed through may be provided with a metal screw 21 on which the cable 23 may be connected to the electrical power source PS. The power source PS may be controlled by controller CN to control the operation of the apparatus for removal of ions.

The electrodes may be made substantially metal free to keep them corrosion free in the wet interior of the housing and at the same time cheap enough for mass production. The electrodes may be produced from a current collector 13A, B, 15A, B provided with a substantially metal free electrically conductive high surface area layer, which may contain activated carbon, carbon nanotubes, carbon aerogels, carbon black and/or graphene on both sides which are in contact with the water. The high surface area layer may be provided as a coating onto the current collector or as a separate film. A high surface area layer is a layer with a high surface area in square meter per weight of layer material e.g.>500m^2/gr.

If the electrodes are saturated with ions the electrodes may be regenerated by reducing or even reversing the potential difference and discharging the electrical charge on the electrodes. This may result in the release of ions from the electrodes into the water flowing through the spacer. The increased ion content in the water in the spacer can be flushed out of the spacer. Once most ions are released from the electrodes and the water with increased ion content is flushed out of the spacer the electrodes are regenerated and can be used again for attracting ions.

Figure 2 discloses the cross-section along line Y-Y of the apparatus of figure 1. It shows the clamp 17 clamping the current collectors of the first and second electrode 15A and 13B (see figure 1). The housing is provided with a space 25 for allowing water to flow around the electrodes and the spacers 11 and a second passage 27 for allowing water to collect from all the spacers 11 and flow through the outlet 9 (of figure 1). The connector 18 for connecting the current collector of the first electrode 13A is also shown. Figure 1 is a cross section along the line Z-Z of figure 2.

Figure 3 shows a schematic three dimensional figure of an apparatus for removal of ions according to a further embodiment with 12 capacitive electrode stacks A, B, C , D... Each capacitive electrode stack A, B, C , D... being provided with a first electrode 13A, 13B, 13C, 13D,..... and second electrode 15A, 15B, 15C, 15D,.... The capacitive electrode stacks are provided with an opening 27 for allowing water to enter or exit the capacitive electrode stacks. A first group 31 of capacitive electrode stacks A...F is connected in series and a second group 33 of capacitive electrode stacks G...L is also connected in series. The potential difference that may be applied between the first electrode 13A of the first capacitive electrode stack A and the second electrode 15F of the last capacitive electrode stack F of the first group may be 6 times the potential difference of a single capacitive electrode stack. The potential difference between the first electrode 13A of the first stack A and the second electrode 15F may therefore be for example lower than 12 Volt, preferably lower than 9,4 Volt and even more preferably lower than 8,4 Volt. Clamps (not shown) may be used to press the current collector of a second electrode 15A to a current collector of a first electrode 13B.

Figure 4 depicts a connector according to an embodiment. The connector 41 may be used for connecting a current collector of the apparatus for removal of ions to a power source with a cable or lead 43. The connector 41 may be provided with a closing off portion or contact member 47 to be placed in the housingfor closing of an opening in the housing of the apparatus. The connector 41 may be provided with a connector surface or contact face 45 defined in a head 46 of a contact portion adjacent to the interior of the housing which may be pressed against the current collector to provide an electrical contact. The closing off portion or contact member 47 of the connector 41 may be provided with carbon such as graphite so as to avoid corrosion and for providing a good electrical contact with the carbon current collector of the electrodes. The connector 41 may be provided with a flexible material or seal 49 for providing a watertight connection with the housing. The seal 49 may be an o-ring, for example made of rubber to provide a water tight connection with the housing. The cable or lead 43 may be provided in a connector portion having a neck 42 extending from the head in a direction away from the contact face and having a receptacle at a dry surface 48 of the connector portion so as to avoid corrosion of the cable or lead 43. The lead or cable 43 may be engaged with the neck of the connector portion and is capable of directing an electrical

current to the contact member via the head. The contact portion is configured to engage with the stack so that the contact member is in electrical communication with the stack. The contact portion may be substantially cylindrical and may define the contact face 45. The perimeter of the contact face may form an arcuate rim. The contact portion may include a recess inward of the perimeter and a protrusion extending from the recess that terminates substantially coplanar with the rim. The contact face and the protrusion may be substantially cylindrical. The housing further may have a recess proximate to the opening, and the contact portion may be seated in the recess. The connector or contact member 47 is press fit or adhered to the opening. A seal portion may be defined by at least one of the head and the neck such that the seal portion establishes a hydraulic seal between the seal portion and a mount into which the electrical connector is seated during operation. Figure 5 depicts the connector of figure 4 provided in a ring 51 of the housing. The ring is provided with a connector clamp 53 for clamping the electrode against the surface 45 of the connector. The connector clamp 53 may be provided with a fixed part or protrusion member 55 which is extending from an interior surface of the housing and may comprise a pair of arms. The connector clamp may also be provided with a movable part or bridge 57 which is moveable along the pair of arms to adjust a pressure applied to the plurality of current collectors between the bridge 57 and the contact portion. Between fixed parts 55 and movable part 57 a ratchet mechanism may be provided. For example, the ratchet mechanism may comprise a surface with saw teeth which allows movement of the movable portion 55 in the direction of the connector but blocks movements of the movable portion 57 in opposite direction. The electrode may be provided in between the moveable portion 57 and the contact surface 45, by pressing the moveable portion 57 against the electrode and against the connector surface 45 a good connection will be provided between the electrode and the cable 43. Figure 6 shows a full ring 51 for the housing with two connectors 41. The contact surface may define a contact face having a contact plane and the current collector of the electrode may be provided with an electrode plane which may be substantially parallel to the contact plane. The opening 50 provided in the ring 51 of the housing may define an elbow passage having a first portion extending substantially perpendicular to a longitudinal axis of the housing and a second portion extending substantially parallel to the longitudinal axis. The closing off portion or contact member 47 may be seated in the second portion.

Figure 7 depicts the capacitive electrode stack of figure 3 wherein capacitive electrode stack A, B are provided with a tray 71A, 71B. The tray 71A, 71B may improve manufacturability because it may protect the electrodes during assembling of the capacitive electrode stacks in the housing. During manufacturing of one capacitive electrode stack the tray 71 may help in aligning the electrodes and or the spacer. During use of the apparatus the

tray may electrically and/or ionically insulate one capacitive electrode stack from another capacitive electrode stack and counteracting leak currents.

The capacitive electrode stacks may be clamped between a bottom plate 73 and a pressure plate 75. A rod 77 may be provided through the opening 27 of the stacks and a nut may be provided which in cooperation with a thread on the rod may press the pressure plate 75 on the capacitive electrode stacks. Before pressing the pressure plate on the capacitive electrode stacks water may be flushed through the spacer along the electrodes. Flushing the stacks with water may comprise flowing water through the stacks with a pressure of between 0,5 and 10 Bar, preferably between 1 and 5 Bar and most preferably between 2 and 4 Bar. Flushing helps to remove any loose material out of the spacer and/or the membranes and/or the electrodes before the pressure is applied and after flushing the capacitive electrode stack will be compressed and the capacitive electrode stacks will be fixed in the housing. The capacitive electrode stacks may be fixated permanently. By exerting a force on the capacitive electrode stacks so as to compress the first and second electrode and the spacer the electrical resistivity may be decreased which may make the apparatus more efficient. It is important that the electrical resistivity is substantially equal for every capacitive electrode stack because otherwise the voltage is not equally divided over the individual capacitive electrode stacks. If one capacitive electrode stack operates at higher voltage than another capacitive electrode stack then the capacitive electrode stack which receives a higher voltage may become damaged due to oxidation and/or electrolysis. Therefore the pressure needs to be equally divided for all the capacitive electrode stacks. The stacks may be compressed with pressure of less than 5 Bar, preferably less than 2 Bar, more preferably between 1 Bar and 0,5 Bar.

The bottom plate 73 may form a part of the housing of the apparatus for removing ions. In figure 7 it is also shown how the electrode 13G may be provided in between the moveable portion 57 and the closing off portion 47 of the connector clamp 53 to be electrically connected to the cable 43. A contact member may be seated in the base member or bottom plate 73 to define a contact portion and a connector portion extending from the contact portion. A lead may be engaged with the connector portion and capable of directing an electrical current to the contact member. A protrusion member may be extending from the base member or bottom plate 73 adjacent to the contact member. A compression member (similar as the design of figure 5) may be configured to selectively engage the protrusion member at a plurality of positions relative to the contact member such that the compression member may be adjusted to compress a current collector of the electrode between the compression member and the contact member. The compression member may include a resilient arm having a first interlocking member; and the protrusion member may include a second interlocking member; the first interlocking member and the second interlocking

member are configured to selectively engage such that first interlocking member of the compression member may be restrained relative to the contact member by the second interlocking member of the protrusion member. The first interlocking member may define a plurality of ramps and the second interlocking member may define a plurality of inverse ramps. The plurality of ramps and the plurality of inverse ramps may engage to inhibit separation of the protrusion member and the compression member.

In figure 8 a first housing portion e.g. a round pipe section 81 is provided to the bottom plate 73 and the ring 51 of figure 6 is located on top of the section 81.

Figure 9 shows a cross section of the apparatus of figure 3 to 7 after a second round pipe section 91 is provided on top of the ring 51, a second ring 93 is provided to the pipe section 91 and a top dome 95 is provided to the apparatus. The housing may be made water tight by providing flexible member 97 for example a rubber o-ring in between the housing portion and the ring 51or between the housing portion 81 and the bottom plate 73. The dome opening 101 in the top dome 95 allows for water intake for example from a water pipe whereas opening 103 may be used for the water outlet. The dome opening 101 may also be used for maintenance of the stacks. For example a socket wrench may be allowed access through the dome opening 101 to tighten a nut cooperating with a threat provided to the rod 77. By tightening the nut the capacitive electrode stacks may be compressed between the bottom plate 73 and the pressure plate 75. Before compressing the pressure plate on the capacitive electrode stacks, water may be flushed through the spacer along the electrodes. Flushing helps to remove any loose material out of the spacer and/or the membranes and/or the electrodes, after which the capacitive electrode stack will be compressed. It is advantageously that the dome opening 101 in the tope dome 95 allows for compressing the stack while the housing is filled with water. Also the dome opening 101 allows for the pressure to be adjusted at a later stage for example during installation of the apparatus or during maintenance.. Further the connector 41 located in an opening 48 in the ring 51 is shown. The clamp 53 presses the current collector of an electrode onto the connector 41 and thereby presses the closing off body 47 in the opening 48, thereby closing off the opening 48 for water inside the housing.Figure 10a discloses a pressure plate 75 according to a second embodiment. The pressure plate 75 is provided with a base 105 and a top portion 107. The top portion is provided with an opening 103 for allowing water to exit the stacks. Figure 10b discloses how the pressure plate 75 according to the second embodiment may be used to compress the capacitive electrode stacks together. A compression member, for example a nut like object 109 may be accessed through the dome opening 101 to be tightened by rotating the nut like object with respect to the top dome 95. The nut like object 109 may be provided with an external thread 111 to cooperate with an internal thread 113 provided to the top dome 95. By rotating the nut like object 109 the capacitive electrode stacks may be

compressed between the bottom plate 73 and the pressure plate 75. The nut like object 109 may be provided with holes for allowing water to pass through and for providing grip to rotate the nut like object 109. In the centre of the nut like object there is provided a hole in which the top portion 107 of the pressure plate 75 rotably fits. The pressure plate 105 may be provided with an interface between the housing and the pressure plate to inhibit a rotation of the pressure plate 105 relative to the housing. The interface may have a projection extending from one of the pressure plate and the housing; and a receiver formed in the other of the one of the pressure plate and the housing to inhibit a rotation. The top portion may define an annular lip 110 and the compression member may define an end face; and the end face of the compression member may engage the annular lip 110 of the top portion to compress the stack.

Before compressing the pressure plate on the capacitive electrode stacks, water may be flushed through the spacer along the electrodes to hydrate the stack. Hydrating and/or flushing helps to remove any loose material out of the spacer, after which the capacitive electrode stack will be compressed. It is advantageously that the dome opening 101 in the top dome 95 allows for the compression to take place because the capacitive electrode stacks may be compressed after the housing has been filled with water. Also during maintenance the compression may be adjusted via the dome opening 101. The top dome 95 which is dome shaped may include a neck that extends into the interior. Internal threads may be formed on an interior surface of the neck; and external threads may be formed on an exterior surface of the compression member. The internal threads and the external threads are configured to engage, such that rotation of the compression member around the longitudinal axis may move the compression member along a longitudinal axis of the housing. A longitudinal slit, receiver or a slot may be formed in the neck and a radial tab 108 may be extending from the top portion 107 wherein the longitudinal slit and the radial tab are configured to interface, such that rotation of the pressure plate 75 relative to the housing is inhibited.

Figure 11a shows a top view of a tray 113a for use in an embodiment. The tray 113a may comprise a main surface 115 for receiving a capacitive electrode stack. The tray 113a may be provided with opening 117 as an alignment feature, which may be used to slide the tray along the rod 77 (See figure 7) and for providing water to, or removing it from the interior of the capacitive electrode stack. The opening 117 may be constructed and arranged to cooperate with the rod 77, for example the size of the opening and the rod 77 may be substantially matching. The tray 113a may be provided with additional alignment features for alignment with the capacitive electrode stack, the rod, the housing, and/or other trays. Alignment features such as for example protrusion 119 may be used to align the tray 113a with the housing, or keep it at a constant distance of the housing. Another example of an alignment features may be tab 121 provided with teeth and provided to the first tray 113a to

interlock the tray with a second tray positioned on top of the first tray 113a. Surrounding the opening 117 there may be provided as alignment features a first and second pillar structure 123a and 123b respectively, both pillar structures may be provided with pillars and holes. The pillars 125 of the first pillar structure 123a may align with the holes 127 of a second pillar structure provided to a second tray 113b (See figure 11b). The tabs 121 with teeth of the first tray 113a may protrude through an opening in the second tray 113b and the teeth of the first tray may interlock with an edge of the opening of the second tray 113b. A spring 129 (See figure 11c) may be provided to the tab 121 of the second tray 113b to press the teeth (not shown) against the edge 131. Figure 11d shows how the teeth of the tab 121 interlock with second tray 113b. Further a first electrode 133 is shown the electrode is provided with a first current collector 135 and is positioned within the tray and is aligned by the alignment features of the second tray 113b. The first current collector 135 is protruding outside the second tray 113b so that it may be connected to other current collectors. The second tray 113b may be provided with an opening 137 which may interlock with a clamp (not shown) which clamps the first current collector of the second tray 113b to the second current collector of another tray. The trays may function as an electrical insulator between capacitive electrode stacks. By interlocking a number of trays each provided with a capacitive electrode stack and by connecting the current collectors to each other the capacitive electrode stack may be assembled together. Subsequently the capacitive electrode stacks may be put into a housing and flushed with water. After flushing the capacitive electrode stacks the stacks may be compressed by rotating the nut like object 109 of figure 10 and the capacitive electrode stacks may be compressed between the bottom plate 73 and the pressure plate 75.

While specific embodiments of the invention have been described above, it will be appreciated that the invention may be practiced otherwise than as described. For example, the invention may take the form of a computer program containing one or more sequences of machine-readable instructions describing a method as disclosed above, or a data storage medium (e.g. semiconductor memory, magnetic or optical disk) having such a computer program stored therein.

Embodiments are also provided in the following numbered clauses:

1. An apparatus for removal of ions provided with a plurality of capacitive electrode stacks, each capacitive electrode stack comprising:

a first electrode provided with a first current collector;

a second electrode provided with a second current collector; and,

a spacer between the first and second electrodes for allowing water to flow in between the electrodes, wherein the second current collector of a first of the plurality of capacitive electrode stacks is directly connected to the first current collector of a second of the plurality of capacitive electrode stacks.

2. The apparatus according to any of the preceding clauses, wherein the second current collector of the second of the plurality of capacitive electrode stacks is in direct electrical connection to the first current collector of a third of the plurality of capacitive electrode stacks.

3. The apparatus according to any of the preceding clauses, wherein the apparatus is provided with a housing, the apparatus comprising:

a water inlet for water entering an interior of the housing;

a water outlet for letting water out of the interior of the housing and the second current collector of the first of the plurality of capacitive electrode stacks is directly connected to the first current collector of the second of the plurality of capacitive electrode stacks within the same housing.

4. The apparatus according to any of the preceding clauses, wherein the first and second current collector are directly connected by pressing them against each other.

5. The apparatus according to any of the preceding clauses, wherein the apparatus is provided with a clamp to press the current collectors against each other.

6. The apparatus according to clause 5, wherein the clamp is of a non metal material.

7. The apparatus according to any of the preceding clauses, wherein the current collectors are metal free.

8. The apparatus according to any of the preceding clauses, wherein the current collectors comprise carbon to conduct an electrical charge.

9. The apparatus according to any of the preceding clauses wherein the apparatus is provided with a power connector for connection with a power supply and the stacks are in connected in series with the power connector.

10. The apparatus according to clause 9, wherein the power connector is connected in series to a first current collector of a first of the plurality of capacitive electrode stacks and to a second current collector of the last of the plurality of capacitive electrode stacks.

11. The apparatus according to any of clauses 9 to 10, wherein the power connector is provided with a metal and a carbon portion.

12. The apparatus according to clause 11, wherein the apparatus comprises a power connector clamp for pressing the current collector against the carbon portion of the power connector.

13. The apparatus according to any of the preceding clauses, wherein an insulator is provided between each capacitive electrode stack so to electrically insulate both stacks from each other.

14. The apparatus according to any of the preceding clauses wherein the insulator comprises a tray for holding the stack.

15. The apparatus according to clause 14, wherein a second insulator is provided substantially surrounding the current collector so as to electrically insulate the current collector.

16. The apparatus according to any of clause 9 to 15, wherein the apparatus is provided with a housing, the apparatus comprising:

a water inlet for water entering an interior of the housing;

a water outlet for letting water out of the interior of the housing and the power connector is providing an electrical connection between the current collector and the outside of the housing.

17. The apparatus according to any of the preceding clauses, wherein each capacitive electrode stack comprises:

a plurality of first electrodes provided with a plurality of first current collectors;

a plurality of second electrodes provided with a plurality of second current collectors; and,

the second current collectors of a first of the plurality of capacitive electrode stacks are directly connected to the first current collectors of a second of the plurality of capacitive stacks.

18. The apparatus according to clause 17, wherein the plurality of current collectors within the electrode stack are connected in parallel.

19. An apparatus for removal of ions provided with a plurality of capacitive electrode stacks, each electrode capacitive electrode stack comprising:

a first electrode provided with a first current collector;

a second electrode provided with a second current collector; and,

a spacer between the first and second electrodes for allowing water to flow in between the electrodes, wherein the apparatus comprises a power connector for connecting a power source to a plurality of capacitive electrode stacks in electrical serial connection with each other and the resistivity in each of the capacitive electrode stacks is substantially equal so as to divide the potential difference of the power source substantially equally over all capacitive electrode stacks.

20. The apparatus according to clause 19, wherein the apparatus is provided with a housing, the apparatus comprising:

a water inlet for water entering an interior of the housing;

a water outlet for letting water out of the interior of the housing and the capacitive electrode stacks are serially connected within the housing.

21. The apparatus according to any of clauses 19 to 20 wherein the electrical current going through the second electrode of the first capacitive electrode stack is equal to the electrical current going into the first electrode of the second capacitive electrode stack.

22. The apparatus according to any of clause 19 to 21 wherein the capacitive electrode stacks that are in electrical serial connection with each other are placed in the same housing

23. The apparatus according to any of clauses 19 to 22, wherein the second current collector of the first of the plurality of capacitive electrode stacks is directly connected to the first current collector of the second of the plurality of capacitive electrode stacks.

24. The apparatus according to any of the clauses 19 to 23, wherein the apparatus comprises a pressure device to provide a pressure to the stacks such that the pressure for each of the stack is equal.

25. A method for manufacturing an apparatus for removal of ions comprising:

providing a plurality of capacitive electrode stacks, each capacitive electrode stack manufactured by:

providing a first electrode provided with a first current collector;

providing a second electrodes provided with a second current collectors; and,

providing a spacer between the first and second electrodes for allowing water to flow in between the electrodes,

wherein the method comprises connecting the second current collectors of a first of the plurality of capacitive electrode stacks to the first current collectors of a second of the plurality of capacitive electrode stacks.

26. An apparatus for removal of ions, the apparatus being provided with a housing, the apparatus comprising:

a water inlet for water entering an interior of the housing;

a water outlet for letting water out of the interior of the housing;

a first electrode being provided with a current collector;

a second electrode;

a spacer for separating the electrodes and allowing water to flow in between the electrodes; and,

a connector to connect the current collector inside the housing with an electrical source outside the housing, wherein the connector comprises a closing off portion for closing an opening in the housing and for forming a boundary for the water in the housing.

27. The apparatus according to clause 26, wherein the current collector is pressed against a substantially flat surface of the connector.

28. The apparatus according to any of the clauses 26 to 27, wherein the connector is pressed against the housing.

29. The apparatus according to any of the clauses 26 to 28, wherein a flexible material is provided between the connector and the opening so as to close the opening of in a water tight manner.

30. The apparatus according to any of the clauses 26 to 29, wherein the closing off portion is made from a material comprising carbon.

31. The apparatus according to any of clauses 26 to 30, wherein the material comprises graphite.

32. The apparatus according to any of clauses 26 to 30, wherein the material comprises a conductive polymer.

33. The apparatus according to any of clauses 26 to 32, wherein the connector is provided with a metal portion connecting to the carbon portion at a dry surface of the carbon portion.

34. The apparatus according to any of clauses 26 to 33, wherein the carbon portion is provided with a hole in a dry surface of the carbon surface and the metal portion is entering the carbon portion through the hole.

35. The apparatus according to any of the clauses 26 to 34, wherein the apparatus is provided with a clamp to press the electrode against the closing off portion of the connector.

36. The apparatus according to any of the clauses 26 to 35, wherein the clamp comprises a stationary part and a moveable part and the moveable part is moveable against the electrode to press the electrode against the closing off portion of the connector.

37. The apparatus according to clause 36, wherein the moveable and the stationary part of the clamp is constructed and arranged so that the moveable part is moveable in a first direction but blocked in an opposite direction.

38. A capacitive deionization device, comprising:

a housing defining an opening between an interior of the housing and an exterior of the housing;

a stack within the housing;

a contact member seated in the opening and defining a contact portion adjacent to the interior of the housing and a connector portion adjacent to the exterior of the housing; and

a lead engaged with the connector portion and capable of directing an electrical current to the contact member;

wherein the contact portion is configured to engage the stack such that the contact member is in electrical communication with the stack.

39. The capacitive deionization device of clause 38, wherein:

the contact portion is substantially cylindrical and defines a contact face; and

a perimeter of the contact face forms an arcuate rim.

40. The capacitive deionization device of clause 38, wherein:

the contact portion defines a contact face having a rim about a perimeter of the contact face; and

the contact face includes a recess inward of the perimeter, and a protrusion extending from the recess that terminates substantially coplanar with the rim.

41. The capacitive deionization device of clause 40, wherein:
the contact face is substantially circular; and
the protrusion is substantially cylindrical.

42. The capacitive deionization device of clause 38, wherein:
the connector portion is substantially cylindrical; and
a receptacle is formed in the connector portion such that the lead is engaged within the receptacle.

43. The capacitive deionization device of clause 38, wherein:
the housing further defines a recess proximate the opening; and
the contact portion of the contact member is seated in the recess.

44. The capacitive deionization device of clause 38, wherein the contact member is at least one of press fit in the opening and adhered in the opening.

45. The capacitive deionization device of clause 38, further comprising a seal formed between the contact member and the opening such that a fluid within the interior of the housing is inhibited from flowing through the opening toward the exterior of the housing.

46. The capacitive deionization device of clause 45, wherein the seal includes an o-ring seated in an annular channel formed in a radial face of the contact portion.

47. The capacitive deionization device of clause 38 further comprising:
a plurality of electrodes within the stack;
a protrusion member extending from an interior surface of the housing; and
a compression member configured to selectively engage the protrusion member at a plurality of positions relative to the contact member such that the compression member may be adjusted to compress the plurality of electrodes between the compression member and the contact portion of the contact member.

48. The capacitive deionization device of clause 47, wherein:
the protrusion member includes a pair or arms;
the compression member includes a bridge spanning between the pair or arms; and
the bridge is moveable along the pair of arms to adjust a pressure applied to the plurality of electrodes between the bridge and the contact portion.

49. The capacitive deionization device of clause 38, wherein:
the stack includes an electrode having an electrode plane;
the contact portion defines a contact face having a contact plane; and
the electrode plane and the contact plane are substantially parallel.

50. The capacitive deionization device of clause 38, wherein:
the opening defines an elbow passage having a first portion extending substantially perpendicular to a longitudinal axis of the housing and a second portion extending substantially parallel to the longitudinal axis; and

the contact member is seated in the second portion.

51. The capacitive deionization device of clause 38, wherein the contact member is at least partially formed of graphite.

52. An electrical connector assembly, comprising:

a base member;

a contact member seated in the base member and defining a contact portion and a connector portion extending from the contact portion;

a lead engaged with the connector portion and capable of directing an electrical current to the contact member;

a protrusion member extending from the base member adjacent to the contact member; and

a compression member configured to selectively engage the protrusion member at a plurality of positions relative to the contact member such that the compression member may be adjusted to compress an electrode between the compression member and the contact member.

53. The electrical connector assembly of clause 52, wherein:

the contact portion is substantially cylindrical and defines a contact face; and

a perimeter of the contact face forms an arcuate rim.

54. The electrical connector assembly of clause 52, wherein:

the contact portion defines a contact face having a rim about a perimeter of the contact face; and

the contact face includes a recess inward of the perimeter, and a protrusion extending from the recess that terminates substantially coplanar with the rim.

55. The electrical connector assembly of clause 54, wherein:

the contact face is substantially circular; and

the protrusion is substantially cylindrical.

56. The electrical connector assembly of clause 52, wherein:

the connector portion is substantially cylindrical; and

a receptacle is formed in the connector portion such that the lead is engaged within the receptacle.

57. The electrical connector assembly of clause 52, wherein:

the base member defines a recess; and

the contact portion of the contact member is seated in the recess.

58. The electrical connector assembly of clause 57, wherein the contact member is at least one of press fit in the recess and adhered in the recess.

59. The electrical connector assembly of clause 57, further comprising a seal formed between the contact member and the recess such that a fluid is inhibited from flowing past the seal.

60. The electrical connector assembly of clause 59, wherein the seal includes an o-ring seated in an annular channel formed in a radial face of the contact portion.

61. The electrical connector assembly of clause 52, wherein:

the protrusion member includes a pair of arms;

the compression member includes a bridge spanning between the pair of arms; and

the bridge is moveable along the pair of arms to adjust a pressure applied to the electrode between the bridge and the contact portion of the contact member.

62. The electrical connector assembly of clause 52, wherein:

the compression member includes a resilient arm having a first interlocking member; and

the protrusion member includes a second interlocking member;

wherein the first interlocking member and the second interlocking member are configured to selectively engage such that first interlocking member of the compression member may be restrained relative to the contact member by the second interlocking member of the protrusion member.

63. The electrical connector assembly of clause 62, wherein:

the first interlocking member defines a plurality of ramps;

the second interlocking member defines a plurality of inverse ramps;

the plurality of ramps and the plurality of inverse ramps engage to inhibit separation of the protrusion member and the compression member.

64. The electrical connector assembly of clause 52, wherein:

the contact portion defines a contact plane;

the compression member defines a compression plane; and

the contact plane and the compression plane are substantially parallel.

65. The electrical connector assembly of clause 52, wherein:

the base member includes an opening that defines an elbow passage having a first portion extending substantially perpendicular to a wall of the base member and a second portion extending substantially parallel to the wall; and

the contact member is seated in the second portion.

66. The electrical connector assembly of clause 52, wherein the contact member is at least partially formed of graphite.

67. An electrical connector, comprising:

a contact portion having a head that defines a contact face;

a connector portion having a neck extending from the head in a direction away from the contact face;

a lead engaged with the neck and capable of directing an electrical current to the head; and

a seal portion defined by at least one of the head and the neck such that the seal portion establishes a hydraulic seal between the seal portion and a mount into which the electrical connector is seated during operation.

68. The electrical connector of clause 67, wherein:

the head is substantially cylindrical; and

the neck is substantially cylindrical.

69. The electrical connector of clause 67, wherein a perimeter of the contact face forms an arcuate rim.

70. The electrical connector of clause 67, wherein the contact face further comprises:

a rim about a perimeter of the contact face;

a recess inward of the perimeter; and

a protrusion extending from the recess that terminates substantially coplanar with the rim.

71. The electrical connector of clause 70, wherein:

the contact face is substantially circular; and

the protrusion is substantially cylindrical.

72. The electrical connector of clause 67, wherein:

the connector portion is substantially cylindrical; and

a receptacle is formed in the neck such that the lead is engaged within the receptacle.

73. The electrical connector of clause 67, wherein the seal portion is defined by the head.

74. The electrical connector of clause 73, wherein the seal portion includes:

an annular channel formed in a radial face of the head; and

an o-ring seated in the annular channel.

75. The electrical connector of clause 67, wherein the head defines an annular mounting face opposite to the contact face.

76. The electrical connector of clause 67, wherein the contact portion is at least partially formed of graphite.

77. The electrical connector of clause 76, wherein the connector portion is at least partially formed of graphite.

78. The electrical connector of clause 67, wherein the contact portion and the connector portion are integral.

79. A capacitive deionization device, comprising:

a housing defining a opening;

a stack within the housing;

a pressure plate within the housing and adjacent to the stack; and

a compression member within the opening and adjacent to the pressure plate;

wherein the compression member engages the housing and the pressure plate such that moving the compression member relative to the housing urges the pressure plate toward the stack to compress the stack.

80. The capacitive deionization device of clause 79, further comprising:

a first fluid passage formed through the compression member and in fluid communication with the opening; and

a second fluid passage formed through the pressure plate and in fluid communication with the opening.

81. The capacitive deionization device of clause 79, further comprising an interface between the housing and the pressure plate that inhibits rotation of the pressure plate relative to the housing.

82. The capacitive deionization device of clause 81, wherein the interface comprises:

a projection extending from one of the pressure plate and the housing; and

a receiver formed in the other of the one of the pressure plate and the housing.

83. The capacitive deionization device of clause 79, further comprising:

internal threads formed on an interior surface of the opening; and

external threads formed on an exterior surface of the compression member;

wherein the internal threads and the external threads are configured to engage, such that rotation of the compression member relative to the housing moves the compression member along an axis of the housing.

84. The capacitive deionization device of clause 79, wherein rotating the compression member relative to the housing adjusts the compression member to alter a position of the pressure plate.

85. The capacitive deionization device of clause 79, wherein the stack comprises a plurality of stacks.

86. A capacitive deionization device, comprising:

a housing, the housing including:

a first end; and

a second end opposite to the first end;

a stack arranged within the housing, the stack including:

a first electrode;

an anion member adjacent to the first electrode;

a second electrode;

a cation member adjacent to the second electrode; and

a spacer between the anion member and the cation member;

a pressure plate adjacent to the stack, the pressure plate including:

a base; and

a top portion extending from the base; and

a compression member proximate to the pressure plate and the housing;

wherein the compression member engages the top portion of the pressure plate and the first end of the housing, such that the compression member may be adjusted to alter a position of the pressure plate relative to the first end of the housing to compress the stack toward the second end of the housing.

87. The capacitive deionization device of clause 86, wherein rotating the compression member relative to the housing adjusts the compression member to alter the position of the pressure plate relative to the first end of the housing.

88. The capacitive deionization device of clause 86, wherein:

the housing defines internal threads; and

the compression member defines external threads configured to threadably engage the internal threads of the housing.

89. The capacitive deionization device of clause 86, wherein:

the top portion defines an annular lip;

the compression member defines an end face; and

the end face of the compression member engages the annular lip of the top portion to compress the stack toward the second end of the housing when the compression member is adjusted.

90. The capacitive deionization device of clause 86, further comprising:

an opening formed through the first end of the housing;

a first fluid passage formed through the compression member and in fluid communication with the opening; and

a second fluid passage formed though the pressure plate, and in fluid communication with the opening;

wherein the first fluid passage defines a fluid inlet directing untreated fluid into the housing; and

wherein the second fluid passage defines a fluid outlet directing treated water from the housing.

91. The capacitive deionization device of clause 86, further comprising an interface between the housing and the pressure plate, such that the interface inhibits rotation of the pressure plate relative to the housing.

92. The capacitive deionization device of clause 91, wherein the interface comprises:

a projection extending from the top portion of the pressure plate; and

a receiver formed in the first end of the housing.

93. The capacitive deionization device of clause 86, further comprising an interior defined between the first end and the second end of the housing, wherein the first end is dome-shaped and includes a neck that extends into the interior.

94. The capacitive deionization device of clause 93, further comprising:

internal threads formed on an interior surface of the neck; and

external threads formed on an exterior surface of the compression member;

wherein the internal threads and the external threads are configured to engage, such that rotation of the compression member moves the compression member along a longitudinal axis of the housing.

95. The capacitive deionization device of clause 94, further comprising:

a longitudinal slit formed in the neck; and

a radial tab extending from the top portion;

wherein the longitudinal slit and the radial tab are configured to interface, such that rotation of the pressure plate relative to the housing is inhibited.

96. The capacitive deionization device of clause 86, wherein the stack comprises a plurality of stacks.

97. A capacitive deionization device, comprising:

a housing defining a longitudinal axis;

a stack within the housing;

a pressure plate within the housing and adjacent to the stack;

a compression member engaged with the housing and adjacent to the pressure plate, such that movement of the compression member relative to the housing urges the pressure plate along the longitudinal axis toward the stack; and

an interface between the housing and the pressure plate that inhibits rotation of the pressure plate relative to the housing.

99. The capacitive deionization device of clause 97, wherein the interface comprises:

a projection extending from one of the pressure plate and the housing; and

a receiver formed in the other of the one of the pressure plate and the housing.

100. The capacitive deionization device of clause 98, wherein the interface comprises:

a tab radially extending from the pressure plate; and

a slot formed in the housing;

wherein the tab is sized to seat within the slot, such that the pressure plate is inhibited from rotation relative to the housing as the tab of the pressure plate abuts the slot of the housing.

101. The capacitive deionization device of clause 98, wherein:

the housing defines internal threads;

the compression member defines external threads configured to threadably engage the internal threads of the housing; and

rotation of the compression member urges the pressure plate along the longitudinal axis toward the stack.

102. The capacitive deionization device of clause 101, wherein:

the compression member rotates about the longitudinal axis; and

the compression member directly engages the pressure plate.

103. The capacitive deionization device of clause 97, further comprising:

an opening formed through the housing;

a first fluid passage formed through the compression member and in fluid communication with the opening; and

a second fluid passage formed through the pressure plate and in fluid communication with the opening.

104. The capacitive deionization device of clause 103, wherein the opening and the second fluid passage are concentric and axially aligned with the longitudinal axis.

105. The capacitive deionization device of clause 97, wherein rotating the compression member relative to the housing adjusts the compression member to alter a position of the pressure plate.

106. A capacitive deionization device, comprising:

a housing defining an opening between an interior of the housing and an exterior of the housing;

a stack within the housing;

a pressure plate within the housing and adjacent to the stack;

a compression member engaged with the housing and adjacent to the pressure plate;

a first fluid passage formed through the compression member and extending into the opening of the housing; and

a second fluid passage formed through the pressure plate and extending into the opening of the housing;

wherein moving the compression member relative to the housing urges the pressure plate toward the stack to compress the stack;

wherein the first fluid passage defines one of a fluid inlet directing untreated fluid from the exterior to the interior of the housing and a fluid outlet directing treated water from the interior to the exterior of the housing; and

wherein the second fluid passage defines the other of the one of the fluid inlet and the fluid outlet.

107. The capacitive deionization device of clause 106, further comprising:

internal threads formed on an interior surface of the opening; and

external threads formed on an exterior surface of the compression member;

wherein the internal threads and the external threads are configured to engage, such that rotation of the compression member urges the pressure plate toward the stack.

108. The capacitive deionization device of clause 106, wherein rotating the compression member relative to the housing adjusts the compression member to alter a position of the pressure plate.

109. The capacitive deionization device of clause 106, wherein the opening and the second fluid passage are concentric.

110. The capacitive deionization device of clause 106, further comprising an interface between the housing and the pressure plate that inhibits rotation of the pressure plate relative to the housing.

111. The capacitive deionization device of clause 110, wherein the interface comprises:

a projection extending from one of the pressure plate and the housing; and

a receiver formed in the other of the one of the pressure plate and the housing.

112. The capacitive deionization device of clause 106, wherein:

the compression member is cylindrical, and defines an interior surface and an exterior surface; and

the first fluid passage comprises a plurality of fluid passages radially spaced about the compression member and formed between the interior surface and the exterior surface.

113. The capacitive deionization device of clause 112, wherein the exterior surface of the compression member defines external threads that are configured to engage internal threads formed on an interior surface of the opening.

114. A method of using a capacitive deionization device, comprising:

providing a housing defining an opening between an interior of the housing and an exterior of the housing;

positioning a stack in the interior of the housing;

orienting a pressure plate in the interior of the housing and adjacent to the stack;

engaging a compression member with the housing and the pressure plate;

adjusting the compression member relative to the housing to urge the pressure plate toward the stack to compress the stack with the pressure plate; and

hydrating the stack by directing fluid through the opening.

115. The method of clause 114, wherein the compression member is adjusted after hydrating the stack.

116. The method of clause 114, wherein adjusting the compression member increases a pressure applied to the stack by the pressure plate.

117. The method of clause 114, further comprising a first fluid passage formed through the compression member, wherein hydrating the stack includes directing the fluid into the first passage.

118. A method of producing an apparatus for removal of ions from water, the method comprises:

providing a first electrode;

providing a spacer against the first electrode; and

providing a second electrode against the spacer;

wherein the method further comprises:

flushing water through the spacer and subsequently exerting a force on the stack so as to compress the first and second electrode and the spacer.

119. The method according to clause 118, wherein the steps of:

providing a first electrode;

providing a spacer against the first electrode;

providing a second electrode against the spacer; and,

providing a spacer against the second electrode are repeated multiple times.

120. The method according to any of the clauses 118 to 119, wherein exerting a force results in a pressure of less than 5 Bar, preferably less than 2 Bar, more preferably between 1 Bar and 0,5 Bar between the electrodes and the spacer.

121. The method according to any of the clauses 118 to 120, wherein the method comprises providing a tray for holding the electrodes and the spacer.

122. The method according to any of the clauses 118 to 121, wherein the method comprises aligning the electrodes and the spacer with each other.

123. The method according to any of the clauses 118 to 122, wherein flushing water through the spacer comprises flushing with a pressure of between 0,5 and 10 Bar, preferably between 1 and 5 Bar and most preferably between 2 and 4 Bar.

124. The method according to any of the clauses 118 to 123, wherein the method comprises providing the electrodes and the spacer in a housing, the housing comprising an inlet and an outlet opening and providing water to the housing via the inlet opening for flushing water through the spacer.

125. The method according to any of the clauses 118 to 124, wherein exerting a force so as to compress the first and second electrode and the spacer comprises providing a first pressure plate against one side of a stack formed by the electrodes and the spacer and a second pressure plate against the other side of the stack, providing a rod through all the electrodes and spacers and exerting a force on the first and second pressure plate via the rod to compress the stack in between the plates.

126. The method according to of the clauses 118 to 125, wherein the first and second electrodes comprise current collectors and some current collectors may be connected together before compressing the first and second electrode and the spacer.

The descriptions above are intended to be illustrative, not limiting. Thus, it will be apparent to one skilled in the art that modifications may be made to the invention as described without departing from the scope of the claims set out below.

C O N C L U S I E S

1. Een apparaat voor het verwijderen van ionen, voorzien van een meervoud van capacitieve electrode stapels, elk capacitieve elektrode stapel omvattende:

een eerste elektrode voorzien van een eerste stroomcollector;

een tweede elektrode voorzien van een tweede stroomcollector, en,

een afstandshouder tussen de eerste en tweede elektroden voor het toestaan van een waterstroom tussen de elektroden, met het kenmerk dat de tweede stroomcollector van een eerste van de meervoud van capacitieve electrode stapels is verbonden met de eerste stroomcollector van een tweede van de meervoud van capacitieve electrode stapels.

2. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat de tweede stroomcollector van de tweede van de meervoud van capacitieve electrode stapels in directe elektrische verbinding is met de eerste stroomcollector van een derde van de meervoud van capacitieve electrode stapels.

3. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat het apparaat is voorzien van een behuizing, het apparaat omvat:

een waterinlaat voor het binnen laten van water in een binnenruimte van de behuizing;

een waterafvoer voor het buitenlaten van water uit de binnenruimte van de behuizing; en de tweede stroomcollector van de eerste van de meervoud van capacitieve electrode stapels is direct verbonden met de eerste stroomcollector van de tweede van de meervoud van capacitieve electrode stapels binnen hetzelfde huis .

4. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat de eerste en de tweede stroomcollector direct verbonden zijn door ze tegen elkaar te persen.

5. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat het apparaat is voorzien van een klem om de stroomcollectoren tegen elkaar te persen.

6. Het apparaat volgens conclusie 5, met het kenmerk dat de klem is van een niet metalen materiaal.

7. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat de stroomcollectoren metaal vrij zijn.

8. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat de stroomcollectoren omvatten koolstof om een elektrische lading te vervoeren.

9. Het apparaat volgens een van de voorgaande conclusies met het kenmerk dat het apparaat is voorzien van een voedingsverbinding voor verbinding met een voeding en de stapels in serie geschakeld zijn met de voedingsverbinding.

10. Het apparaat volgens conclusie 9, met het kenmerk dat de voedingsverbinding in serie is geschakeld met een eerste stroomcollector van een eerste van de meervoud van capacitieve electrode stapels en een tweede stroomcollector van de laatste van de meervoud van capacitieve electrode stapels.

11. Het apparaat volgens een van de conclusies 9-10, met het kenmerk dat de voedingsverbinding is voorzien van een metalen en een koolstof gedeelte.

12. Het apparaat volgens conclusie 11, met het kenmerk dat het apparaat omvat een voedingsverbindingsklem voor het drukken van de stroomcollector tegen het koolstof gedeelte van de voedingsverbinding.

13. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat een isolator is voorzien tussen elke capacitieve electrode stapel om zo elektrisch de stapels te isoleren van elkaar.

14. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat de isolator omvat een drager voor het vasthouden van de stapel.

15. Het apparaat volgens conclusie 14, met het kenmerk dat een tweede isolator is voorzien overwegend rondom de stroomcollector om elektrisch de stroomcollector te isoleren.

16. Het apparaat volgens een van conclusie 9 tot 15, met het kenmerk dat het apparaat is voorzien van een behuizing, het apparaat omvat:
een waterinlaat voor het binnenlaten van water in een binnenruimte van de behuizing;
een waterafvoer voor het buitenlaten van water uit de binnenruimte van de behuizing en de voedingsverbinding is voorzien van een elektrische verbinding tussen de stroomcollector en de buitenkant van de behuizing.

17. Het apparaat volgens een van de voorgaande conclusies, met het kenmerk dat elke capacitieve elektrode stapel omvat:

een meervoud van eerste elektroden voorzien van een meervoud van eerste stroomcollectoren;

een meervoud van tweede elektroden voorzien van een meervoud van tweede stroomcollectoren, en,

de tweede stroomcollector van een eerste van de meervoud van capacitieve electrode stapels zijn direct verbonden met de eerste stroomcollector van een tweede van de meervoud van capacitieve stapels.

18. Het apparaat volgens conclusie 17, met het kenmerk dat de meervoud van de stroomcollectoren binnen de elektrode stapel parallel zijn aangesloten.

19. Een apparaat voor het verwijderen van ionen voorzien van een meervoud van capacitieve electrode stapels, elke elektrode capacitieve elektrode stapel omvattende:

een eerste elektrode voorzien van een eerste stroomcollector;

een tweede elektrode voorzien van een tweede stroomcollector, en,

een afstandshouder tussen de eerste en tweede elektrode voor het toestaan van een waterstroom tussen de elektroden, met het kenmerk dat het apparaat omvat een voedingsverbinding voor het aansluiten van een voedingsbron voor een meervoud van capacitieve electrode stapels in elektrische seriële verbinding met elkaar en de weerstand in elk van de de capacitieve electrode stapels is nagenoeg gelijk, zodat de potentiaal verschillen van de voedingsbron in hoofdzaak gelijk over alle capacitieve electrode stapels is verdeelt.

20. Het apparaat volgens conclusie 19, met het kenmerk dat het apparaat is voorzien van een behuizing, het apparaat omvat:

een waterinlaat voor het binnenlaten van water in een binnenruimte van de behuizing;

een waterafvoer voor het buitenlaten van water uit de binnenruimte van de behuizing en de capacitieve elektrode stapels zijn serieel verbonden in de behuizing.

21. Het apparaat volgens een van de conclusies 19-20, met het kenmerk dat de elektrische stroom door de tweede elektrode van de eerste capacitieve electrode stapel gelijk is aan de elektrische stroom door de eerste elektrode van de tweede capacitieve electrode stapel.

22. Het apparaat volgens een van de conclusies 19 tot 21, met het kenmerk dat de capacitieve elektrode stapels in elektrische seriële verbinding met elkaar worden geplaatst in dezelfde behuizing.

23. Het apparaat volgens een van de conclusies 19-22, met het kenmerk dat de tweede stroomcollector van de eerste van de meervoud van capacitieve electrode stapels direct is verbonden met de eerste stroomcollector van de tweede van de meervoud van capacitieve electrode stapels.

24. Het apparaat volgens een van de conclusies 19-23, met het kenmerk dat het apparaat omvat een drukmiddel om een druk te verlenen aan de stapels zodanig dat de druk voor elk van de stapel gelijk is.

25. Een werkwijze voor het vervaardigen van een apparaat voor het verwijderen van ionen, omvattende:

het voorzien van een meervoud van capacitieve electrode stapels, elk capacitieve elektrode stapel vervaardigd door:

het voorzien van een eerste elektrode voorzien van een eerste stroomcollector;

het voorzien van een tweede elektroden voorzien van een tweede stroomcollector, en,

het voorzien van een afstandshouder tussen de eerste en tweede elektroden voor het toelaten van een waterstroom tussen de elektroden,

met het kenmerk dat de werkwijze omvat het aansluiten van de tweede stroomcollectoren van een eerste van de meervoud van capacitieve electrode stapels aan de eerste stroomcollectoren van een tweede van de meervoud van capacitieve electrode stapels.

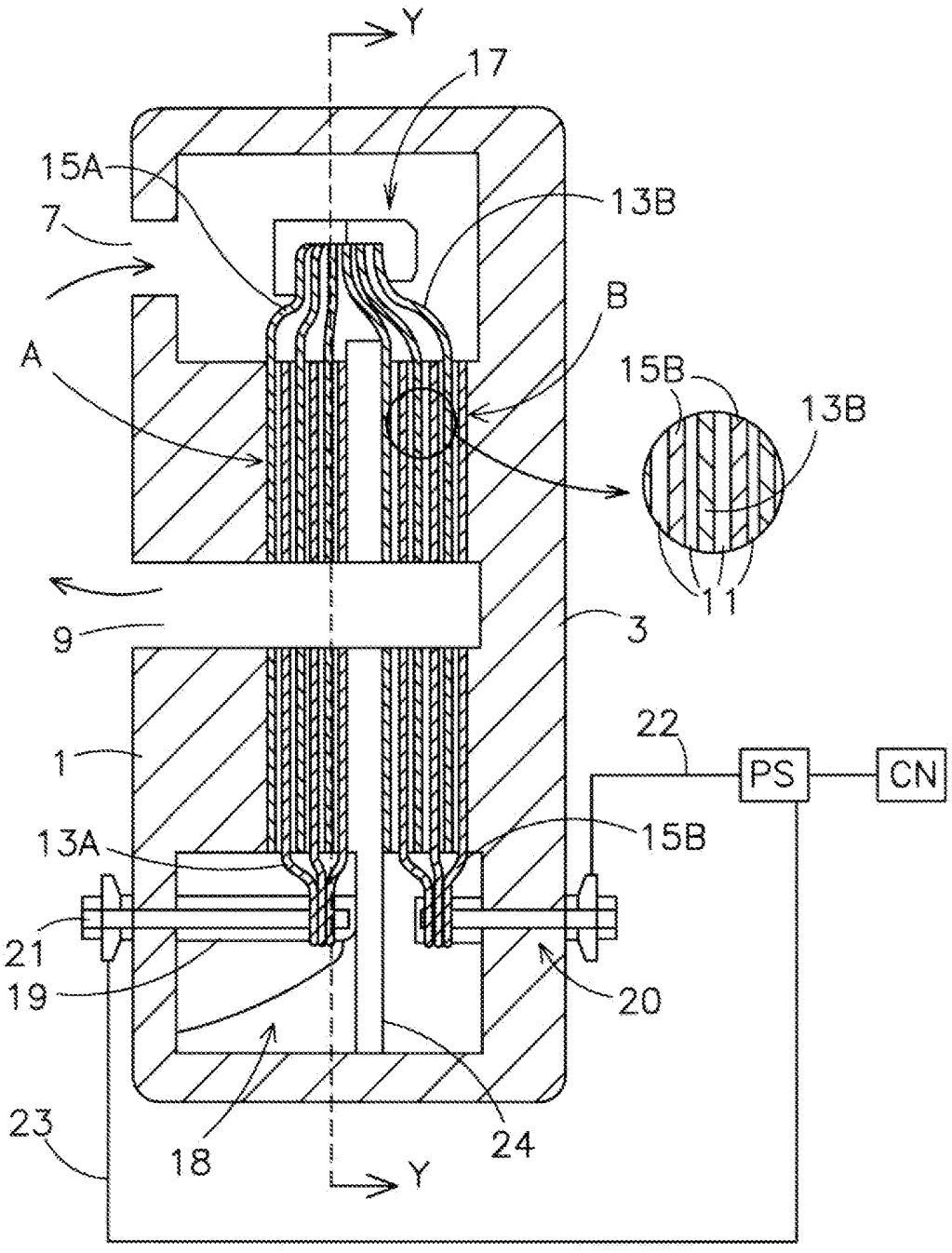

Fig 1

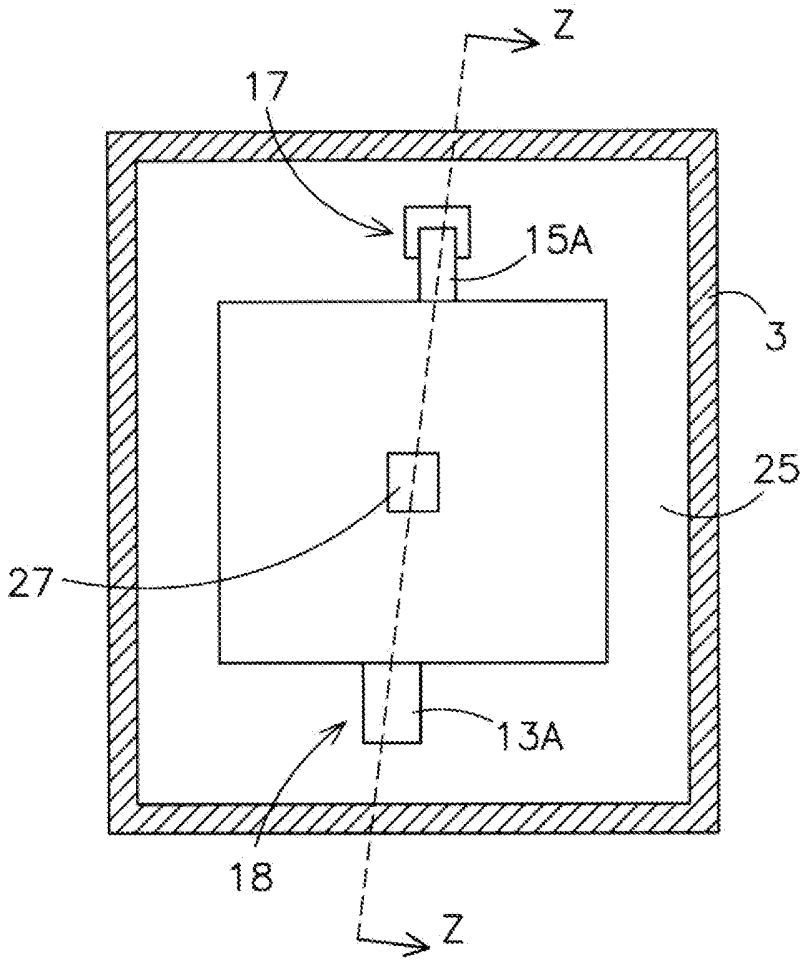

Fig 2

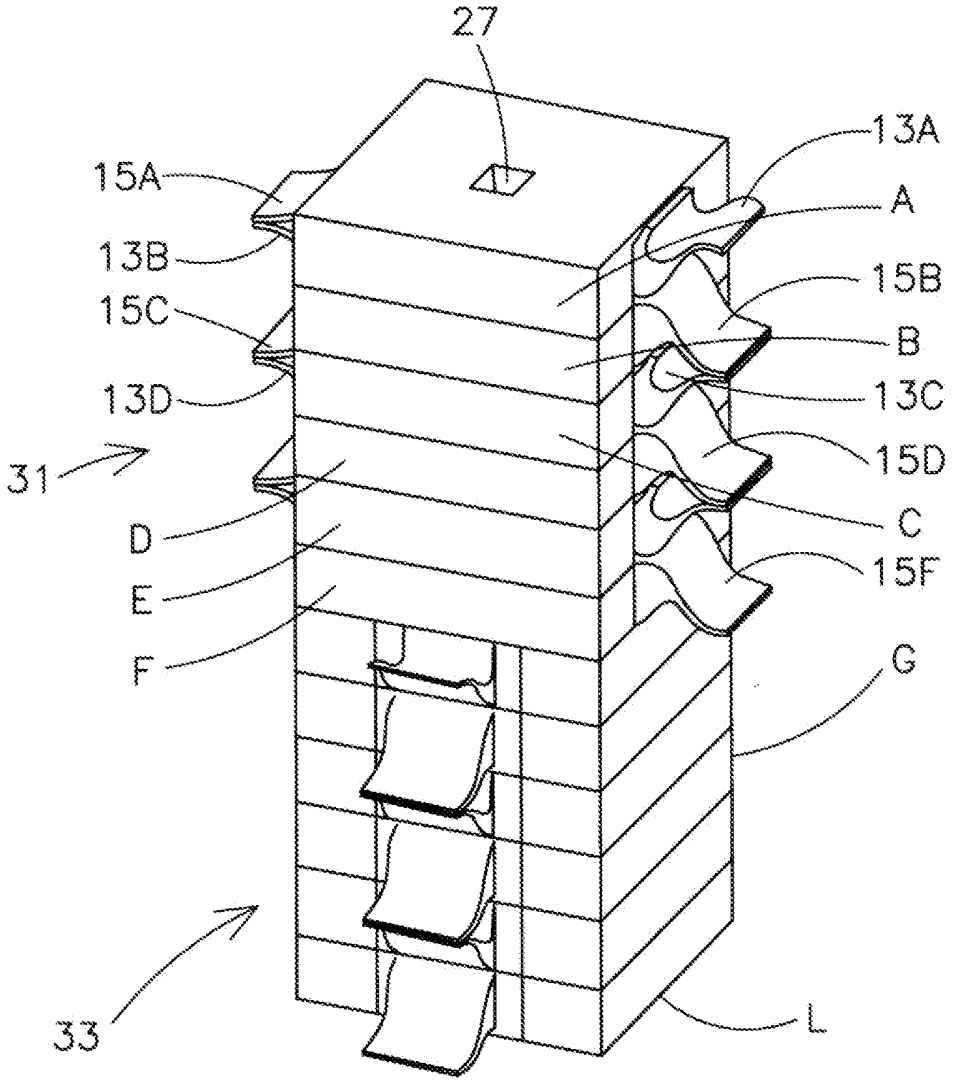
27
15A
13A
A
13B
15B
15C
B
13D
13C
31
15D
C
D
15F
E
F
G
33
L

Fig 3

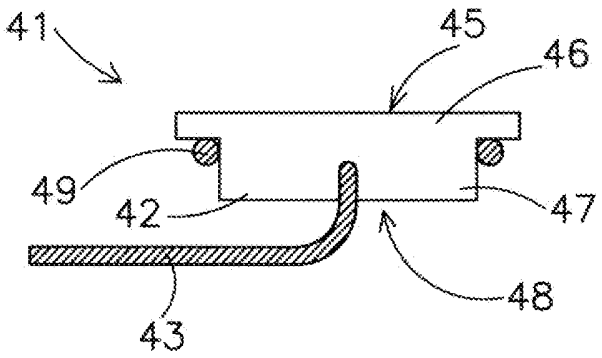
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Fig 4

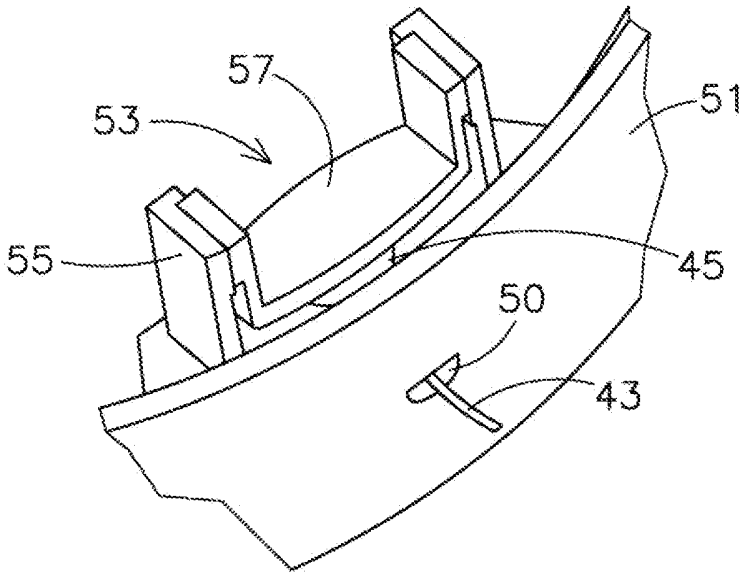

Fig 5

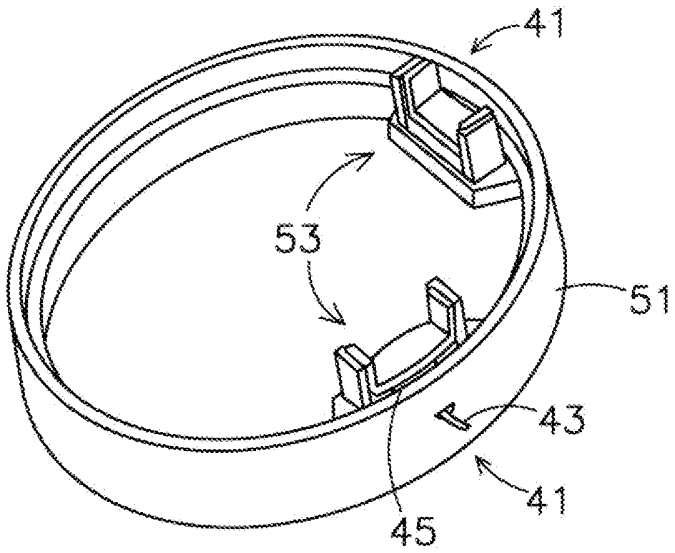

Fig 6

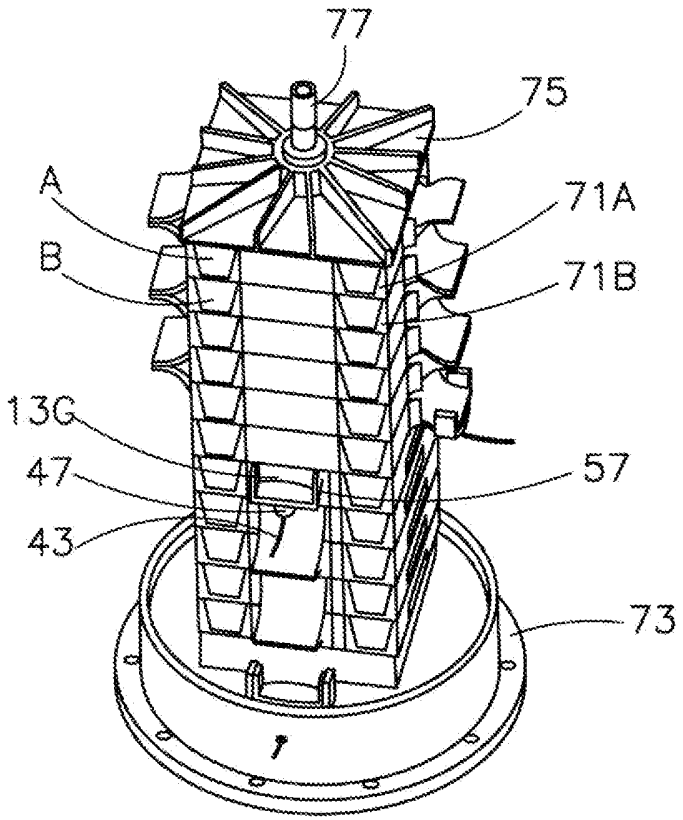

Fig 7

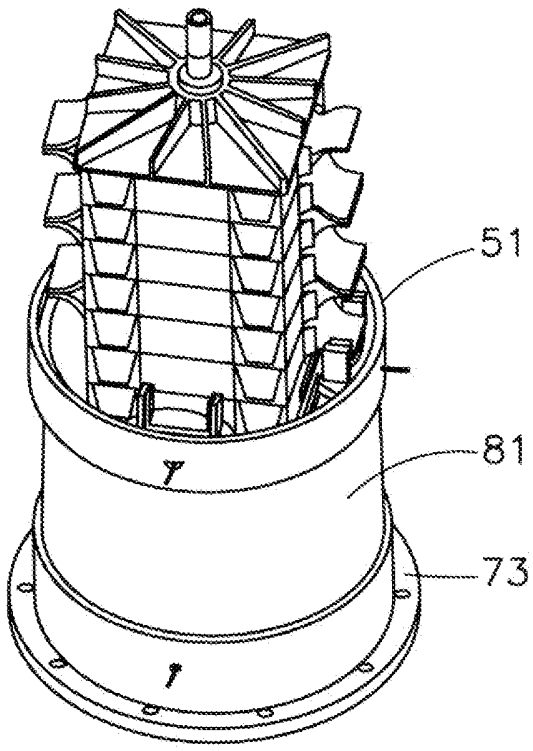

Fig 8

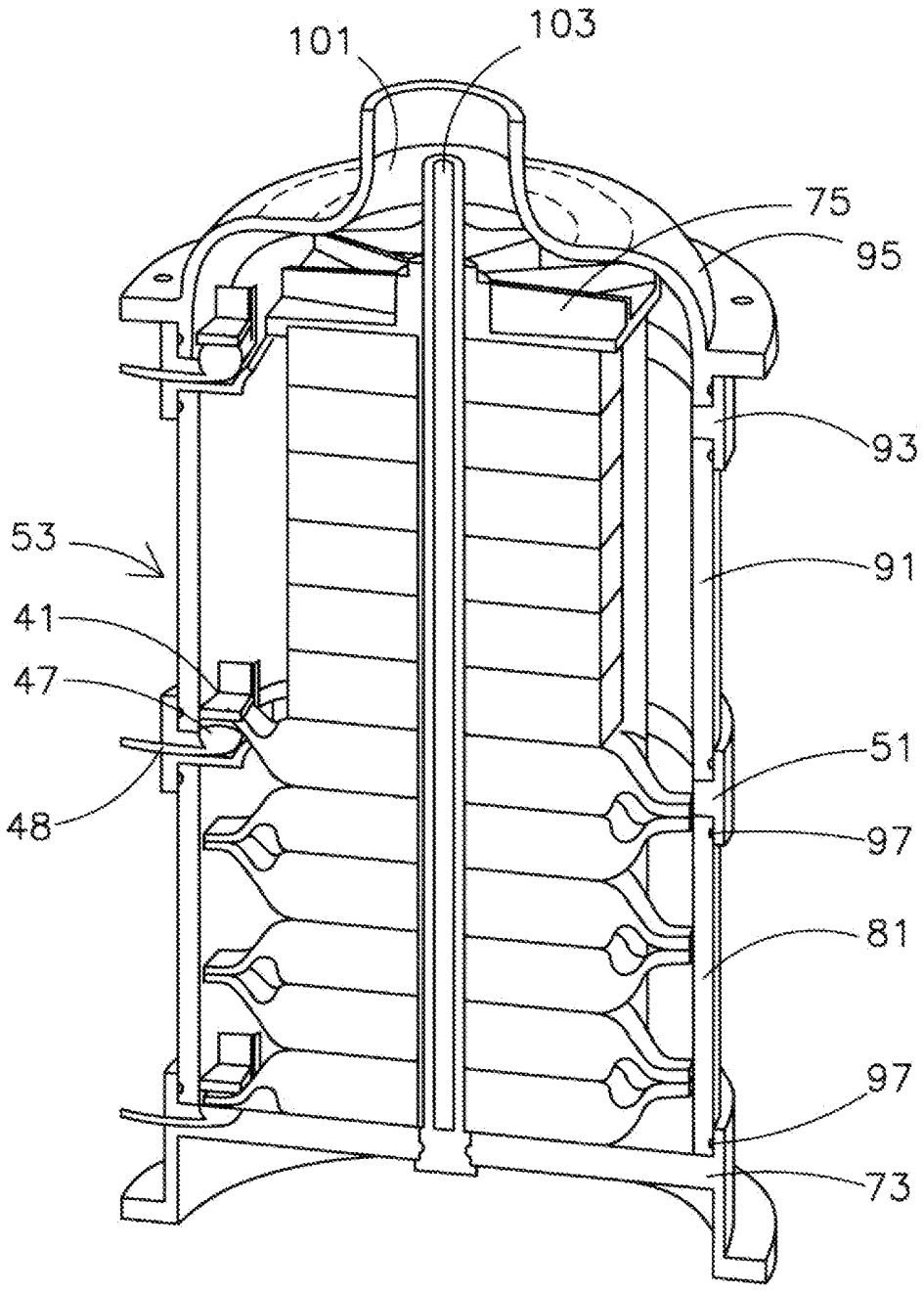

Fig 9

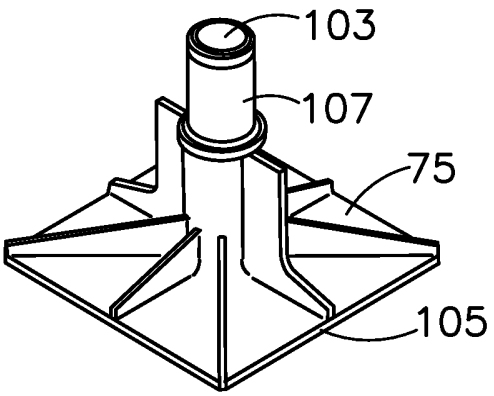

Fig 10a

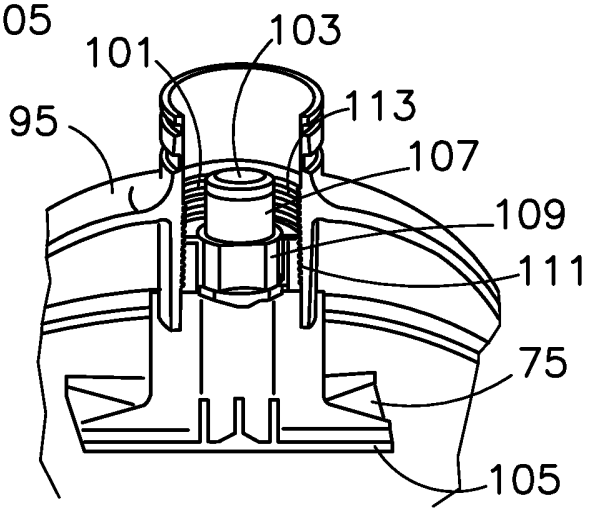

Fig 10b

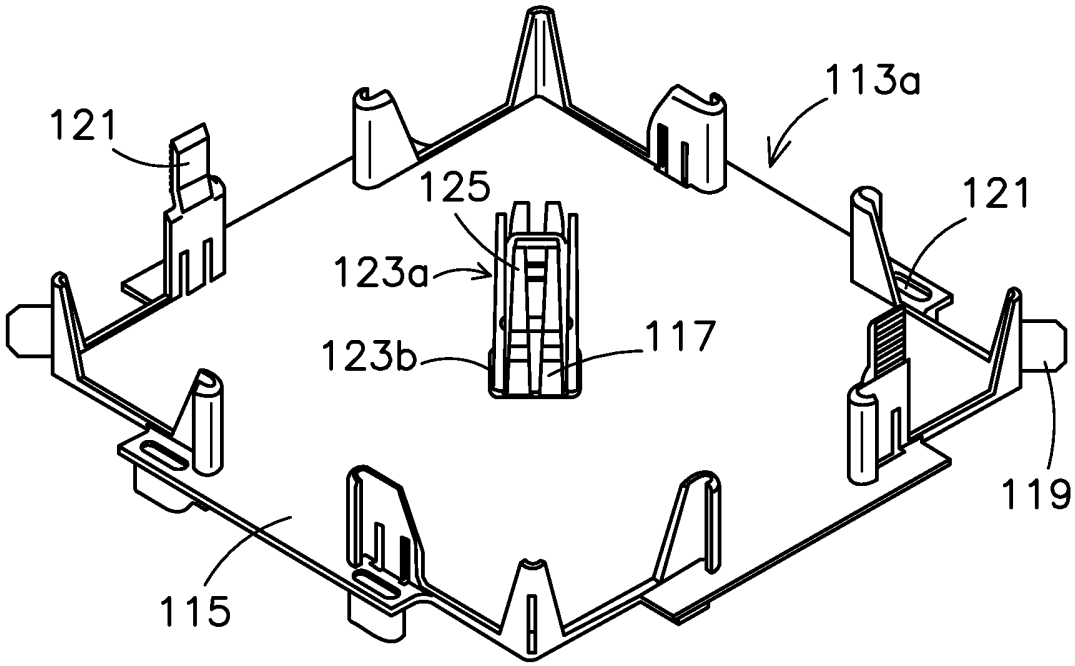

Fig 11a

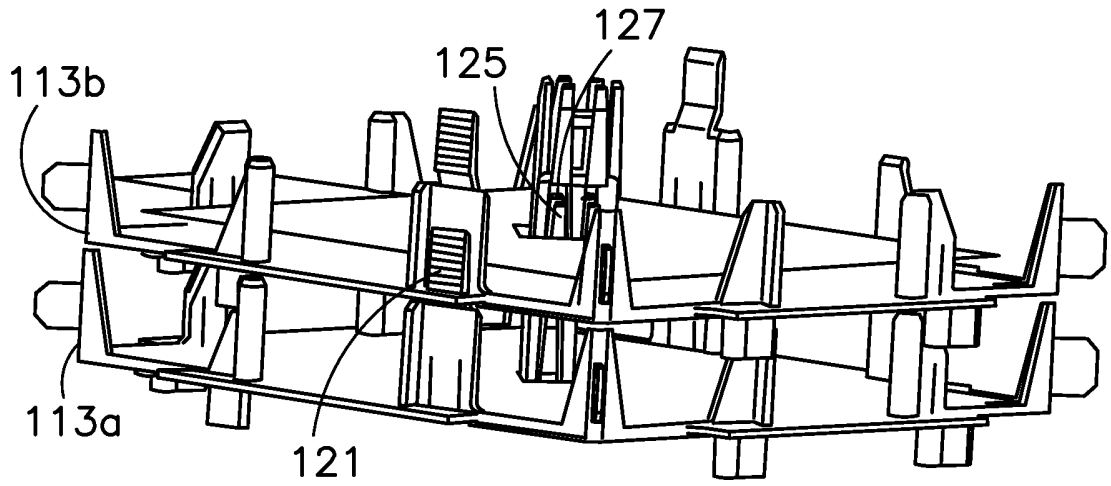

Fig 11b

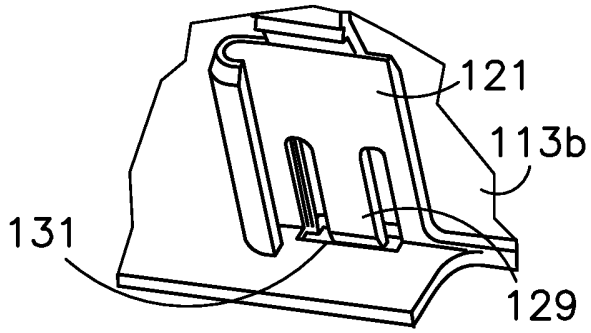

Fig 11c

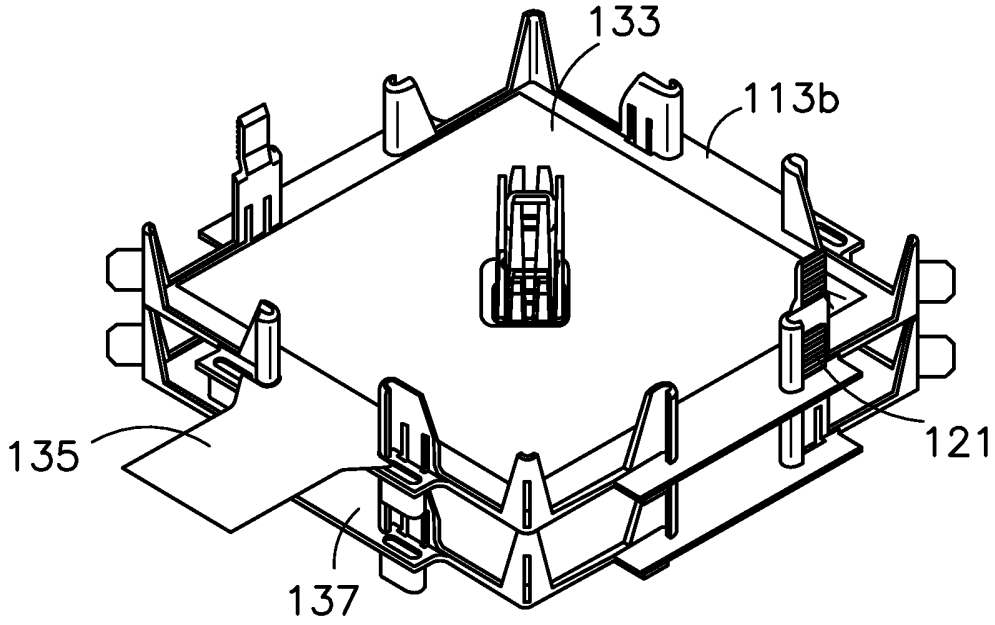

Fig 11d

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P30810NL00/JFL
Nederlands aanvraag nr. **2007598**	Indieningsdatum **14-10-2011**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Voltea B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **21-01-2012**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN 57496**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

C02F1/469

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen		
IPC8	**C02F**	**B01D**	**H01G**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III. ☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV. ☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2007598

A. CLASSIFICATIE VAN HET ONDERWERP
INV. C02F1/469
ADD. C02F103/08

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
C02F B01D H01G

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	EP 1 164 110 A1 (ABB RESEARCH LTD [CH]) 19 december 2001 (2001-12-19)	1,19,25
Y	* alineas [0022], [0035]; conclusie 1; figuren 2a,2b *	1-25

X	US 2008/105551 A1 (WANG SHENGXIAN [CN] ET AL) 8 mei 2008 (2008-05-08)	1,19,25
Y	* alineas [0042] - [0045]; conclusies 1,23,24,26; figuur 6 *	1-25

X	WO 2011/072400 A1 (ENPAR TECHNOLOGIES INC [CA]; SEED LEONARD PAUL [CA]; PARGARU IURIE [CA) 23 juni 2011 (2011-06-23)	1,19,25
Y	* alineas [0068], [0077]; conclusie 1; figuren 4-8 *	1-25

	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
28 maart 2012	
Naam en adres van de instantie European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	**De bevoegde ambtenaar** Van Iddekinge, R

2

Formulier PCT/ISA/201 (tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2007598

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X Y	US 5 584 981 A (TURNER ANDREW D [GB] ET AL) 17 december 1996 (1996-12-17) * kolom 11, regel 39 - kolom 11, regel 56; figuur 6 *	1,19,25 1-25
X Y	US 2011/042205 A1 (KIM CHANG-HYUN [KR] ET AL) 24 februari 2011 (2011-02-24) * alineas [0099] - [0103], [0108], [0109]; figuren 9-12 *	1,19,25 1-25
X Y	WO 01/13389 A1 (ANDELMAN MARC D [US]) 22 februari 2001 (2001-02-22) * conclusies 1-12; figuren 1-6 *	1,19,25 1-25
A	EP 2 253 593 A1 (VOLTEA B V [NL]) 24 november 2010 (2010-11-24) * conclusies 1,15; figuur 1 *	1-25
A	EP 2 322 486 A1 (VOLTEA B V [NL]) 18 mei 2011 (2011-05-18) * conclusie 1; figuur 1 *	1-25
A	WO 00/14304 A1 (ANDELMAN MARC D [US]; OTOWA TOSHIRO [JP]; TANAKA NAOTO [JP]) 16 maart 2000 (2000-03-16) * conclusies 1-5; figuur 4 *	1-25
A	EP 2 338 843 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 29 juni 2011 (2011-06-29) * alineas [0086], [0087], [0094]; figuur 5 *	1-25
A	WO 2010/069065 A1 (ENPAR TECHNOLOGIES INC [CA]; SEED LEONARD PAUL [CA]; YETMAN DAREN D [C) 24 juni 2010 (2010-06-24) * alinea [0057]; figuren 1-4 *	1-25
A	OREN ET AL: "Capacitive deionization (CDI) for desalination and water treatment - past, present and future (a review)", DESALINATION, ELSEVIER, AMSTERDAM, NL, deel 228, nr. 1-3, 15 augustus 2008 (2008-08-15), bladzijden 10-29, XP022735169, ISSN: 0011-9164, DOI: 10.1016/J.DESAL.2007.08.005 [gevonden op 2008-06-18] * bladzijden 20-23: "3.2 Design and modes of operation of CDI units" *	1-25

2

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2007598

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)		Datum van publicatie
EP 1164110	A1 19-12-2001	AU	5458601 A	24-12-2001
		EP	1164110 A1	19-12-2001
		WO	0196245 A1	20-12-2001
US 2008105551	A1 08-05-2008	CN	101331088 A	24-12-2008
		US	2008105551 A1	08-05-2008
		WO	2007070594 A2	21-06-2007
WO 2011072400	A1 23-06-2011	GEEN		
US 5584981	A 17-12-1996	CA	2148320 A1	07-11-1995
		JP	7308548 A	28-11-1995
		US	5584981 A	17-12-1996
US 2011042205	A1 24-02-2011	EP	2287117 A1	23-02-2011
		JP	2011041940 A	03-03-2011
		KR	20110019573 A	28-02-2011
		US	2011042205 A1	24-02-2011
WO 0113389	A1 22-02-2001	AU	6503700 A	13-03-2001
		WO	0113389 A1	22-02-2001
EP 2253593	A1 24-11-2010	EP	2253593 A1	24-11-2010
		WO	2010130465 A1	18-11-2010
EP 2322486	A1 18-05-2011	EP	2322486 A1	18-05-2011
		WO	2011056070 A1	12-05-2011
WO 0014304	A1 16-03-2000	AT	520803 T	15-09-2011
		EP	1115909 A2	18-07-2001
		ES	2371599 T3	05-01-2012
		JP	4286931 B2	01-07-2009
		JP	2000091169 A	31-03-2000
		WO	0014304 A1	16-03-2000
EP 2338843	A1 29-06-2011	EP	2338843 A1	29-06-2011
		KR	20110071701 A	29-06-2011
		US	2011147212 A1	23-06-2011
WO 2010069065	A1 24-06-2010	CA	2746346 A1	24-06-2010
		EP	2379456 A1	26-10-2011
		GB	2477701 A	10-08-2011
		US	2011240474 A1	06-10-2011
		WO	2010069065 A1	24-06-2010

Agentschap NL
Ministerie van Economische Zaken,
Landbouw en Innovatie

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN57496	14.10.2011		NL2007598

International Patent Classification (IPC)
INV. C02F1/469 ADD. C02F103/08

Applicant
Voltea B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

	Examiner
	Van Iddekinge, R

Application number

WRITTEN OPINION

NL2007598

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	2-18, 20-25
	No:	Claims	1, 19
Inventive step	Yes:	Claims	
	No:	Claims	1-25
Industrial applicability	Yes:	Claims	1-25
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 EP 1 164 110 A1 (ABB RESEARCH LTD [CH]) 19 december 2001

D2 US 2008/105551 A1 (WANG SHENGXIAN [CN] ET AL) 8 mei 2008

D3 WO 2011/072400 A1 (ENPAR TECHNOLOGIES INC [CA]; SEED LEONARD PAUL [CA]; PARGARU IURIE [CA) 23 juni 2011

D4 US 5 584 981 A (TURNER ANDREW D [GB] ET AL) 17 december 1996

D5 US 2011/042205 A1 (KIM CHANG-HYUN [KR] ET AL) 24 februari 2011

D6 WO 01/13389 A1 (ANDELMAN MARC D [US]) 22 februari 2001

D7 EP 2 253 593 A1 (VOLTEA B V [NL]) 24 november 2010

D8 EP 2 322 486 A1 (VOLTEA B V [NL]) 18 mei 2011

D9 WO 00/14304 A1 (ANDELMAN MARC D [US]; OTOWA TOSHIRO [JP]; TANAKA NAOTO [JP]) 16 maart 2000

D10 EP 2 338 843 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 29 juni 2011

D11 WO 2010/069065 A1 (ENPAR TECHNOLOGIES INC [CA]; SEED LEONARD PAUL [CA]; YETMAN DAREN D [C) 24 juni 2010

D12 OREN ET AL: "Capacitive deionization (CDI) for desalination and water treatment - past, present and future (a review)", DESALINATION, ELSEVIER, AMSTERDAM, NL, deel 228, nr. 1-3, 15 augustus 2008, bladzijden 10-29, XP022735169, ISSN: 0011-9164, DOI: 10.1016/J.DESAL.2007.08.005 [gevonden op 2008-06-18]

The present application does not meet the criteria of patentability, because the subject-matter of claims 1 and 19 is not new and because the subject-matter of claims 1-25 does not involve an inventive step.

Documents D1, D2, D3, D4, D5 and D6 disclose an apparatus for removing ions according to the independent claims 1 and 19 of the application, see parts of these documents cited in the search report.

It is to be noted that the serially connected capacitive electrode cells (in the stacks) in each of the documents D1, D2, D3, D4, D5 and D6 appear to be identical. Consequently the resistivity will be substantially equal as required by claim 19.

Independent claim 25 describes a method for manufacturing an apparatus for removing ions like the ones described in claims 1-24.

It appears that the process features for manufacturing an apparatus for removing ions according to claim 25 are implicit or at least banal in view of documents D1, D2, D3, D4, D5 and D6.

Therefore the subject-matter of claim 25 lacks an inventive step in view of documents D1, D2, D3, D4, D5 and D6.

Dependent claims 2-18,20-24 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of inventive step, see documents D1-D12 and references applying to these documents cited in the search report.