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(54) **METHOD OF PRODUCING HYDROGEN PEROXIDE IN A MULTIFUNCTION ELECTROCHEMICAL CELL**

(57) The present disclosure provides a method of producing hydrogen peroxide in a multifunction electrochemical cell in which the color and type of material of the clothing is determined and compared to a function data-

base containing a plurality of different functions for the electrochemical cell. The appropriate function is extracted, and the electrochemical cell performs the function to complete a wash cycle.

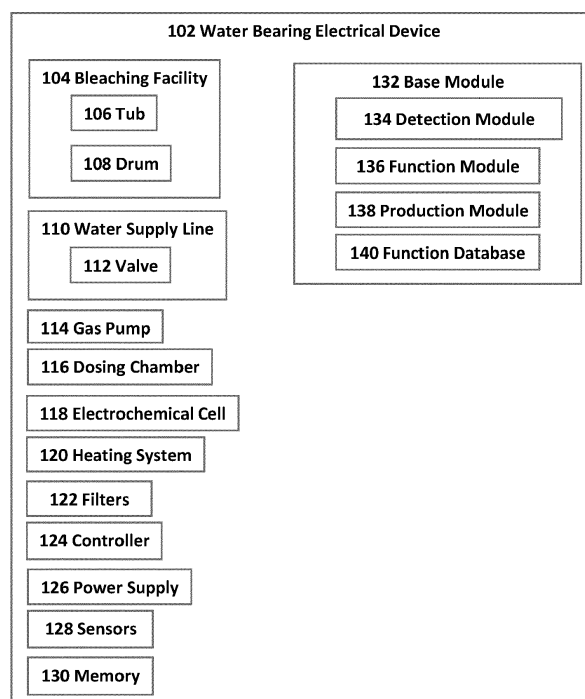


Fig.1 Method Producing Hydrogen Peroxide In A Multifunction Electrochemical Cell

EP 4 575 062 A1

Description

FIELD OF THE DISCLOSURE

[0001] The present disclosure is generally related to producing hydrogen peroxide in a multifunction electrochemical cell.

BACKGROUND

[0002] Currently, household appliances as well as professional used appliances for washing or cleaning textiles do not use a multifunction electrochemical cell for producing hydrogen peroxide depending on the textiles located within the appliance. Also, such systems do not determine the color of the textiles or the type of material the textiles are made of. Lastly, most appliances with an ability to treat the water supply for a washing process do not provide a method of determining the contents of the appliance and then adjust the function of the electrochemical cell to properly wash the contents of the appliance. Thus, there is a need in the prior art to provide a method of producing hydrogen peroxide in a multifunction electrochemical cell.

DESCRIPTIONS OF THE DRAWINGS

[0003]

FIG. 1: Illustrates a method producing hydrogen peroxide in a multifunction electrochemical cell, according to an embodiment.

FIG. 2: Illustrates a Base Module, according to an embodiment.

FIG. 3: Illustrates a Detection Module, according to an embodiment.

FIG. 4: Illustrates a Function Module, according to an embodiment.

FIG. 5: Illustrates a Production Module, according to an embodiment.

FIG. 6: Illustrates a Function Database, according to an embodiment.

DETAILED DESCRIPTION

[0004] Embodiments of the present disclosure will be described more fully hereinafter with reference to the accompanying drawings in which like numerals represent like elements throughout the several figures, and in which example embodiments are shown. Embodiments of the claims may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. The examples set forth herein are non-limiting examples and are merely examples among other possible examples.

[0005] This is a method of producing hydrogen peroxide in a multifunction electrochemical cell. This method comprises of a water bearing electrical device 102 in

which cleaning is to be achieved using a bleaching agent, and a water-bearing electrical device which carries out cleaning using a bleaching agent, i.e., hydrogen peroxide produced from electrolysis, such as by a washing machine, a dishwasher, a type of household or professional disinfectant appliance, etc. The water bearing electrical device 102 may include a bleaching facility 104 and an electrochemical cell 118 with a cathode arranged in a cathode chamber and an anode arranged in an anode chamber, which are spatially separated, having the following steps during a cleaning program, which includes a washing process and has several rinsing processes. First, providing a solution in the electrochemical cell which comprises water and an electrolyte. Second, applying a current to the electrochemical cell and simultaneously introducing an oxygen-containing gas to produce a bleach in a catholyte. Third, feeding the catholyte from the electrochemical cell into the bleaching facility 104 before and/or during the washing process. In the first step, a water and electrolyte containing solution is provided in the electrochemical cell 118, wherein the solution can be arranged in the electrochemical cell 118 or passed through it. The electrolyte can comprise or consist of an inorganic salt and/or a builder. The inorganic salt is preferably sodium sulfate and/or sodium hydrogen carbonate. In a preferred embodiment, the builder has one or more components selected from the group consisting of citric acid, lactic acid, phosphonate, polycarboxylic acid, aminocarboxylic acid, polyacrylic acid and/or their salts. Alternatively, the builder preferably consists of one or more of these components. In the second step, if the oxygen-containing gas is supplied to the electrochemical cell 118, which preferably has a gas diffusion electrode in the cathode space, and current is applied to it, an electrolysis starts in which a bleaching agent, such as hydrogen peroxide, is formed. Due to the spatial separation of the cathode and anode compartments, the anolyte and the catholyte are produced separately from one another. The pH of the catholyte is shifted into the alkaline pH range, while a pH value of the anolyte is shifted into the acidic pH range. If the anode compartment and the cathode compartment were not separated, the catholyte and the anolyte would at least partially neutralize each other, which has proven to be disadvantageous. A pH of the catholyte is preferably in the range from 9 to 14, more preferably 10 to 12. In the third step, only the catholyte is fed to the bleaching facility 104. In other words, the catholyte is fed to the bleaching facility 104 without an anolyte produced in the second step. The catholyte is anolyte-free. During the washing process, items to be cleaned or the bleaching facility 104 itself is washed with the bleaching agent produced, such as hydrogen peroxide produced from electrolysis, and, if necessary, other ingredients of the solution in order to clean it. During the one or more rinsing processes, the items to be cleaned or the bleaching facility 104 itself is rinsed with water in order to rinse the solution out of the bleaching facility 104 and possibly the items to be cleaned. In some embodiments,

the method furthermore has a step of feeding the anolyte produced in the second step from the electrochemical cell 118 into the bleaching facility 104 after a washing process has been carried out. The anolyte produced in the second step is preferably fed to the bleaching facility 104 before and/or during the execution of a rinsing process from the electrochemical cell 118. By inserting the acidic anolyte solution into one of the wash cycles, any calcium deposits that may have formed in the water-conducting electrical device and/or on the items to be cleaned can be dissolved again. Hygiene is increased, since both alkaline and acidic pH values are run through in the water-bearing electrical device during a washing and rinsing cycle. The anolyte is therefore used sensibly. In some embodiments, the bleaching agent may refer to a chemical compound, may be hydrogen peroxide produced by an electrochemical process, such as by an electrochemical cell 118, may be an anolyte or catholyte resulting from or generated as an intermediary product during an electrochemical process. In some embodiments, the bleaching agent may remove dyes, contaminants, pathogens, etc. from textiles, fabrics, materials, surfaces, fluids, etc. For instance, a water bearing electrical device 102 such as a water bearing electrical device 102 of EP3865614A1. Further, embodiments may include a bleaching facility 104 which may contain a tub 106 and a drum 108 contained within the tub 106. The bleaching facility 104 may receive the catholyte produced from the first electrochemical cell 118 before and/or during a washing process via a supply line to clean the items stored in the drum 108. In some embodiments, after the washing process the anolyte produced by the second electrochemical cell 118 may be fed to the bleaching facility 104 before and/or during the execution of a rinsing process from the second electrochemical cell 118. By inserting the acidic anolyte solution into one of the wash cycles, any calcium deposits that may have formed in the water-conducting electrical device and/or on the items to be cleaned can be dissolved again. Hygiene is increased, since both alkaline and acidic pH values are run through in the water-bearing electrical device during a washing and rinsing cycle. For instance, a bleaching facility 104 such as a bleaching facility 104 of EP3865614A1. Further, embodiments may include a tub 106 that seals in the water of the water bearing electrical device 102 and may vibrate, shake, rotate, etc. by a motor and a counterweight in order to clean, wash, rinse, etc. the items contained in the drum 108 which may be contained within the tub 106. In some embodiments, the bleaching facility 104 may contain a tub 106 and drum 108, such as a washing machine. In some embodiments, the tub 106 may include a drain, drain line, drain pump, and drain valve to dispose of the wastewater created during the wash process. In some embodiments, the tub 106 may be drained or emptied of the wastewater by activating a drain valve located in a drain line connected to a drain entrance at the bottom of the tub 106. In some embodiments, the bleaching facility may only contain a tub 106 or water

sealed drum 108, such as a dishwasher. In some embodiments, the bleaching facility may be used for a household or professional use disinfectant appliance that may or may not include a tub 106 or drum 108. For instance, a tub 106 such as a tub 106 of US6841058B2. Further, embodiments may include a drum 108 that is contained within the tub 106 and is where the items to be cleaned are placed. The drum 108 may include sides that perforated with holes to allow water to enter and exit upon spinning the drum 108. For instance, a drum 108 such as a drum 108 of US6841058B2. Further, embodiments may include a water supply line 110 that connects to the electrochemical cell 118 to supply the water for the washing process. The water supply line 110 may include a valve 112 that may be opened or closed based on the control signals received from the controller 130 to feed the water to the electrochemical cell 118 for the wash cycle. The water supply line 110 may be connected to a water source, such as a water line for a household, building, or dwelling. In some embodiments, the water supply line 110 may be replaced with a water tank located within the water bearing electrical device 102 to supply the water to the electrochemical cell 118. In some embodiments, the water supply line 110 may include a pump, a pressurized source, etc. to move the water through the water supply line 110. For instance, a water supply line 110 such as a feed supply of US7950254B2. Further, embodiments may include a valve 112 for the water supply line 110 that may be opened or closed based on the control signals received from the controller 130 to feed the water to the electrochemical cell 118 for the wash cycle. In some embodiments, the valve 112 may be used to control the supply of water from a water tank or another source of water for the washing process or cycle. Further, embodiments may include a gas pump 114 which connects to the cathode through a gas supply line to supply air or oxygen to the cathode chamber. The gas pump 114 supplies air or oxygen as an oxygen-containing gas via a gas supply line to the cathode chamber and a current is applied to the electrochemical cell 118. Applying a current to the electrochemical cell 118 at the same time introducing an oxygen-containing gas, such as air, into the cathode space by activating the gas pump 114 generates hydrogen peroxide in the aqueous electrolyte-containing solution. For instance, a gas pump 114 such as an oxygen supply line of JP2005146344A. Further, embodiments may include a dosing chamber 116 which is designed to meter an electrolyte, for example an electrolyte-containing solution, such as a salt-containing solution, and possibly a detergent into the electrochemical cell 118 by means of a metering pump. When the electrochemical cell 118 is supplied with water in a predetermined quantity, the electrolyte, such as a solution containing salt, and possibly a detergent is metered from the dosing chamber 116 into the electrochemical cell 118 via the metering pump. In some embodiments, the dosing chamber 116 may provide the electrolyte to the electrochemical cell 118 through a pipe, hose, tubing, etc. In some embodi-

ments, the dosing chamber 116 may be replaced with a dosing pump, metering pump, etc. to provide the electrolyte to the electrochemical cell 118. In some embodiments, the electrolytes may include sodium, chloride, potassium, magnesium, calcium, etc. For instance, a dosing chamber 116 such as a dosing chamber 116 of EP2798995B1. Further, embodiments may include an electrochemical cell 118 with a cathode compartment and an anode compartment, that provides an aqueous electrolyte-containing solution in the electrochemical cell 118 and applies a current to the electrochemical cell 118 and simultaneously introduces an oxygen-containing gas to generate hydrogen peroxide in the aqueous electrolyte-containing solution. Then the electrolyzed solution is fed from the electrochemical cell 118 into the bleaching device and a bleach activator is fed into the electrochemical cell 118 and/or the bleaching facility 104. The electrochemical cell 118 is designed to produce a hydrogen peroxide-containing bleaching agent using the electrolyte, water, air and electric current. If the electrochemical cell 118 has the electrolyte, water and air and an electric current flows, water is oxidized at an anode of the electrochemical cell, with protons being formed. At the same time, the oxygen contained in the air is reduced at a cathode of the electrochemical cell 118, in particular a gas diffusion electrode. The protons are used up, for example, the protons combine with the electrons to form hydrogen, and hydrogen peroxide is produced. The cathode is preferably designed as an oxygen diffusion electrode. The anode can be a dimensionally stable anode, a mixed oxide electrode or a boron-doped diamond electrode. The reaction product of electrolysis is a hydrogen peroxide solution. An anode compartment in which the anode is located and a cathode compartment in which the cathode is located are preferred, for example, through a membrane such as a cation exchange membrane spatially separated, so that an alkaline hydrogen peroxide solution is preferably produced. The electrode, such as diamond electrode, of the reactor is preferably boron- or nitrogen-doped. One or more of the electrodes may be a boron-doped diamond electrode, such as diamond electrodes which have a possibly doped diamond layer applied to a carrier material. The diamond electrode may function as an anode or a cathode in the process, the reactor having a counter electrode of a suitable material, such as steel, which may also form the reactor itself. It is also possible that the reactor has two diamond electrodes which function as anode and cathode. The reactor therefore constitutes an electrolyzer. It may also be designed as an electrolyzer having a membrane which spatially separates the anode and the cathode, so that products and/or intermediates formed on electrolysis on a diffusion from the cathode to the anode space and/or prevented vice versa. For instance, an electrochemical cell 118 such as an electrochemical cell 118 of EP3865614A1, US6132572A, US9994463B2, JP2005146344A. Further, embodiments may include a heating system 120 which may be used to heat the water

supply to a desired temperature for a washing process. The water bearing electrical appliance may include a built in heater to heat the water supply. In some embodiments, the water supply line 110 may include a hot water supply line to provide heated water to the cleaning process. In some embodiments, the heating system 120 may include a container with an inlet channel and an outlet channel and in the container two spaced plates which act as electrodes and each have an electrical connection for connection to an electrical voltage source for generating a current flow I through the water between the plates, with at least one plate being movably mounted to the distance between the plates and thereby to change the volume of water provided between the plates. The plates may have a large distance from each other. A movable plate is guided in the container by means of a lever mechanism. A drive means serves to drive the lever mechanism to move the plate in order to change the parallel distance of the plate to the fixed plate. A control device is designed to switch the appropriate AC voltage to the plates and to activate the drive means in order to set the distance between the plates. The conductance of the liquid located in the container can be detected with the detection means and fed to the control device. Based on the detected conductance and the specified requirements for the water heating, the control device can activate the drive means in order to set the distance in such a way that an electrical current flow is set, which leads to the desired heating of the water. The heating system 120 is designed as a continuous-flow heater, it can also be designed as a boiler. The current is an alternating current of the same frequency due to the alternating voltage applied to the plates. Further, embodiments may include a plurality of filters 122 to capture unwanted elements from entering or exiting the water bearing electrical device 102, such as dirt, lint, harmful contaminants, etc. The filters 122 may be located within the water supply line 110 and/or at the drainage component of the water bearing electrical device 102. For instance, a filter 122 such as a filter 122 of US9994463B2. Further, embodiments may include a controller 124 which is a computing device comprised of a processor for performing computations and communicates with a memory 130 for storing data. The controller 124 is in communication with a plurality of components of the water bearing electrical device 102 and may further be allowed to control the functions of the water bearing electrical device 102. The controller 124 may be a commercially available central processing unit (CPU) or graphical processing unit (GPU) or may be a proprietary, purpose-build design. More than one controller 124 may operate in tandem and may be of different types, such as a CPU and a GPU. A GPU is not restricted to only processing graphics or image data and may be used for other computations. Further, embodiments may include a power supply 126 which may be a hardware component that supplies power to the water bearing electrical device 102. It receives power from an electrical outlet and converts the current from AC, alternating

current, to DC, direct current, or may supply the alternating current, and may regulate the voltage to an adequate amount. The power supply 126 may be wired, wireless, such as through a battery. The power supply 126 may supply a current to the water bearing electrical device 102, electrochemical cell 118, gas pump 114, heating system 120, sensors 128, etc. collectively or individually. Further, embodiments may include a sensor 128 which is a measurement tool for monitoring a characteristic or metric associated with the water bearing electrical device 102. A sensor 128 may be discrete or part of an array or assembly. A sensor 128 may be a pH sensor which may be used to accurately measure acidity and alkalinity in water and other liquid substances. A sensor 128 may be a sensor to detect contamination within the water, either entering or exiting the water bearing electrical device 102, such as chemical sensors, electrochemical piezo-electric sensors, functional DNA biosensors, TOC sensors, etc. One or more of the sensors 128 may include temperature sensors, rotor position sensors, water level sensors, dirt sensors, photoelectric sensors, pressure sensors, vibration sensors, water flow sensors, proximity sensors, humidity sensors, image sensor, color sensor, or any combination thereof, etc. The sensors 128 may be integrated into the operation of the water bearing electrical device 102 or may monitor the status of the device. In some embodiments, the data collected by the sensors 128 may be in real-time or may need to be analyzed further to produce findings. For instance, a sensor 128 such as a sensor 128 of US9702074B2, US11147650B2, and a gas sensor of EP2397062B1. Further, embodiments may include a memory 130 such as the electronic circuitry within a computing device that temporarily stores data for usage by the controller 124. The memory 130 may additionally comprise persistent data storage for storing data used by the controller 124. The memory 130 may be integrated into a controller 124 or may be a discrete component. The memory 130 may be integrated into a circuit, such as soldered on component of a single board computer (SBC) or may a removable component such as a discrete dynamic random-access memory (DRAM) stick, secure digital (SD) card, flash drive, solid state drive (SSD), magnetic hard disk drive (SSD), etc. In some embodiments, memory 130 may be part of a controller 124. Further, embodiments may include a base module 132 which begins with the user selecting the wash cycle. The base module 132 initiates the detection module 134. The base module 132 receives the color and material detected in the drum 108 from the detection module 134. The base module 132 sends the color and material of the textiles detected in the drum 108 to the function module 136. The base module 132 initiates the function module 136. The base module 132 receives the function from the function module 136. The base module 132 sends the function to the production module 138. The base module 132 initiates the production module 138. The base module 132 receives the completion signal from the production module 138. The base module

132 ends at step 218. Further, embodiments may include a detection module 134 which begins by being initiated by the base module 132. The detection module 134 collects the sensor 128 data from the sensors 128 located in the drum 108. The detection module 134 determines the color of the materials or textiles located in the drum 108. The detection module 134 determines the type of the materials or textiles located in the drum 108. The detection module 134 sends the color and type of the materials or textiles located in the drum 108 to the base module 132. The detection module 134 returns to the base module 132. Further, embodiments may include a function module 136 which begins by being initiated by the base module 132. The function module 136 receives the color and type of the materials located within the drum 108 from the base module 132. The function module 136 compares the color and type of the materials to the function database 140. The function module 136 extracts the corresponding function that the electrochemical cell 118 needs to perform in order to properly wash and treat the textiles located in the drum 108. The function module 136 sends the extracted function to the base module 132. The function module 136 returns to the base module 132. Further, embodiments may include a production module 138 which begins by being initiated by the base module 132. The production module 138 receives the function from the base module 132. The production module 138 sends the function to the controller 124. The production module 138 activates the electrochemical cell 118. The production module 138 determines if the wash cycle is complete. if it is determined that the wash cycle is not complete the production module 138 continues activating the electrochemical cell 118 and the process returns to determining if the wash cycle is complete. If it is determined that the wash cycle is complete the production module 138 sends a completion signal to the base module 132. The production module 138 returns to the base module 132. Further, embodiments may include a function database 140 which contains the function to be performed by the electrochemical cell 118 depending on the color and type of materials or textiles located in the drum 108. The database may contain a plurality of colors of the material, types of the material, functions to be performed by the electrochemical cell 118, and the data file to be sent to the controller for the electrochemical cell 118 to perform the function to properly wash and treat the textiles.

[0006] Functioning of the base module 132 will now be explained with reference to FIG. 2. One skilled in the art will appreciate that, for this and other processes and methods disclosed herein, the functions performed in the processes and methods may be implemented in differing order. Furthermore, the outlined steps and operations are only provided as examples, and some of the steps and operations may be optional, combined into fewer steps and operations, or expanded into additional steps and operations without detracting from the essence of the disclosed embodiments.

[0007] This figure displays the base module 132. The process begins with the user loads, at step 200, the materials into the drum 108. For example, the user places the textiles that will be washed into the drum 108 of the water bearing electrical device 102. The base module 132 initiates, at step 202, the detection module 134. For example, the detection module 134 may begin by being initiated by the base module 132. The detection module 134 collects the sensor 128 data from the sensors 128 located in the drum 108. The detection module 134 determines the color of the materials or textiles located in the drum 108. The detection module 134 determines the type of the materials or textiles located in the drum 108. The detection module 134 sends the color and type of the materials or textiles located in the drum 108 to the base module 132. The detection module 134 returns to the base module 132. The base module 132 receives, at step 204, the color and material detected in the drum 108 from the detection module 134. For example, the base module 132 receives the color, such as whites, light colored, dark colors, etc. and the material, such as cotton, linen, silk, lace, etc. of the textiles located in the drum 108 from the detection module 134. The base module 132 sends, at step 206, the color and material of the textiles detected in the drum 108 to the function module 136. For example, the base module 132 sends the color, such as whites, light colored, dark colors, etc. and the material, such as cotton, linen, silk, lace, etc. of the textiles located in the drum 108 to the function module 136. The base module 132 initiates, at step 208, the function module 136. For example, the function module 136 begins by being initiated by the base module 132. The function module 136 receives the color and type of the materials located within the drum 108 from the base module 132. The function module 136 compares the color and type of the materials to the function database 140. The function module 136 extracts the corresponding function that the electrochemical cell 118 needs to perform in order to properly wash and treat the textiles located in the drum 108. The function module 136 sends the extracted function to the base module 132. The function module 136 returns to the base module 132. The base module 132 receives, at step 210, the function from the function module 136. For example, the base module 132 receives the function of the electrochemical cell 118, including the data file containing the instructions that will be sent to the controller 124 to allow the electrochemical cell 118 to perform the appropriate function. In some embodiments, the data file may also include instructions for the controller 124 to use a specific wash cycle, such as regular, delicate, heavy, etc. and water temperature, such as hot, cold, warm, etc. The base module 132 sends, at step 212, the function to the production module 138. For example, the base module 132 sends the function of the electrochemical cell 118, including the data file containing the instructions that will be sent to the controller 124 to allow the electrochemical cell 118 to perform the appropriate function to the production module 138. In some embodi-

ments, the data file may also include instructions for the controller 124 to use a specific wash cycle, such as regular, delicate, heavy, etc. and water temperature, such as hot, cold, warm, etc. The base module 132 initiates, at step 214, the production module 138. For example, the production module 138 begins by being initiated by the base module 132. The production module 138 receives the function from the base module 132. The production module 138 sends the function to the controller 124. The production module 138 activates the electrochemical cell 118. The production module 138 determines if the wash cycle is complete. If it is determined that the wash cycle is not complete the production module 138 continues activating the electrochemical cell 118 and the process returns to determining if the wash cycle is complete. If it is determined that the wash cycle is complete the production module 138 sends a completion signal to the base module 132. The production module 138 returns to the base module 132. The base module 132 receives, at step 216, the completion signal from the production module 138. For example, the base module 132 receives a signal from the production module 138 that the wash cycle has been completed. The base module 132 ends at step 218.

[0008] Functioning of the detection module 134 will now be explained with reference to FIG. 3. One skilled in the art will appreciate that, for this and other processes and methods disclosed herein, the functions performed in the processes and methods may be implemented in differing order. Furthermore, the outlined steps and operations are only provided as examples, and some of the steps and operations may be optional, combined into fewer steps and operations, or expanded into additional steps and operations without detracting from the essence of the disclosed embodiments.

[0009] This figure displays the detection module 134. The process begins with the detection module 134 being initiated, at step 300, by the base module 132. The detection module 134 collects, at step 302, the sensor 128 data from the sensors 128 located in the drum 108. For example, the detection module 134 may collect sensor 128 data from an image sensor, color sensor, high resolution cameras, tactile sensors, tactile imaging, etc. to detect the color of the materials in the drum 108. An image sensor may be a sensor that detects and conveys information used to make an image. It does so by converting the variable attenuation of light waves, i.e., as they pass through or reflect off objects, into signals, small bursts of current that convey the information. The waves can be light or other electromagnetic radiation. A color sensor may be a type of "photoelectric sensor" which emits light from a transmitter, and then detects the light reflected back from the detection object with a receiver. High resolution cameras may capture high quality digital images of the textiles located in the drum 108 to determine the material of the textiles. For example, a supervised machine learning algorithm may be used to teach the system individual types of materials based on close

up high resolution images of the textiles located within the drum 108 and the information be sent to the detection module 134. In some embodiments, images may be captured when the drum 108 is loaded with the textiles, while the textiles are being loaded, or when each textile is loaded into the drum 108 individually. In some embodiments, RFID tags may be embedded in or on the textiles to collect data about the textiles, QR codes may be scanned by the water bearing electrical device 102 to determine the data associated with the textiles, a smart device, such as a smart phone, tablet, iPad, etc., may be connected to the water bearing electrical device 102 to send information about the textiles to the water bearing electrical device 102. The detection module 134 determines, at step 304, the color of the materials or textiles located in the drum 108. For example, the detection determines the color of the materials or textiles located in the drum 108 based on the collected sensor 128 data from the image sensor, color sensor, etc. to determine if the user is washing white only textiles or colored textiles. For example, A color sensor may be a type of photoelectric sensor which emits light from a transmitter, and then detects the light reflected back from the detection object with a receiver. A color sensor can detect the received light intensity for red, blue and green respectively, making it possible to determine the color of the target object, such as the textiles located in the drum 108. The light source may include red, green, and blue wavelengths, and the ratio between each of these lights can be calculated, it is possible to differentiate the appearance and color of target textiles. A red wavelength photoelectric sensor has difficulty differentiating some color combinations, such as red and white. A color sensor allows for stable detection, even for these kinds of difficult combinations. With a conventional photoelectric sensor, when the distance to the target textile changes, the received light intensity also changes. On the other hand, with a color sensor, there is no change in color identification even when the distance to the target textile changes. As a result, the target textile's color can be stably differentiated even if the distance changes or the target is tilted. When the distance to a target textile changes, the following occurs for conventional photoelectric sensors, received light intensity, and color sensors, ratio of light received. The detection module 134 determines, at step 306, the type of the materials or textiles located in the drum 108. For example, the detection module 134 may use high resolution cameras to capture high quality digital images of the textiles located in the drum 108 to determine the material of the textiles. For example, a supervised machine learning algorithm may be used to teach the system individual types of materials based on close up high resolution images of the textiles located within the drum 108 and the information be sent to the detection module 134. For example, the type of material may be cotton, polyester, linen, synthetics, etc. wish would be used in a regular wash cycle, or silk, wool, lace, etc. would be used in a delicate wash cycle. In some embodiments,

the detection module 134 may be able to determine the difference between two materials, such as cotton or silk, by using the high resolution cameras to determine the thread count on each material, such as 300 for cotton and 400 for silk, and to determine the texture of the material, such as some cotton textiles having a coarse texture and silk having a smooth texture. The detection module 134 sends, at step 308, the color and type of the materials or textiles located in the drum 108 to the base module 132. For example, the detection module 134 sends the base module 132 the color, such as whites, light colored, dark colors, etc. and the material, such as cotton, linen, silk, lace, etc. of the textiles located in the drum 108. The detection module 134 returns, at step 310, to the base module 132.

[0010] Functioning of the function module 136 will now be explained with reference to FIG. 4. One skilled in the art will appreciate that, for this and other processes and methods disclosed herein, the functions performed in the processes and methods may be implemented in differing order. Furthermore, the outlined steps and operations are only provided as examples, and some of the steps and operations may be optional, combined into fewer steps and operations, or expanded into additional steps and operations without detracting from the essence of the disclosed embodiments.

[0011] This figure displays the function module 136. The process begins with the function module 136 being initiated, at step 400, by the base module 132. The function module 136 receives, at step 402, the color and type of the materials located within the drum 108 from the base module 132. For example, the function module 136 receives the attributes of the textiles located in the drum 108, for example, the color, such as whites, lights, darks, etc. and the type of materials, such as cottons, denims, polyester, silk, lace, etc. from the base module 132. The function module 136 compares, at step 404, the color and type of the materials to the function database 140. For example, if the function module 136 receives that the color of the material is whites and the type of material is cotton, the function module 136 would compare that information to function database 140 which would allow the function database to extract the appropriate wash cycle and wash options for the textiles located in the drum. The function module 136 extracts, at step 406, the corresponding function that the electrochemical cell 118 needs to perform in order to properly wash and treat the textiles located in the drum 108. For example, if the color of the material is whites and the type of material is cotton the extracted function would be that the electrochemical cell 118 would produce a hydrogen peroxide water solution and the solution would make up 50% of the water used for the wash cycle, such as 50% of the hydrogen peroxide solution and 50% of fresh water from the water supply line 110, and the function module 136 would extract the corresponding data file containing the instructions for the electrochemical cell 118 to perform the associated function. In some embodiments, the func-

tion module 136 may also extract the wash cycle for the white cotton, such as a regular wash cycle, the temperature of the wash cycle such as hot water, etc. The function module 136 sends, at step 408, the extracted function to the base module 132. For example, the function module 136 sends the extracted function of the electrochemical cell 118, including the data file containing the instructions that will be sent to the controller 124 to allow the electrochemical cell 118 to perform the appropriate function. In some embodiments, the data file may also include instructions for the controller 124 to use a specific wash cycle, such as regular, delicate, heavy, etc. and water temperature, such as hot, cold, warm, etc. The function module 136 returns, at step 410, to the base module 132.

[0012] Functioning of the production module 138 will now be explained with reference to FIG. 5. One skilled in the art will appreciate that, for this and other processes and methods disclosed herein, the functions performed in the processes and methods may be implemented in differing order. Furthermore, the outlined steps and operations are only provided as examples, and some of the steps and operations may be optional, combined into fewer steps and operations, or expanded into additional steps and operations without detracting from the essence of the disclosed embodiments.

[0013] This figure displays the production module 138. The process begins with the production module 138 being initiated, at step 500, by the base module 132. The production module 138 receives, at step 502, the function from the base module 132. For example, the production module 138 receives the data file for the wash cycle to be performed on the materials or textiles located in the drum 108, including the data file containing the instructions for the controller 124 for the electrochemical cell 118 to perform the required function to properly wash the materials. In some embodiments, the data file may also include instructions for the controller 124 to use a specific wash cycle, such as regular, delicate, heavy, etc. and water temperature, such as hot, cold, warm, etc. The production module 138 sends, at step 504, the function to the controller 124. For example, the production module 138 sends the function to the controller 124, such as how long the electrochemical cell 118 should be activated for, the temperate to be used in the wash cycle, which wash should be used, etc. For example, if the color of the material is whites and the type of material is cotton the function would be that the electrochemical cell 118 would produce a hydrogen peroxide water solution that would be contained in 50% of the water used in the wash cycle. In some embodiments, the function may also include the wash cycle for the white cotton, such as a regular wash cycle, the temperature of the wash cycle such as hot water, etc. For example, if the user is placing white cotton sheets into the drum 108 the function that is sent to the controller 124 may be to activate the electrochemical cell 118 to produce hydrogen peroxide and use hot water to bleach the white sheets. In some embodiments, the electrochemical cell 118 may be used to produce hydro-

gen peroxide to treat the cotton sheets by bleaching them and then for the rinsing cycle the electrochemical cell 118 may be used to produce hydroxide ions to remove odors from the cotton sheets in a rinsing or refreshing cycle. In some embodiments, if the user is placing gym or workout clothes into the drum 108 the function sent to the controller 124 may be to activate the electrochemical cell 118 to produce hydroxyl and use water to clean the textiles and remove the odors produced from the sweat contained on the textiles. In some embodiments, the electrochemical cells 118 may have different types of electrodes, such as nickel, stainless steel, platinum, graphite, diamond, etc. The different electrodes may allow the electrochemical cells 118 to better produce hydrogen peroxide, hydrogen ions, hydroxide ions, etc. For example, the electrochemical cell 118 may have nickel electrodes to better produce hydrogen peroxide for the washing cycle, the electrochemical cell 118 may have diamond electrodes to better produce hydroxide ions, etc. The electrochemical cells 118 may be used depending on the electrodes that are contained within the electrochemical cell 118 for each different function of the wash processes. In some embodiments, the data file received by the production module 138 may include the function of the water bearing electrical device 102, such as instructions for the controller 124 to use a specific wash cycle, such as regular, delicate, heavy, etc. and water temperature, such as hot, cold, warm, etc. For example, if the function is a regular wash, with hot water and the textile load only contained white colored textiles, the function database 140 may include a data file containing instructions to activate the electrochemical cell 118, by supply 1.2 volts to the nickel electrodes of the electrochemical cell 118, to produce a hydrogen peroxide water solution that would be contained in 50% of the water used in the washing cycle and the textiles will be rotated for 20 minutes, etc. In some embodiments, the database may include a plurality of electrochemical cells 118 that contain different electrodes, different voltages to apply to each of the electrochemical cells 118, how long to apply the voltages to the electrochemical cells, the product generated by the electrochemical cell 118 such as hydrogen peroxide, hydrogen ions, hydroxide ions, etc. In some embodiments, the database may contain the different shapes of the electrodes, the distance between each electrode, the rate of production for the product generated by different times and different voltages, etc. The production module 138 activates, at step 506, the electrochemical cell 118. For example, the washing module 136 may send a signal to the controller 124 to activate the electrochemical cell 118 by sending a specific voltage to the electrochemical cell 118, such as 1.2 volts. The electrochemical cell 118 may produce hydrogen peroxide as the water supply passes through the electrochemical cell 118, as well as being supplied the solution from the dosing chamber 116. In some embodiments, the electrochemical cell 118 may utilize a sensor 128 to measure the correct voltage to produce hydrogen peroxide, for exam-

ple, by using a hydrogen peroxide sensor 128. For example, the electrochemical cell 118 is designed to produce a hydrogen peroxide-containing bleaching agent using the electrolyte, water, air and electric current. If the electrochemical cell 118 has the electrolyte, water and air and an electric current flows, water is oxidized at an anode of the electrochemical cell, with protons being formed. At the same time, the oxygen contained in the air is reduced at a cathode of the electrochemical cell 118, in particular a gas diffusion electrode. The protons are used up, for example, the protons combine with the electrons to form hydrogen, and hydrogen peroxide is produced. The cathode is preferably designed as an oxygen diffusion electrode. The anode can be a dimensionally stable anode, a mixed oxide electrode or a boron-doped diamond electrode. The reaction product of electrolysis is a hydrogen peroxide solution. An anode compartment in which the anode is located and a cathode compartment in which the cathode is located are preferred, for example, through a membrane such as a cation exchange membrane spatially separated, so that an alkaline hydrogen peroxide solution is preferably produced. The electrode, such as diamond electrode, of the reactor is preferably boron- or nitrogen-doped. One or more of the electrodes may be a boron-doped diamond electrode, such as diamond electrodes which have a possibly doped diamond layer applied to a carrier material. The diamond electrode may function as an anode or a cathode in the process, the reactor having a counter electrode of a suitable material, such as steel, which may also form the reactor itself. It is also possible that the reactor has two diamond electrodes which function as anode and cathode. The reactor therefore constitutes an electrolyzer. It may also be designed as an electrolyzer having a membrane which spatially separates the anode and the cathode, so that products and/or intermediates formed on electrolysis on a diffusion from the cathode to the anode space and/or prevented vice versa. The production module 138 determines, at step 508, if the wash cycle is complete. For example, the washing cycle may use a predetermined amount of time for each washing cycle as well as a predetermined amount of spins, rotations, vibrations, etc. for each washing cycle and once the predetermined amount of time or spins, rotations, vibrations, etc. have been performed the washing cycle is complete. If it is determined that the wash cycle is not complete the production module 138 continues, at step 510, activating the electrochemical cell 118 and the process returns to determining if the wash cycle is complete. In some embodiments, if the electrochemical cell 118 has produced enough hydrogen peroxide to satisfy the function then the controller 124 may deactivate the electrochemical cell 118 and continue with the wash cycle by performing a predetermined number of spins, rotations, vibrations, etc. until the materials in the drum 108 are washed. If it is determined that the wash cycle is complete the production module 138 sends, at step 512, a completion signal to the base module 132. For example, the

production module 138 may send a signal to the base module 132 that the wash cycle is complete. The production module 138 returns, at step 514, to the base module 132.

5 **[0014]** Functioning of the function database 140 will now be explained with reference to FIG. 6. One skilled in the art will appreciate that, for this and other processes and methods disclosed herein, the functions performed in the processes and methods may be implemented in differing order. Furthermore, the outlined steps and operations are only provided as examples, and some of the steps and operations may be optional, combined into fewer steps and operations, or expanded into additional steps and operations without detracting from the essence of the disclosed embodiments.

10 **[0015]** This figure displays the function database 140. The database contains the functions the water bearing electrical device 102 is to perform based on the materials or textiles located within the drum 108. The database is used by the function module 136 to determine which wash cycle, temperature, and function of the electrochemical cell 118 the water bearing electrical device 102 is to perform by extracting the corresponding data file in the database and sending the data file to the controller 124 to set the proper wash cycle for the materials to be washed. The database contains a plurality of the color of materials, the type of material or textiles, the wash cycle to be performed, the temperature to be used, the function of the electrochemical cell 118, and the data file which contains the instructions for the controller 124 to select the proper wash options for the wash cycle. In some embodiments, the percentage for the function of the electrochemical cell 118 is the amount of hydrogen peroxide to be used in the wash cycle depending on the amount of water that will be used in the wash cycle. For example, if the textiles in the drum 108 are white cotton the electrochemical cell 118 will produce a hydrogen peroxide water solution that would be contained in 50% of the water used in the wash cycle. Another example would be if the textiles in the drum 108 are lightly colored silk the electrochemical cell 118 will produce a hydrogen peroxide water solution that would be contained in 10% of the water used in the wash cycle. In some embodiments, the database may include a plurality of electrochemical cells 118 that contain different electrodes, different voltages to apply to each of the electrochemical cells 118, how long to apply the voltages to the electrochemical cells, the product generated by the electrochemical cell 118 such as hydrogen peroxide, hydrogen ions, hydroxide ions, etc. In some embodiments, the database may contain the different shapes of the electrodes, the distance between each electrode, the rate of production for the product generated by different times and different voltages, etc.

45 **[0016]** The functions performed in the processes and methods may be implemented in differing order. Furthermore, the outlined steps and operations are only provided as examples, and some of the steps and operations

may be optional, combined into fewer steps and operations, or expanded into additional steps and operations without detracting from the essence of the disclosed embodiments.

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Claims

1. A method of producing hydrogen peroxide in a multi-function electrochemical cell, comprising;

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- determining the color of the clothing, and
- determining the type of material of the clothing, and
- comparing the color and type of material to a function database, and
- extracting the appropriate function, and
- activating the electrochemical cell based on the function, and
- performing a wash cycle.

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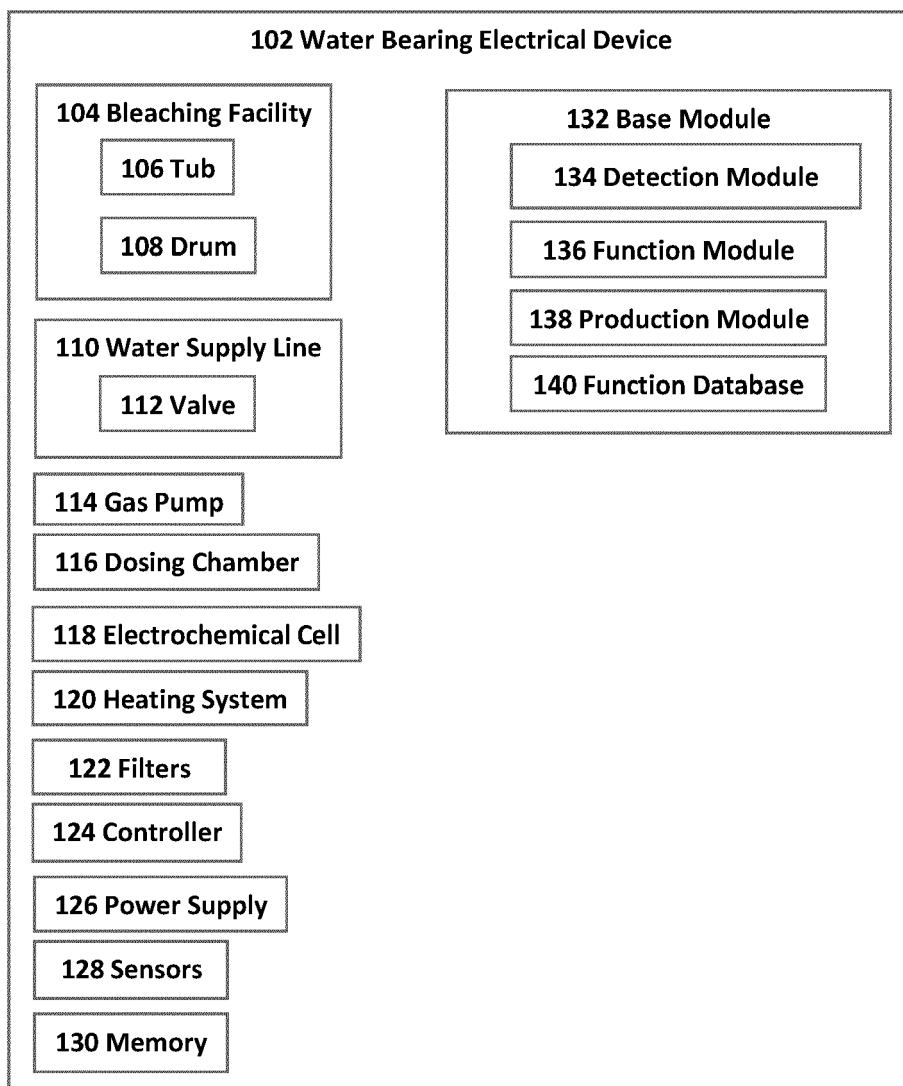


Fig.1 Method Producing Hydrogen Peroxide In A Multifunction Electrochemical Cell

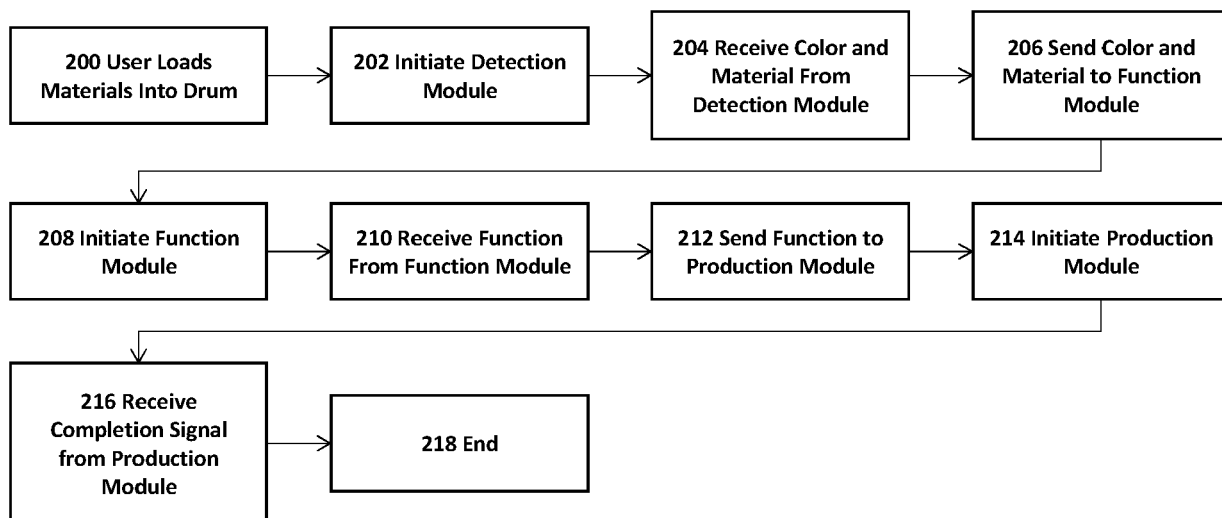


Fig.2 Base Module

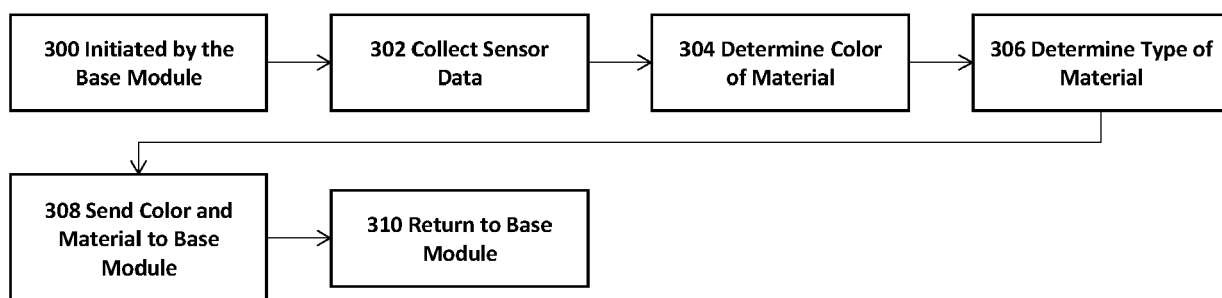


Fig.3 Detection Module

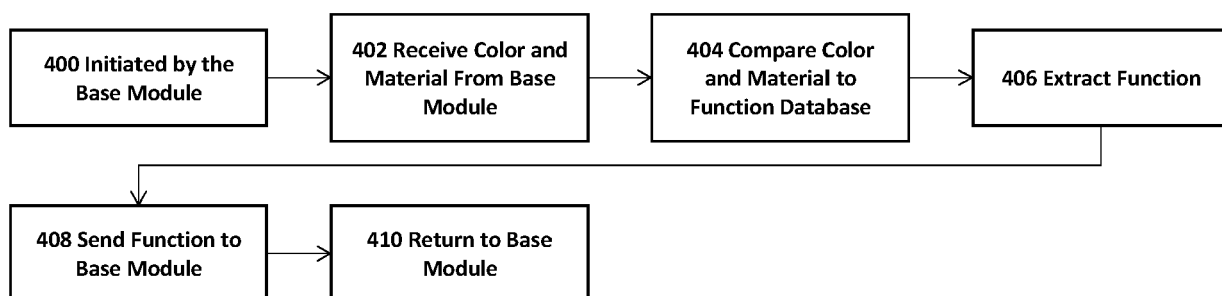
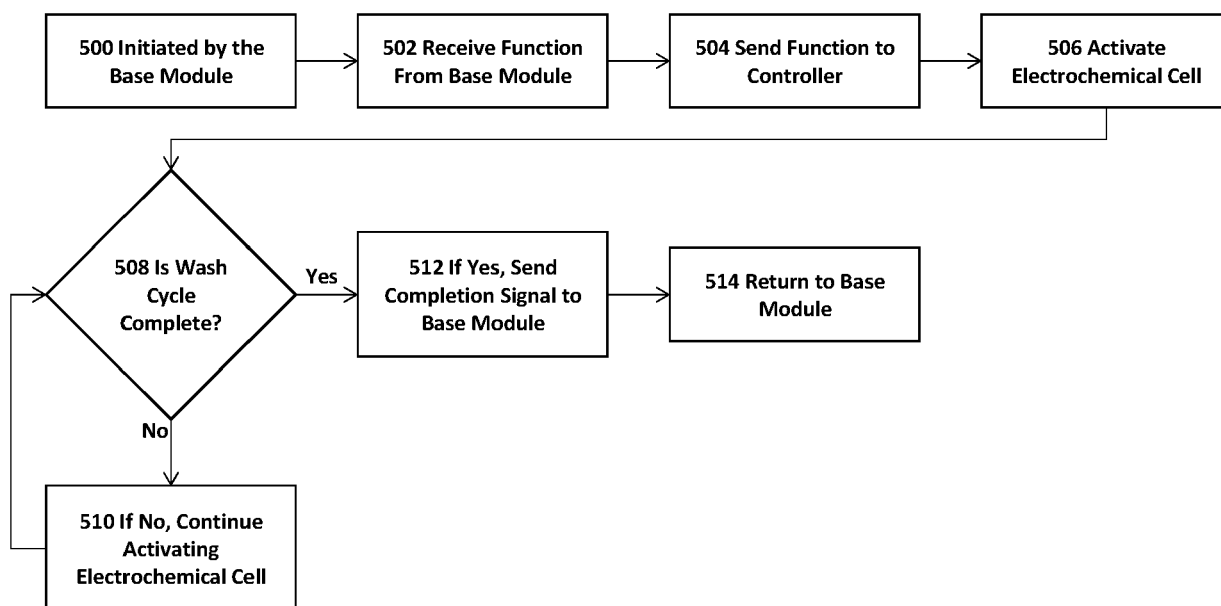


Fig.4 Function Module

**Fig.5 Production Module**

Color of Material	Type of Material	Wash Cycle	Temperature	E.C. Function	Data File
Whites	Cotton	Regular	Hot	50%	WhiteCotton.Data
Dark	Denim	Regular	Cold	0%	Jeans.Data
Light	Silk	Delicate	Warm	10%	Silk.Data
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

Fig.6 Function Database



EUROPEAN SEARCH REPORT

Application Number

EP 23 21 7490

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2008/276964 A1 (HENDRICKSON MICHAEL STEPHEN [US] ET AL) 13 November 2008 (2008-11-13) * paragraph [0035] * * paragraph [0037] * * paragraph [0047] - paragraph [0048] * -----	1	INV. D06F33/36 ADD. D06F35/00 D06F103/06 D06F105/00 D06F105/42
Y	EP 2 220 282 B1 (UNILEVER PLC [GB]; UNILEVER NV [NL]) 4 May 2016 (2016-05-04) * claims 1-2 * * paragraph [0154] * -----	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC) D06F
Place of search Munich		Date of completion of the search 7 May 2024	Examiner Werner, Christopher
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 23 21 7490

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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07-05-2024

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008276964 A1	13-11-2008	BR PI0801253 A2	06-01-2009
		CA 2623564 A1	07-11-2008
		EP 2006435 A2	24-12-2008
		US 2008276964 A1	13-11-2008
EP 2220282 B1	04-05-2016	BR PI0819794 A2	05-05-2015
		CN 101874133 A	27-10-2010
		EP 2220282 A1	25-08-2010
		ES 2580131 T3	19-08-2016
		WO 2009068496 A1	04-06-2009
		ZA 201003053 B	27-07-2011

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 3865614 A1 [0005]
- US 6841058 B2 [0005]
- US 7950254 B2 [0005]
- JP 2005146344 A [0005]
- EP 2798995 B1 [0005]
- US 6132572 A [0005]
- US 9994463 B2 [0005]
- US 9702074 B2 [0005]
- US 11147650 B2 [0005]
- EP 2397062 B1 [0005]