



- (51) International Patent Classification:  
*B01F 35/00* (2022.01) *B01L 99/00* (2010.01)  
*B01F 35/60* (2022.01)
- (21) International Application Number:  
PCT/SE2022/050008
- (22) International Filing Date:  
10 January 2022 (10.01.2022)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
2130015-7 15 January 2021 (15.01.2021) SE
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- (81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CII, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:  
— with international search report (Art. 21(3))

(54) Title: HYDRATION TRIGGERED AQUEOUS DILUTER

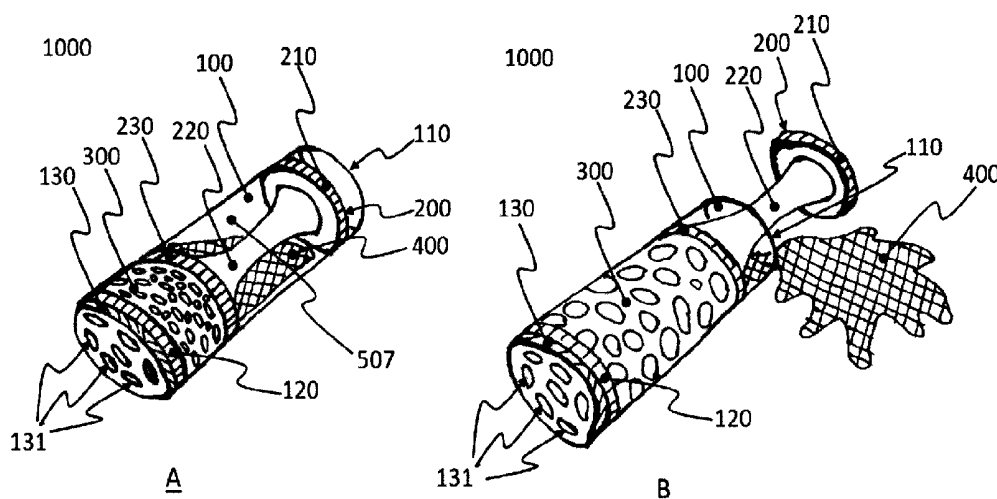


Fig. 1

(57) Abstract: The present invention discloses a diluter (1000) for protecting a user from exposure of an internal composition (400), when being in a closed state, and for releasing the internal composition (400), when being in an open state. The diluter comprises an enclosing cylinder (100), a proximal piston (230), a distal piston (210) and an expanding absorbent (300). A method for production of an aqueous diluted solution of the internal composition (400) is also disclosed.



## Hydration triggered aqueous diluter

### Technical Field

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The present invention generally relates to devices that automatically release an internal composition to and after exposure to an aqueous environment, in particular to and after exposure to water in a sealed container for controlled dilution of a concentrate.

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### Background

Various chemicals and chemical compositions are considered as hazardous and harmful by regulatory authorities when exceeding a specified lower threshold concentration in aqueous solution. When present at a concentration below an upper threshold, the same chemical or composition may, by the same authority, be considered as harmless to the exposed person. When the specified lower threshold concentration is the same as the upper threshold, a situation emerges in which the relevant chemical or composition, from a regulatory viewpoint, is transitioned from harmful to harmless when diluted with water below such a threshold concentration. For example, an aqueous solution of potassium hydroxide is considered by the European Chemicals Agency to be harmless upon exposure to the skin or the eye, or when inhaled in a moisturized form, provided that a threshold concentration of 0.5 % by weight is not exceeded. At concentrations above 0.5 % and above 2.0 %, potassium hydroxide is classified by the same authority as irritating and corrosive, respectively. Dilution of a harmful chemical or composition, i.e. having a concentration above a specified threshold, for obtaining the corresponding harmless chemical or composition, i.e. having a concentration below a specified threshold, is typically carried out by trained personnel in order to minimize the risk of harmful exposure. The undesired need for such trained personnel in the production of harmless aqueous solutions of otherwise harmful chemicals and compositions, has been addressed in the prior-art as exemplified below.

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“Z-water” by SuperSteam Asia Pacific Pte Ltd in Singapore and PT Professional in Karlskrona, Sweden, is formed by electrolysis of aqueous

potassium carbonate. A harmless solution of aqueous potassium hydroxide is thus formed and collected from the cathodic compartment for use in domestic cleaning application. At the corresponding anodic compartment, the carbon content of the potassium carbonate is released as waste into the surroundings  
5 in the form of carbon dioxide. Hence, the corresponding electrolytic device may be operated by personnel, not trained in the art of dilution, to obtain a desired harmless solution of one chemical, generated by chemical conversion of another chemical. Disadvantages of this type of relatively small local devices, carrying out a chemical reaction or electrolysis to convert one compound or  
10 chemical to another, include, for example, high inefficiency and low environmental friendliness, in terms of e.g. high energy need, low chemical yield and undesired release of waste products, as compared to the corresponding industrial production of the desired product.

Dishwasher detergent capsules may typically be coated with an external  
15 layer of suitably modified polyvinyl alcohol or the like. The external layer protects the user from the harmful concentrated composition trapped in the inner void of such a coating. The composition is, however, safely released and diluted within the dishwasher during operation by the coating dissolving in the hot feedwater. Hence, the user may in practice carry out a dilution of a harmfully  
20 high concentration of a composition, without having any skill in the art of dilution and still with a minimized risk of exposure to harmful concentrations of the composition. Disadvantages of this type of capsules include, for example, the relatively narrow range of compatibility between layer protection and contained composition. Furthermore, the conditions under which the content is released  
25 are typically relatively harsh, e.g. the necessity of hot water as compared to cold water.

US 2020238063 A1 discloses an automatic drug delivery device including an enclosure and a piston disposed in the enclosure. A drug is pushed by the piston out of the enclosure by the force generated by an expanding material  
30 absorbing external liquid. Disadvantages of this and other drug delivery devices include, for example, undesired protracted rise of concentration in the external liquid towards the desired target concentration of the composition, originally residing within the enclosure.

35 It would be advantageous with a diluter for simple and safe aqueous dilution of a concentrated hazardous chemical or composition that allows for avoiding some of above-mentioned disadvantages and problems.

## Summary

5 It is an object of the invention, considering the disadvantages mentioned above, to provide a diluter which allows for safe and facile aqueous dilution of a broad scope of chemically and physically diverse compositions.

It is another object of the invention, considering the disadvantages mentioned above, to provide a diluter which does not contaminate the aqueous  
10 solvent, in which the relevant composition is diluted, with solutes not being derived from the composition.

It is yet another object of the invention, considering the disadvantages mentioned above, to provide a diluter which is visually indicative of its state in the process of diluting the composition intended to be diluted.

15 It is yet another object of the invention, considering the disadvantages mentioned above, to provide a diluter which is at least partly recyclable and/or reloadable.

Accordingly, examples of the present invention preferably seek to mitigate, alleviate or eliminate one or more deficiencies, disadvantages or issues in the  
20 art, such as the above-identified, singly or in any combination by providing a diluter according to the appended patent claims.

According to a first aspect, a diluter for protecting a user from exposure of an internal composition, in a closed state thereof, and for releasing the internal  
25 composition to an aqueous environment, in an open state thereof, is provided. The diluter comprises an enclosing cylinder, a double piston element and an expanding absorbent. The enclosing cylinder has a distal opening at its distal end, a second proximal stopper at its proximal end, and a first proximal stopper immediately distal to or withing an inner volume of the second proximal stopper  
30 (130). The second proximal stopper is provided with a singularity or plurality of stopper ducts adapted to allow aqueous transfer from the external surrounding to the proximal end or periphery of the first proximal stopper. The first proximal stopper is a porous or aqueous permeable structure adapted to allow aqueous transfer from the stopper ducts to the proximal end of the expanding absorbent  
35 and to prevent transfer of the expanding absorbent to the stopper ducts. The expanding absorbent, being a polymeric solid, semisolid or gel, adapted to absorb water and to expand in volume upon doing so, is arranged withing the

internal volume of the enclosing cylinder immediately distal of or in conjugation with the second proximal stopper and proximal of the proximal end of the double piston element. The double piston element comprises a proximal piston, at its proximal end, and a distal piston, at its distal end, the proximal piston and the distal piston being adapted to form a gas- and liquid tight seal against the inner surface of the enclosing cylinder and to be movable along a central axis thereof, when residing in the inner volume thereof. The proximal piston and the distal piston being, when residing in the inner volume of the enclosing cylinder, in mechanic- pneumatic- or hydraulic connection with each other via a piston connector selected from the group of piston connectors consisting of mechanic connectors, an air space or the internal composition, respectively. When in the closed state, the distal piston being at least partly residing within the inner volume of the enclosing cylinder, whereby the internal composition is prevented from exiting through the distal opening. When in the open state, the proximal piston is residing within the inner volume of the enclosing cylinder and the distal piston is residing outside the inner volume of the enclosing cylinder, whereby the internal composition is allowed exiting to the surrounding through the distal opening.

According to a second aspect, the diluter of the first aspect may be provided with a sinker. The combination thereof is adapted such that the diluter is arranging its central axis essentially vertically, when being in the closed state and when the diluter is immersed in water or an equivalent aqueous liquid. The sinker having a density exceeding the density of the water or equivalent aqueous liquid. Advantages of a combination according to this second aspect include, for example, a secured entrance of water or the equivalent aqueous liquid through the stopper ducts as these may be adapted, as dependent on the verticality, to be fully under the surface thereof.

According to a third aspect, the diluter of the first aspect or the second may be provided with a bobber. The combination thereof is adapted such that any part of the diluter is above the surface, when being in the closed state, and fully below the surface, when being in the open state, when the diluter is immersed in water or an equivalent aqueous liquid. The bobber having a density being less than the density of the water or equivalent aqueous liquid. Advantages of a combination according to this third aspect include, for example, a facilitated visual detection of the state of the diluter. If no part of the diluter,

such as e.g. a part thereof having a clearly signaling color, e.g. red, can be seen above the surface of the liquid it has been put in, the user may conclude that it is in its open state.

5           According to a fourth aspect, a method for production of an aqueous diluted solution, is provided. The method of this fourth aspect comprises the steps of: (i) providing a charged diluter, i.e. a diluter according to any aspect being in said closed state and charged with an internal composition being  
10           equivalent to a composition to be diluted; (ii) adding the charged diluter from step (i) to a container comprising water; (iii) awaiting transitioning from the closed state to the open state of the diluter from step (ii); and (iv) stirring, shaking or swirling the container to obtain the desired aqueous diluted solution of the composition to be diluted. Advantages of a method according to this  
15           fourth aspect include, for example, the possibility of a user to carry out an aqueous dilution of a hazardous concentrate, i.e. the internal composition of the diluter, to effectively obtain a non-hazardous or less hazardous diluted variant thereof, with a minimized risk of undesired exposure to hazardous concentrations of a wide variety of water-soluble chemicals, concentrates or the like.

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          Further examples of the invention are defined in the dependent claims, wherein features for the second, third and fourth aspect of the disclosure are as for the first aspect *mutatis mutandis*.

          Some examples of the disclosure provide for safe dilution of hazardous  
25           water-soluble concentrates by personnel not qualified for traditional procedures for dilution of such concentrates.

          Some examples of the disclosure provide for safe storage and handling of hazardous water-soluble concentrates.

          Some examples of the disclosure provide for a higher precision in the final  
30           concentration of a diluted water-soluble concentrate.

          Some examples of the disclosure provide for a more environmental friendly process in the production-consumption chain of aqueous solutions as the end-user product.

          It should be emphasized that the term “comprises/comprising” when used  
35           in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

### Brief Description of the Drawings

5           These and other aspects, features and advantages of which examples of the invention are capable of will be apparent and elucidated from the following description of examples of the present invention, reference being made to the accompanying drawings, in which;

10           Fig. 1A is a view from the side and proximal end of a diluter 1000 in a closed state wherein the distal piston 210 is enclosed in the inner volume of a uniformly tube shaped enclosing cylinder 100, further showing a distal opening 110, a first proximal stopper 120, a second proximal stopper 130 provided with a plurality of stopper ducts 131 in the form of through holes, a double piston element 200 comprising the distal piston 210 mechanically attached and in  
15           spatial communication with a proximal piston 230 via an irregularly shaped solid piston connector 220, a mass of granulated expanding absorbent 300 in between the proximal piston 230 and the first proximal stopper 120 within the enclosing cylinder 100, and an internal composition 400 partly filling the void between distal piston 210 and the proximal piston 230, the remaining part of  
20           which void is an air space 507, according to examples of the disclosure;

          Fig. 1B is a view of the diluter 1000 of Fig. 1A, in which the same has transitioned into an open state by water induced swelling of the expanding absorbent 300 induced by entrance of water through the stopper ducts 131 of the second proximal stopper 130 and then via the first proximal stopper 120,  
25           whereby the double piston element 200 has been pushed in a distal direction to release the distal piston 210 from the inner void of the enclosing cylinder 100 while the corresponding proximal piston 230 remains therein, whereby the internal composition 400 has partly leaked out to the surroundings through the distal opening 110, according to examples of the invention;

30           Fig. 2 is a demounted view of the diluter 1000 of Fig. 1A from the side, showing from left to right the first proximal stopper 120, the expanding absorbent 300 in a non-expanded dry or semi-dry form and the double piston element 200 (the not shown internal composition 400 may be introduced after partial mounting of the double piston element 200), in a suitable order by which  
35           these parts may be mounted, into an enclosing cylinder 100 with a pre-mounted second proximal stopper 130, through distal opening 110, to obtain a diluter 1000 according to the invention, according to examples of the invention;

Fig. 3A-D are views of the diluter 1000 of Fig. 1A after having been dropped in an aqueous liquid, e.g. water, having an aqueous surface 501, showing the diluter 1000 in (A) an essentially upwards pointing position in a closed state, (B) in an open state after sub-maximal expansion of the expanding absorbent 300, (C) in a tilting position in an open state after maximum expansion of the expanding absorbent 300 after some of the aqueous liquid has entered the internal volume of the enclosing cylinder 100 whereby dilution of the internal composition 400 has been initiated, and (D) in a submerged position relative the aqueous surface 501 in an open state whereby dilution of the internal composition 400 is continued, according to examples of the invention;

Fig. 4A-D are views of a partly mounted diluter 1000 and Fig. 4E is a view of the corresponding functional diluter 1000 of the invention after complete mounting, showing (A) a double piston element 200 having a mechanic piston connector 220 and a bobber 504 and a sinker 503 integrated with its distal piston 210 and its proximal piston 230, respectively, mounted in a maximum distal position within an enclosing cylinder 100 having distal internal diameter being less than its proximal internal diameter, (B) the distal part of the internal volume of the enclosing cylinder 100 having been partly filled through the distal opening 110 with an internal composition 400 leaving an air space 507, (C) the double piston element 200 having been pushed in a proximal direction to set the distal piston 210 within the internal volume of the enclosing cylinder 100, (D) dry expanding absorbent 300 having been provided proximally to the double piston element 200 and within the internal volume of the enclosing cylinder 100, and (E) a unit consisting of first proximal stopper 120 arranged in the inner space of an enclosing second proximal stopper 130 having been screwed, glued or the like to the proximal end of the enclosing cylinder 100, according to examples of the invention;

Fig. 5A-B are views of the diluter 1000 of Fig. 1A, further comprising a sinker 503 attached or integrated to/with the proximal piston 230, after having been dropped in an aqueous liquid, e.g. water, having an aqueous surface 501, showing the diluter 1000 in (A) an essentially upwards pointing position partly above the aqueous surface 501 in a closed state, (B) in an open state after expansion of the expanding absorbent 300 whereby the diluter 1000 is tilting and/or tumbling below the surface 501 and the internal composition 400 is diluted in the aqueous liquid, according to examples of the invention;

Fig. 6A-B are views of a diluter 1000 according to the invention, comprising a bobber 504 integrated with, attached to or being equivalent to a



second proximal stopper 130 provided with stopper ducts 131 extending in a direction essentially perpendicular to the outer plane of the enclosing cylinder 100 near or at the proximal end thereof to allow peripheral transfer of water to the first proximal stopper 120, and a sinker 503 integrated with or attached to the distal piston 210, having been dropped in a container comprising water or similar with an aqueous surface 501, showing the diluter 1000 (A) in a closed state in a vertical direction having a part of its proximal end above the aqueous surface 501, and (B) in an open state in a vertical direction fully submerged residing with its distal end at the container bottom 505 and having its charge of internal composition 400 being diluted, according to examples of the invention;

Fig. 7A-C are views of a diluter 1000 according to the invention, comprising a distal piston 210 in the form of a snap-lid attached to the outside of the enclosing cylinder 100 near or at the distal end thereof by a connector 506, having been dropped in a container comprising water or similar with an aqueous surface 501, showing the diluter 1000 in (A) a closed state held in a vertical direction by a floating power induced by the air space 507, in (B) a closed state wherein the expanding absorbent 300 has absorbed water whereby the proximal piston 230 has been pushed in a distal direction whereby the air space 507 has been compressed whereby the pressure on the proximal side of the distal piston 210 is substantially higher than on the corresponding distal side, in (C) the moment when the distal piston 210 detaches from the enclosing cylinder 100 whereby the diluter 1000 enters an open state and the internal composition violently exits the distal opening 110, according to examples of the invention;

Fig. 8A-C are views of a diluter 1000 according to the invention, comprising a distal piston 210 in the form of a snap-lid attached to the outside of the enclosing cylinder 100 near or at the distal end thereof by a connector 506, an intermediate piston 215 attached to the distal piston 210 and the proximal piston 230 by piston strings 240, and a sinker 503 at the proximal end, having been dropped in a container comprising water or similar with an aqueous surface 501, showing the diluter 1000 in (A) a closed state wherein an internal composition 400 is arranged between the intermediate piston 215 and the distal piston 210 and the expanding absorbent 300 has absorbed none or only minor amounts of water whereby the air space 507 between the intermediate piston 215 and the proximal piston 230 has a first pressure, in (B) a closed state wherein the expanding absorbent 300 has absorbed substantial amounts of water whereby the proximal piston 230 has been pushed in a distal direction whereby the air space 507 has been compressed whereby a second pressure

thereof is higher than the first pressure, in (C) the moment when the distal piston 210 and the intermediate piston 215 detaches from the enclosing cylinder 100 whereby the diluter 1000 enters an open state and the internal composition violently exits the distal opening 110 mechanically aided by the distally moving intermediate piston 215, according to examples of the invention; and

5 Fig. 9 is a view of the diluter 1000 of Fig. 1A in an open state, showing the transfer of internal composition 400 from a syringe 502 via the distal opening 110 to the inner volume of the enclosing cylinder 100 distally of the proximal piston 230, according to examples of the invention.

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### Detailed Description

Specific examples of the invention will now be described with reference to the accompanying drawings. This invention may, however, be embodied in many different forms and should not be construed as limited to the examples set forth herein, rather, these examples are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. The terminology used in the detailed description of the examples illustrated in the accompanying drawings is not intended to be limiting of the invention. In the drawings, like numbers refer to like elements.

The diluter 1000 of the invention essentially comprise an enclosing cylinder 100 with a distal opening 110, at one end, and a proximal stopper 130 being provided with stopper ducts 131, at or near another end, a double piston element 200 and an expanding absorbent 300. In a typical case of use, a diluter 1000 charged with an internal composition 400, e.g. a concentrated aqueous solution of one or several compounds such as e.g. an alkali metal hydroxide or a concentrated detergent, may be added through the opening of a container partly filled, e.g. filled 10 to 95% such as 80 to 95% of its maximum capacity, with an aqueous liquid, such as e.g. tap water or deionized water. The container, such as e.g. a plastic container equipped with a screw cap or similar and having a volume of e.g. 1 to 25 liters, may be closed. After a waiting period under which the diluter 1000 is allowed to enter an open state, the closed container may be shaken, swirled or the like to allow the thereby released internal composition 400 to be homogeneously diluted in the aqueous liquid. This typical case includes cases in which a hazardous internal composition 400 may

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be advantageously safely diluted to yield a non- or less hazardous aqueous solution for direct application, such as e.g. for spraying on a surface to be cleaned.

5 Upon contact, water enters through stopper ducts 131 of the second proximal stopper 130 to reach the outer surface of the first proximal stopper 120 at its proximal end (see for example Fig. 1A-B) or the peripheral part thereof (see for example Fig. 6A-B). The second proximal stopper 130 and the stopper ducts 131 thereof are suitably arranged to allow entrance of water into the diluter 1000, while simultaneously preventing any part of the first proximal stopper 120 or the expanding absorbent 300 to exit therefrom when the expanding  
10 absorbent 300 increases in volume and pressure when absorbing water. The stopper ducts 131 may consist of a singularity or plurality of passages, such as e.g. through holes having a diameter the range of 1 to 10 mm, or any other suitable geometry as known by the skilled person. The first proximal stopper  
15 120 is selected from a suitable cohesive material with an ability to absorb water from the stopper ducts 131 and transfer that water internally, e.g. by being porous, to allow delivery to the expanding absorbent 300. Examples of suitable materials include, but is not limited to, cellulose fibres, e.g. cotton, modified cellulose fibres, wettex® clothing and the like. The second proximal stopper 130  
20 may be an integral part of the enclosing cylinder 100. Such a monolithic unit may advantageously be produced by injection molding. The first proximal stopper 120 and the second proximal stopper 130 may be separately produced as one integrated unit, e.g. by attaching the former within a central cavity at the distal side of the latter (see for example Fig. 6A-B). Such an integrated unit or  
25 the second proximal stopper 130 may be mounted in or at the proximal end of the enclosing cylinder in a production step, e.g. by press fitting, gluing, screwing by the aid of threads or by any other suitable means known to the skilled person.

Water is transferred to the expanding absorbent 300 from the second  
30 proximal stopper 130, whereby it absorbs such water and increases in volume. The expanding absorbent 300 may be a water absorbing sponge, e.g. a polyvinyl alcohol sponge, a polyurethane sponge, a cotton fiber sponge, a lignocellulose sponge, and/or a chitosan sponge. It may be a polymeric solid, a semisolid, a gel, granular, powdered or mixed or immobilized on a carrier in the  
35 form of suitable fibers, as well known in the art. The expanding absorbent 300 may typically contain a superabsorbent polymer of the kind employed in disposable hygiene products. It may be independently selected from or

comprise one or several of the group of absorbents consisting of sodium polyacrylate modified lignocellulose, chitosan modified lignocellulose, polyether modified polyurethane, sodium polyacrylate modified styrene-butadiene rubber, polytetrahydrofuran modified butadiene rubber and acrylamide modified ethylene-propylene rubber. The type, volume, pressure resistance and expansion rate of the expanding absorbent 300 can be set as required by suitable choice of type of absorbing polymer, its cross-linking and its mixing with suitable excipients, as well known to the skilled person. As dependent on the specific choice of expanding absorbent 300 and specific design of second proximal stopper 130, the former may render the first proximal stopper 120 obsolete as a separate element. For example, the expanding absorbent 300 may be coherent in a wet as well as dry state, such that no residues or parts thereof are released from the interior of the diluter, via stopper ducts 131, to the external environment, e.g. surrounding water. The first proximal stopper 120 and the expanding absorbent 300 are then to be understood as two integrated parts referred to as "expanding absorbent 300".

The expanding absorbent 300 is residing within the internal volume of the enclosing cylinder 100, distal to or in conjugation with the second proximal stopper 120 and proximal to the proximal piston 230. When the expanding absorbent 300 increases in volume, the proximal piston 230 is pushed forwards, i.e. in a distal direction within the enclosing cylinder 100, due to its movability and sealing against the inner surface thereof. The proximal piston 230 is, upon movement, communicating a force to the distal piston 210. The distal piston 210 will thereby also, in a continuous fashion or suddenly, be pushed forward. In some embodiments, such a force is primarily communicated mechanically through a solid element connecting the distal end of the proximal piston 230 with the proximal end of the distal piston 210 (see for example Fig. 1A-B, Fig. 2, Fig. 3A-D, Fig. 4A-E, Fig. 5A-B, Fig. 6A-B and Fig. 9). Such a solid element may be equivalent with the internal composition 400, when being a solid, e.g. a powder or free floating crystalline material. In other embodiments, such a force is communicated primarily through a hydraulic connection, in which the internal composition 400 is a liquid, thus being equivalent with a hydraulic liquid. In yet other embodiments, such a force is communicated through a combined hydraulic and pneumatic connection, in which the internal composition 400 is a liquid, being equivalent with a hydraulic liquid, and the air space 507 being equivalent with a pneumatic gas (see for example Fig. 7A-C and Fig. A-C). The element by which such a force is communicated, between the proximal piston

230 and the distal piston 210, may herein be referred to as “piston connector 220”, independent on the mechanism by which the force is communicated. The proximal piston 230, the distal piston 210 and the piston connector 220, may herein collectively be referred to as “double piston element 200”.

5           When the distal piston 210, or at least an effective part thereof, is residing within the internal volume of the enclosing cylinder 100, the diluter is in a closed state. In such a closed state, the internal composition 400 is residing within the space defined by the distal side of the proximal piston 230, the proximal side of the distal piston 210 and the enclosing cylinder 100. Hence, the internal  
10       composition 400 is sealed from the outer environment in such a closed state. When, however, the distal piston 210 is pushed forward beyond the distal opening 110, the internal composition 400 is in a communicative relationship with the outer environment and may enter the same via the distal opening 110. The diluter 1000 is then in an open state. The amount of expanding absorbent  
15       300 and other relevant parameters, e.g. dimensions of constituting parts of the diluter 1000, are adapted such by the skilled person that the proximal piston 230 may never be pushed beyond the distal opening 110, to prevent any part of the internal composition 400 entering the outer environment under normal use.

          The teachings of this disclosure enables a user, with a minimized risk of  
20       hazardous exposure, to prepare an aqueous diluted solution by utilizing a diluter 1000 of the invention, being pre-charged with an internal composition 400, e.g. during external production thereof. The user may add the pre-charged diluter 1000 to water, such as e.g. 900 ml of deionized water in container, such as e.g. a one-liter plastic container, followed by closing the container, such as with a  
25       sealing screw-on spray handle. When the user, after a waiting period, e.g. of 5 minutes to an hour, detects that the diluter 1000 has entered the open state, e.g. by noting a change in orientation or positioning within the container, the user may shake or swirl the container to yield a homogenous diluted solution.

          The teachings of this disclosure enables a producer to produce pre-  
30       charged diluters 1000 according to the invention. Such a producer may, for example: (i) provide a combination of a suitable enclosing cylinder 100, a suitable first proximal stopper 120, a suitable second proximal stopper 130 and a suitable expanding absorbent 300 with a suitable proximal piston 230, in the internal volume thereof, while keeping the corresponding distal piston 210  
35       outside; (ii) provide a suitable internal composition 400 within the internal volume of the enclosing cylinder 100 distal to the proximal piston 230 (see for example Fig. 9); and (iii) provide the enclosing cylinder 100 with the distal piston

210 in the internal volume of the enclosing cylinder 100 distally to the internal composition 400, e.g. by applying a proximal force to the distal piston 210.

According to one embodiment, the diluter 1000 may comprise a sinker 503, having a density exceeding the density of the water or equivalent aqueous liquid the diluter 1000 is intended to be used in. The sinker 503 may be arranged in or on a suitable part of the diluter 1000 such that the diluter 1000 arranges its central axis essentially vertically when in the closed state and when floating or being submerged. The skilled person will readily understand how to select and arrange such a sinker 503, in relation to all other elements of the diluter 1000, in order to achieve the desired effect, e.g. for securing the desired entrance of water through the stopper ducts 131 in the closed state, for enabling desired facile exit of the internal composition 400 in the open state and/or for visually signaling the state of the diluter 1000 to a user.

According to one embodiment, the diluter 1000 may comprise a bobber 504, having a density being less than the density of the water or equivalent aqueous liquid the diluter 1000 is intended to be used in. The bobber 504 may be arranged in or on a suitable part of the diluter 1000 such that a part of the diluter 1000 is above the surface, when being in the closed state, and fully below the surface, when being in the open state. The skilled person will readily understand how to select and arrange such a bobber 504, in relation to all other elements of the diluter 1000, in order to achieve the desired effect, e.g. for securing the desired entrance of water through the stopper ducts 131 in the closed state, for enabling desired facile exit of the internal composition 400 in the open state and/or for visually signaling the state of the diluter 1000 to a user.

According to one embodiment, the diluter 1000 may comprise a sinker 503 and a bobber 504, having a density being greater than and less, respectively, than the density of the water or equivalent aqueous liquid the diluter 1000 is intended to be used in. The sinker 503 and the bobber 504 may be arranged in or on suitable parts of the diluter 1000 such that a part of the diluter 1000 is above the surface, when being in the closed state, and fully below the surface, when being in the open state. And such that such that the diluter 1000 arranges its central axis essentially vertically when in the closed state and optionally when being in the open state. The skilled person will readily understand how to select and arrange such a sinker 503 and bobber 504, in relation to all other

elements of the diluter 1000, in order to achieve the desired effect, e.g. for securing the desired entrance of water through the stopper ducts 131 in the closed state, for enabling desired facile exit of the internal composition 400 in the open state and/or for visually signaling the state of the diluter 1000 to a user.

According to one embodiment, the diluter 1000 may further comprise an intermediate piston 215 adapted to form a gas- and liquid tight seal against the inner surface of the enclosing cylinder 100 and to be movable along a central axis thereof, when residing in the inner volume thereof. The intermediate piston 215 may be located in the inner volume of the enclosing cylinder 100, proximal of the distal piston 210 and distal of the proximal piston 230, when in the closed state. The proximal piston 230 and the distal piston 210 may be, when residing in the inner volume of the enclosing cylinder 100, in pneumatic- or hydraulic connection with each via the intermediate piston 215. The distal piston 210 may be adapted to intermittently, i.e. suddenly, disconnect from the inner surface of the enclosing cylinder 100 at a predefined pressure difference between the distal and proximal end of the distal piston 210. Advantages such an intermediate piston 215 brings about include, for example, a more complete and sudden release of the internal composition 400 to the surrounding aqueous liquid upon entering the open state.

According to one embodiment, the distal piston 210 of the diluter 1000 may be arranged as a snap-lid, adapted to suddenly release from the enclosing cylinder 100 at a predefined delta-pressure (see for example Fig. 7A-C and Fig. 8A-C). A bendable or resilient connector 506 may be arranged between the distal piston 210 and the enclosing cylinder 100 to keep the diluter 1000 as one unit also in the open state.

According to one embodiment, one, several or all parts of the diluter 1000 are made of a polymeric material independently selected from the group of polymeric materials consisting of polycarbonate, polyurethane, polyacrylate, polymethyl methacrylate, polyetheretherketone, polystyrene, polyethylene and teflon.

According to one embodiment, deionized water, e.g. water with a TDS being less than 10 mg/l, such as less than 5 mg/l or less than 1 mg/l or less

than 0.1 mg/l, may be used for achieving transition from the closed to the open state. Advantages of using such deionized water, in comparison to e.g. water with a higher mineral content such as tap water, include a better swelling of the expanding absorbent 300.

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The present invention has been described above with reference to specific examples. However, other examples than the above described are equally possible within the scope of the invention. The different features and steps of the invention may be combined in other combinations than those described.

10 The scope of the invention is only limited by the appended patent claims.

More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the teachings of the present invention is/are used.

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## Claims

1. A diluter (1000), for protecting a user from exposure of an internal composition (400) in a closed state of said diluter (1000) and for releasing said internal composition (400) to an aqueous environment in an open state of said diluter (1000), comprising an enclosing cylinder (100), a double piston element (200) and an expanding absorbent (300), wherein
- 5 - said enclosing cylinder (100) has a distal opening (110) at its distal end, a second proximal stopper (130) at its proximal end, and a first proximal stopper (120) immediately distal to or within an inner volume of said second proximal stopper (130);
  - 10 - said second proximal stopper (130) being provided with a singularity or plurality of stopper ducts (131) adapted to allow aqueous transfer from the external surrounding to the proximal end or periphery of said first proximal stopper (120);
  - 15 - said first proximal stopper (120), being a porous or aqueous permeable structure adapted to allow aqueous transfer from said stopper ducts (131) to the proximal end of said expanding absorbent (300) and to prevent transfer of said expanding absorbent (300) to said stopper ducts (131);
  - 20 - said expanding absorbent (300), being a polymeric solid, semisolid or gel, adapted to absorb water and to expand in volume upon doing so, and being arranged within the internal volume of said enclosing cylinder (100) immediately distal of or in conjugation with said second proximal stopper (120) and proximal of the proximal end of said double piston element (200);
  - 25 - said double piston element (200) comprise a proximal piston (230), at its proximal end, and a distal piston (210), at its distal end, said proximal piston (230) and said distal piston (210) being adapted to form a gas- and liquid tight seal against the inner surface of said enclosing cylinder (100) and to be movable along a central axis thereof, when residing in the inner volume thereof;
  - 30 - said proximal piston (230) and said distal piston (210) being, when residing in the inner volume of said enclosing cylinder (100), in mechanic- pneumatic- or hydraulic connection with each other via a piston connector (220) selected from the group of piston connectors consisting of mechanic connectors, an air space (507) or said internal composition (400), respectively;
  - 35 - when in said closed state, said distal piston (210) being at least partly residing within the inner volume of said enclosing cylinder (100), whereby said internal

- composition (400) is prevented from exiting through said distal opening (110);  
and
- when in said open state, said proximal piston (230) residing within the inner volume of said enclosing cylinder (100) and said distal piston (210) residing  
5 outside the inner volume of said enclosing cylinder (100), whereby said internal composition (400) is allowed exiting to the surrounding through said distal opening (110).
2. A diluter (1000) according to claim 1, wherein said second proximal stopper  
10 (130) and said enclosing cylinder (100) are integral parts of one monolithic unit.
3. A diluter (1000) according to any one of the preceding claims, wherein said singularity or plurality of stopper ducts (131) being a plurality of through holes, independently having a diameter in the range of 1 to 10 mm.  
15
4. A diluter (1000) according to any one of the preceding claims, further comprising a sinker (503) and adapted such that said diluter (1000) is arranging its central axis essentially vertically, when being in said closed state and when said diluter (1000) is immersed in water or an equivalent aqueous liquid,  
20 wherein said sinker (503) having a density exceeding the density of said water or equivalent aqueous liquid.
5. A diluter (1000) according to any one of the preceding claims, further comprising a bobber (504) and adapted such that a part of said diluter (1000) is  
25 above the surface, when being in said closed state, and fully below the surface, when being in said open state, when said diluter (1000) is immersed in water or an equivalent aqueous liquid, wherein said bobber (504) having a density being less than the density of said water or equivalent aqueous liquid.
- 30 6. A diluter (1000) according to any one of the preceding claims, further comprising an intermediate piston (215) adapted to form a gas- and liquid tight seal against the inner surface of said enclosing cylinder (100) and to be movable along a central axis thereof, when residing in the inner volume thereof, wherein  
35 - said intermediate piston (215) being located in the inner volume of said enclosing cylinder (100), proximal of said distal piston (210) and distal of said proximal piston (230), when said diluter (1000) being in said closed state;

- said proximal piston (230) and said distal piston (210) being, when residing in the inner volume of said enclosing cylinder (100), in pneumatic- or hydraulic connection with each via said intermediate piston (215); and
- said distal piston (210) being adapted to intermittently disconnect from the inner surface of said enclosing cylinder (100) at a predefined pressure difference between the distal and proximal end of said distal piston (210).

7. A diluter (1000) according to claims 1 to 5, wherein said piston connector (220) is a mechanic connector.

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8. A diluter (1000) according to any one of the preceding claims, further comprising a bendable or resilient connector (506) attached in one end to said distal piston (210) and in the other end to said enclosing cylinder (100).

15 9. A method for production of a diluter (1000) for protecting a user from exposure of an internal composition (400) in a closed state of said diluter (1000) and for releasing said internal composition (400) to an aqueous environment in an open state of said diluter (1000), comprising an enclosing cylinder (100), a

double piston element (200) and an expanding absorbent (300), wherein

20 - said enclosing cylinder (100) has a distal opening (110) at its distal end, a second proximal stopper (130) at its proximal end, and a first proximal stopper (120) immediately distal to or within an inner volume of said second proximal stopper (130);

25 - said second proximal stopper (130) being provided with a singularity or plurality of stopper ducts (131) adapted to allow aqueous transfer from the external surrounding to the proximal end or periphery of said first proximal stopper (120);

30 - said first proximal stopper (120), being a porous or aqueous permeable structure adapted to allow aqueous transfer from said stopper ducts (131) to the proximal end of said expanding absorbent (300) and to prevent transfer of said expanding absorbent (300) to said stopper ducts (131);

- said expanding absorbent (300), being a polymeric solid, semisolid or gel, adapted to absorb water and to expand in volume upon doing so, and being arranged within the internal volume of said enclosing cylinder (100)

35 immediately distal of or in conjugation with said second proximal stopper (120) and proximal of the proximal end of said double piston element (200);

- said double piston element (200) comprise a proximal piston (230), at its proximal end, and a distal piston (210), at its distal end, said proximal piston (230) and said distal piston (210) being adapted to form a gas- and liquid tight seal against the inner surface of said enclosing cylinder (100) and to be  
5 movable along a central axis thereof, when residing in the inner volume thereof;
- said proximal piston (230) and said distal piston (210) being, when residing in the inner volume of said enclosing cylinder (100), in mechanic- pneumatic- or hydraulic connection with each other via a piston connector (220) selected from the group of piston connectors consisting of mechanic connectors, an air space  
10 (507) or said internal composition (400), respectively;
- when in said closed state, said distal piston (210) being at least partly residing within the inner volume of said enclosing cylinder (100), whereby said internal composition (400) is prevented from exiting through said distal opening (110);  
and
- 15 - when in said open state, said proximal piston (230) residing within the inner volume of said enclosing cylinder (100) and said distal piston (210) residing outside the inner volume of said enclosing cylinder (100), whereby said internal composition (400) is allowed exiting to the surrounding through said distal opening (110),  
20 comprising the steps of:
  - (i) providing said enclosing cylinder (100) with said proximal piston (230) in the internal volume of said enclosing cylinder (100) and said distal piston (210) outside the internal volume of said enclosing cylinder (100);
  - (ii) providing said internal composition (400) within the internal volume of said  
25 enclosing cylinder (100) distal to said proximal piston (230); and
  - (iii) providing said enclosing cylinder (100) with said distal piston (210) in the internal volume of said enclosing cylinder (100) distal to said internal composition (400).
  
- 30 10. A method for production of an aqueous diluted solution, comprising the steps of:
  - (i) Providing a charged diluter, being a diluter (1000) according to any one of claims 1 to 8 being in said closed state and comprising said internal composition (400) equivalent to a composition to be diluted;
  - 35 (ii) Adding the charged diluter from step (i) to a container comprising water;
  - (iii) Awaiting transitioning from said closed state to said open state of the diluter from step (ii);

(iv) stirring, shaking or swirling said container to obtain said aqueous diluted solution of said composition to be diluted.

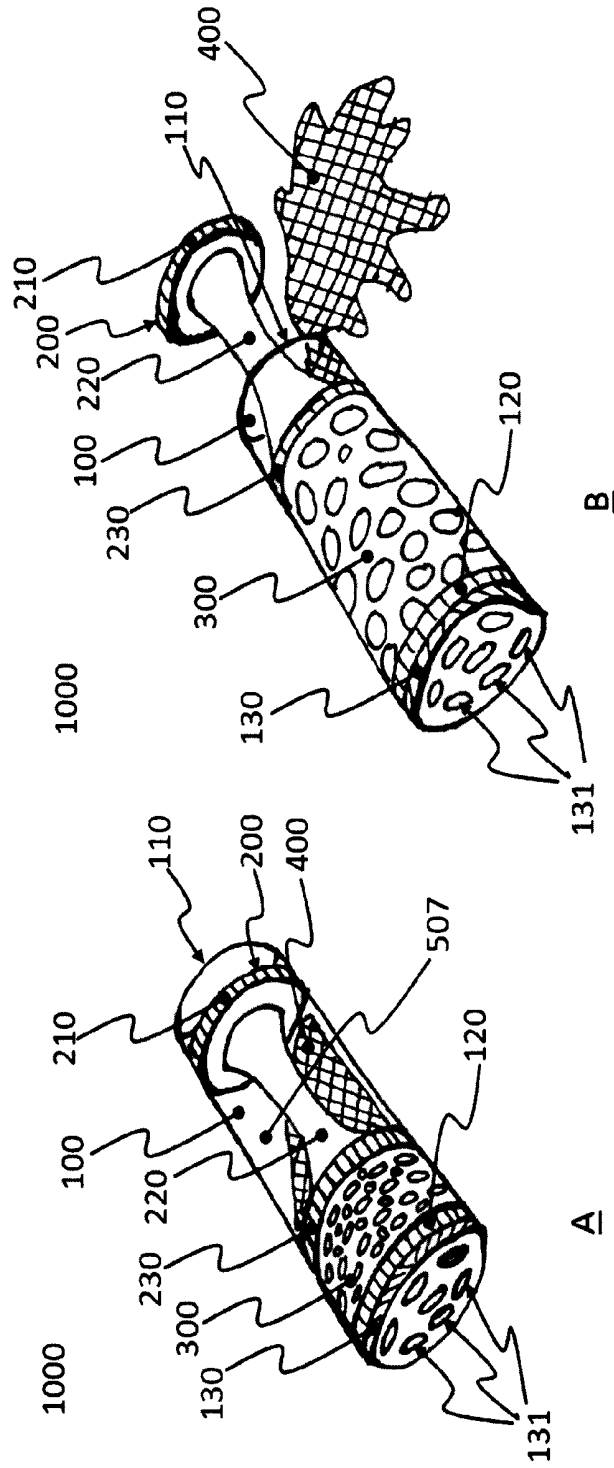


Fig. 1

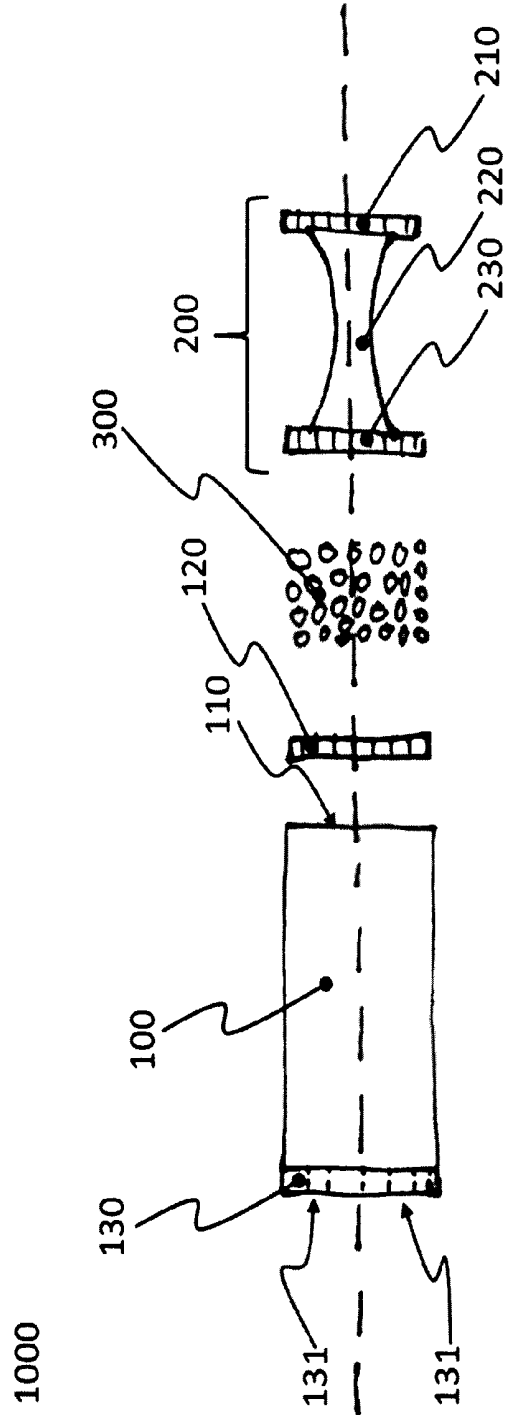


Fig. 2

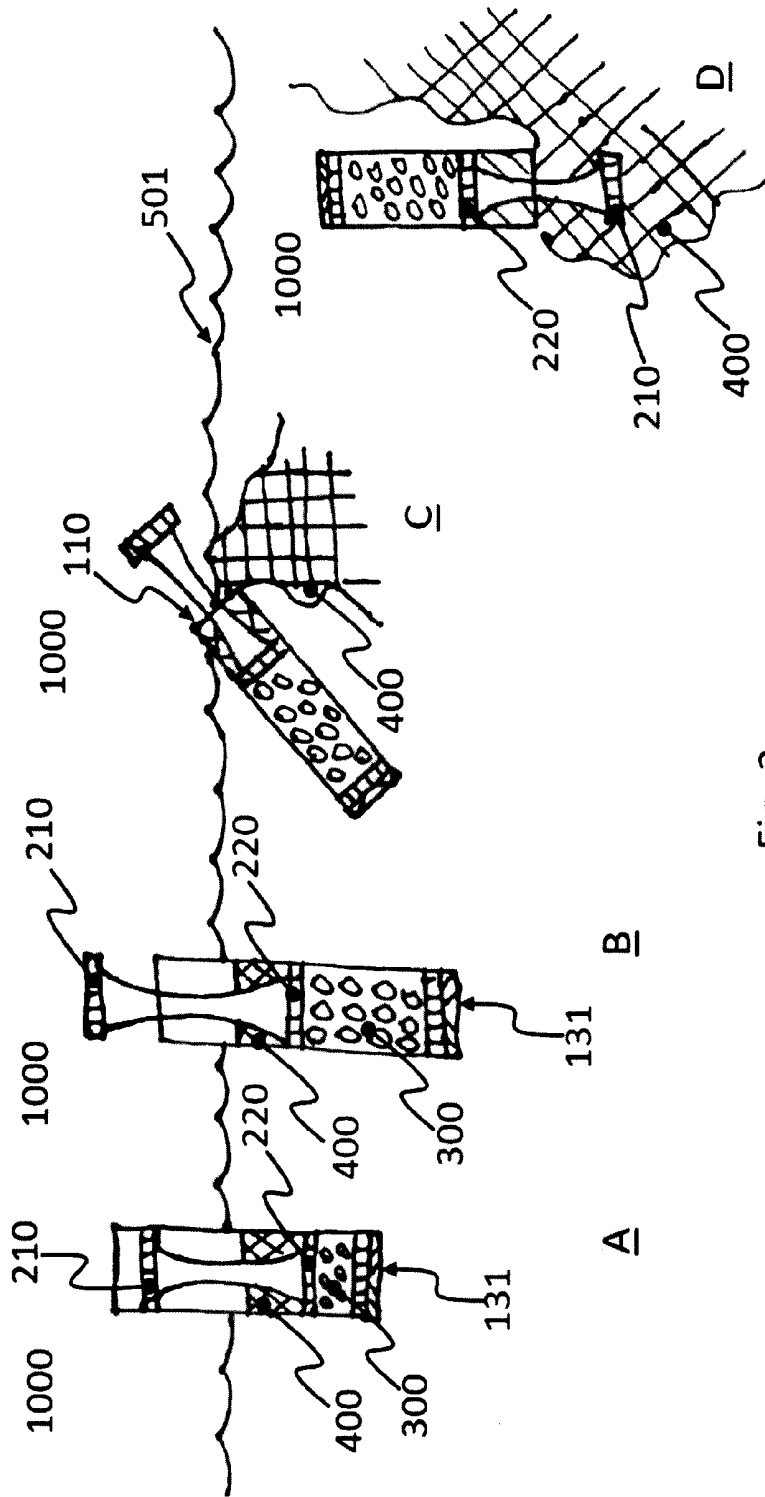


Fig. 3



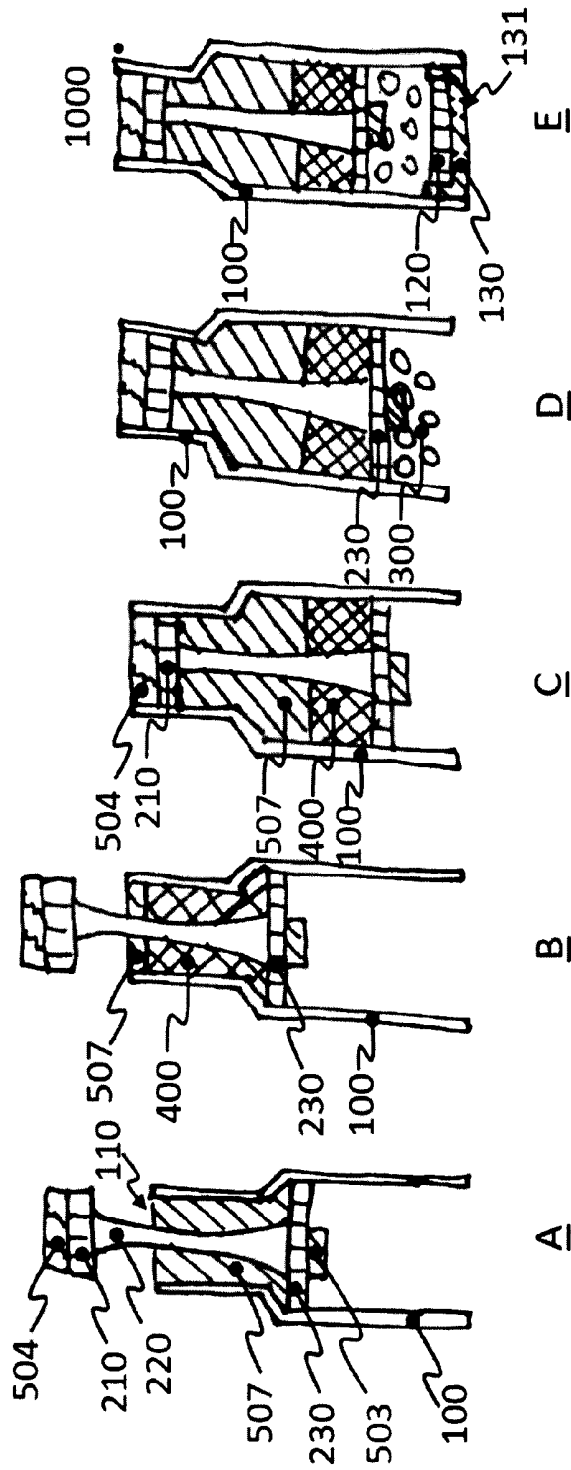


Fig. 4

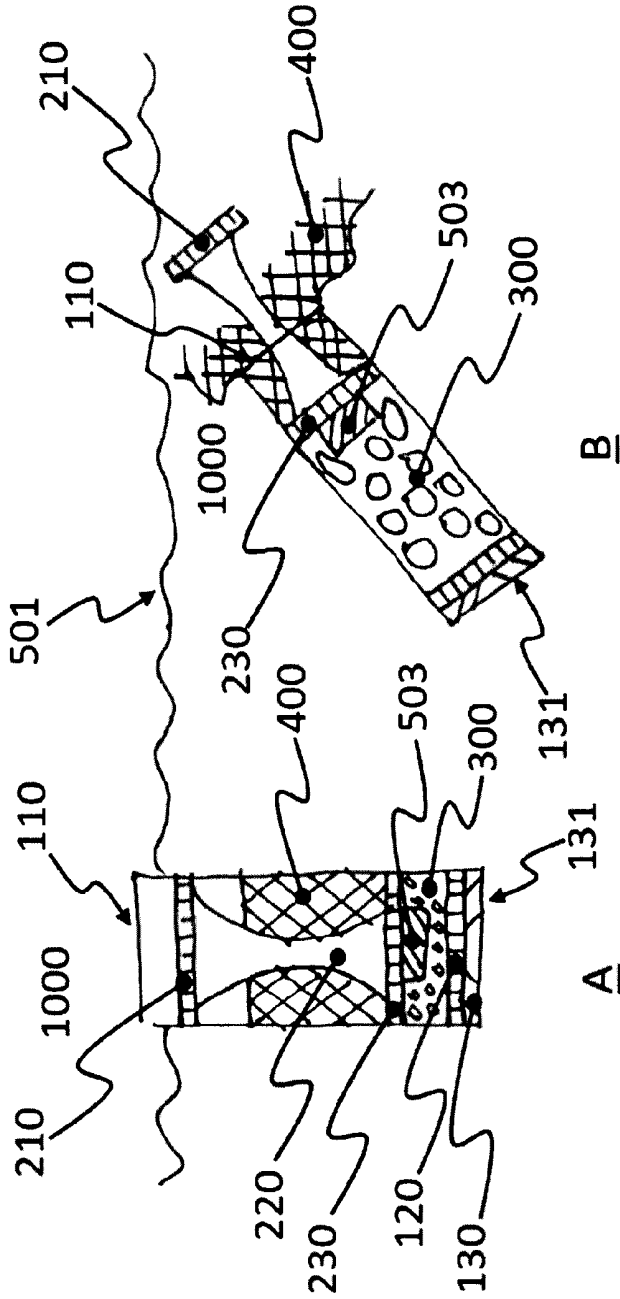


Fig. 5

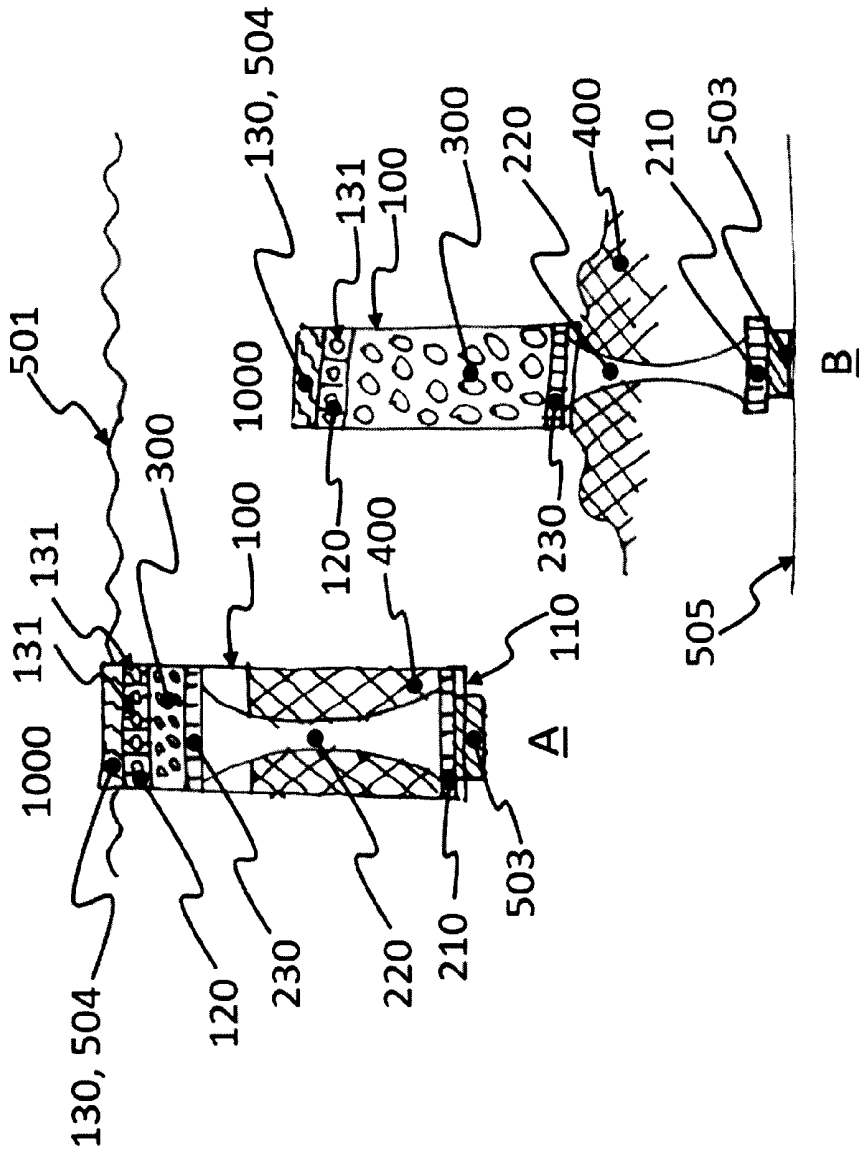


Fig. 6

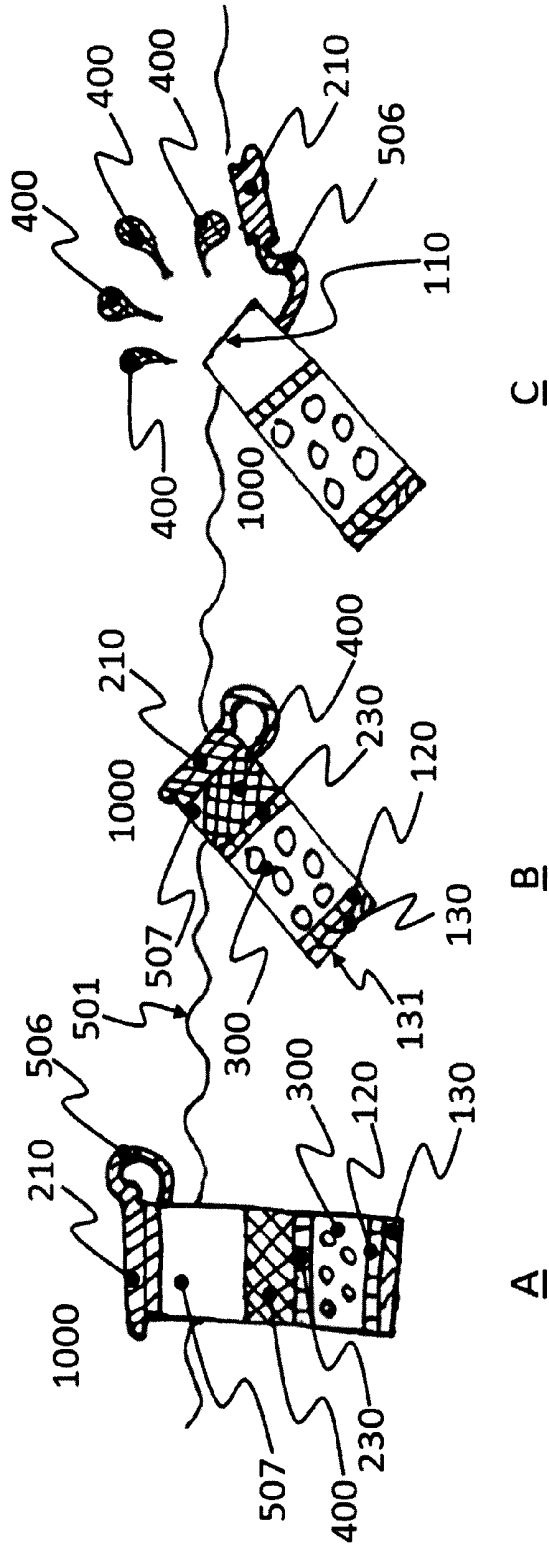


Fig. 7

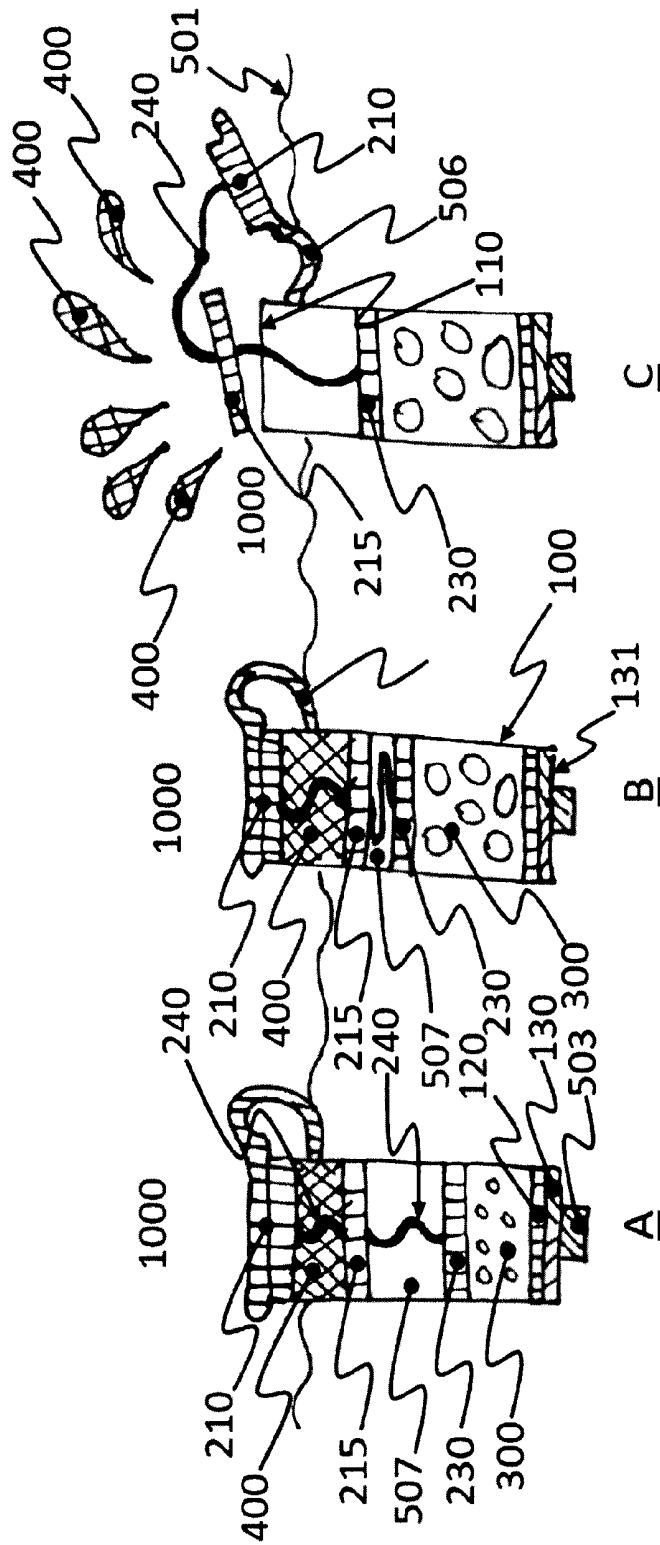


Fig. 8

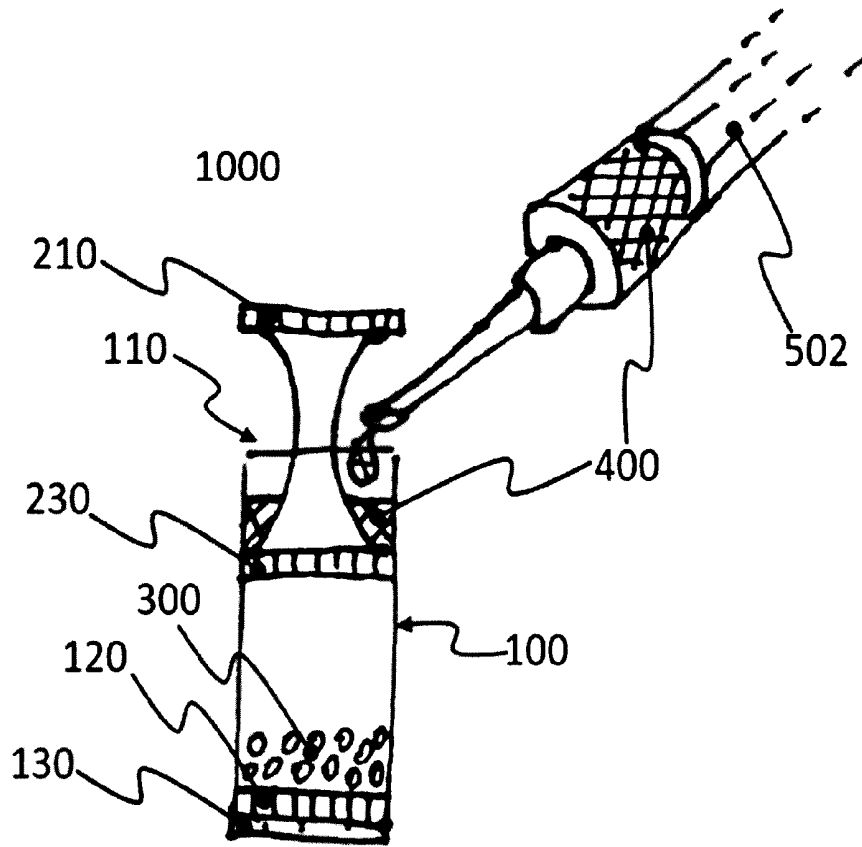


Fig. 9

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE2022/050008

A. CLASSIFICATION OF SUBJECT MATTER IPC: see extra sheet According to International Patent Classification (IPC) or to both national classification and IPC	
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC: B01F, B01L Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched SE, DK, FI, NO classes as above Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, PAJ, WPI data	
C. DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages Relevant to claim No.
A	US 20200238063 A1 (DUAN XIAODONG ET AL), 30 July 2020 (2020-07-30); abstract; figures 1,2; claims 1,2 --
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A	US 20180045627 A1 (BLANKENSTEIN GERT ET AL), 15 February 2018 (2018-02-15); figures 2,5a; claim 1 -- -----
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.	
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 10-02-2022	Date of mailing of the international search report 10-02-2022
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**Continuation of:** second sheet

**International Patent Classification (IPC)**

***B01F 35/00*** (2022.01)

***B01F 35/60*** (2022.01)

***B01L 99/00*** (2010.01)



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Information on patent family members

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