(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 150 168 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
01.05.2024 Bulletin 2024/18

(21) Application number: **21726961.2**

(22) Date of filing: **12.05.2021**

(51) International Patent Classification (IPC):
E03D 9/02 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E03D 9/033; E03D 9/007

(86) International application number:
PCT/GB2021/051131

(87) International publication number:
WO 2021/229216 (18.11.2021 Gazette 2021/46)

(54) **PLUMBING FIXTURE SANITISING SYSTEM**

SANITÄRSYSTEM FÜR SANITÄRARMATUREN

SYSTÈME D'ASSAINISSEMENT D'APPAREIL SANITAIRE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **12.05.2020 GB 202006948**

(43) Date of publication of application:
22.03.2023 Bulletin 2023/12

(73) Proprietor: **GreenTeck Holdings Limited**
Lancashire PR7 6TB (GB)

(72) Inventor: **THURSTON, David**
Gifford Oxfordshire OX10 8DS (GB)

(74) Representative: **Boult Wade Tennant LLP**
Salisbury Square House
8 Salisbury Square
London EC4Y 8AP (GB)

(56) References cited:
US-A1- 2018 002 910
US-A1- 2018 112 317
US-B1- 6 319 390

EP 4 150 168 B1

Description

Background

[0001] The present application relates to a plumbing fixture sanitising system, a method of sanitising a plumbing system, and a use of ozonated water to sanitise a plumbing system. In particular, the plumbing system may be a toilet or a urinal.

[0002] Commercial urinal installations are typically formed of a plurality of urinals, each of which are connected to a cistern which provides a supply of water to flush the urinals. Similar systems may be provided for commercial toilet installations where a plurality of toilets are connected to the cistern in order for the cistern to provide a water supply to flush the toilets.

[0003] Alternatively, a single elongate multi-user urinal may include a plurality of water inlets spaced from one another, each of which is connected to the cistern. Thus the cistern provides a supply of water to flush the multi-user urinal at a number of spaced apart locations.

[0004] A typical problem for conventional systems is how to clean the plumbing fixture, and how to mask the smell of human waste, such as urine. Urine presents a particular problem as the smell can be particularly strong over time. In particular, as the uric acid present in urine can form uric acid crystals (also known as uric salts) which can build up in the plumbing fixture as a source of malodour.

[0005] Conventional systems incorporate a sanitising device which releases one or more cleaning chemicals into the supply of water for cleaning the plumbing fixture. Such cleaning chemicals may include, for example, liquid or solid detergent compositions. This may include one or more of: sodium hypochlorite solution, sodium (C12-14) alkyl ethoxy sulphate, 1,2-benzisothiazolin-3-one, benzenesulphonic acid mono C10-C13 alkyl derivs. Some toilet cleaners may also include sodium salts. These cleaning chemicals must be carefully stored and disposed of, as there is otherwise a risk of environmental damage.

[0006] Alternative solutions involve the use of an enzyme mat or sleeve which then leads down to a bottle trap of the waste water outlet of the plumbing fixture. The enzyme mat includes enzymes and/or bacteria which break down the build-up of uric salts. While this does not use the same cleaning chemicals as other conventional systems, the trap is typically made from non-recyclable plastics. Further, if any of the conventional cleaning chemicals are added to the plumbing fixture, such as during a supplemental cleaning routine, the enzymes in the mat may be deactivated or denatured. Additionally, each type of enzyme has a relatively small pH range in which it is optimally effective. Once it falls out of this range, the enzymes may denature and stop working. The mat then needs replacement, generating more waste which may be difficult to dispose of in an environmentally friendly manner.

[0007] Either of these systems will typically not entirely remove the unpleasant smells. Accordingly, additional fragrance delivery devices are usually installed. These may be in the form of aerosol dispensers such as automated air fresheners. Typically these fragrances will also include cleaning chemicals to mask the unpleasant smells, and hence suffer from the same issues regarding storage, handling and disposal of these cleaning chemicals as other systems discussed above. For example, these may contain one or more of: C11-15-ISO-alkanes, alpha-isomethyl ionone, butylphenyl methylpropional, cyclamen aldehyde, geraniol, limonene, tetramethyl acetyloctahydronaphthalenes, isopropanol, dipropylene, and/or Glycol.

[0008] The use of ozone (Os) to clean and disinfect a toilet system is disclosed in WO 2018/100349 A1. An electrochemical cell is provided to produce ozone in water flowing into the toilet bowl. The electrolysis of water at high electrode potential produces ozone at the anode in the electrochemical cell.

[0009] In systems including a cistern, the electrochemical cell is provided in the conduit between the cistern and the toilet bowl to produce ozone in water flowing to the bowl for flushing. In systems without a cistern, the electrochemical cell is provided on the conduit between the mains supply of water and the toilet bowl.

[0010] The concentration of ozone generated in the water will determine the rate of oxidation and hence the degree of disinfection. The concentration of ozone depends upon the effective contact time between the water and the electrochemical cell, which is limited by the flow rate of the water passing the cell. The flow rate of the water passing the cell must be sufficiently large enough to have a mechanical flushing effect on the toilet bowl to dislodge debris. Thus, the concentration of ozone generated in WO 2018/100349 A1 is limited to around 0.5 ppm (0.5 mg/L). This will naturally decrease in the portion of the conduit between the electrochemical cell and the toilet bowl as the ozonated water contacts the conduit walls, air, and debris in the conduit.

[0011] There is therefore a need for an improved plumbing fixture sanitising system.

[0012] US 2011/0277227 A1 discloses a procedure for disinfecting a toilet appliance in which water for flushing a toilet is introduced from a cistern into a flush pipe and from there into the interior of the toilet. Ozone gas is injected so as to provide ozone gas to the air around the toilet appliance.

[0013] US 2004/0133968 A1 discloses water which is electrochemically treated to achieve disinfectant properties.

[0014] US 2020/0131749 A1 discloses an antimicrobial toilet including one or more pairs of electrodes positioned

below a water line when the hydraulic circuit is at equilibrium.

[0015] JP H06158701 A discloses city water which is supplied to a shower nozzle through a stop cock and a branching water cock, and an ion formation device and an ozonizer which are connected into a pipe line thereof. The ozonizer generates gaseous ozone from air, which is injected into the water line.

[0016] EP 1939366 A1 discloses flush toilet equipment comprising a bowl, a flush mechanism that supplies flush water to the bowl through a flush water passage, and a minute bubble generator.

[0017] DE 10048299 A1 discloses a device for electrolytic disinfection of drinking water, service water and waste water using anodically generated disinfectants.

[0018] US 6 319 390 B1 discloses a method of and system for cleansing a toilet or urinal. A urinal is provided with a continuous electrolytic cell having at least a pair of electrodes, a passage formed between the electrodes, and an inlet and an outlet that lead to the passage. Tap water is electrolyzed by the continuous electrolytic cell, whereby free chlorine is produced. Then the water containing free chlorine produced is supplied to the urinal.

[0019] US 2018/002910 A1 discloses a sterilizing device for a toilet that includes an ozone generator and an impelling device fluidically connected to the ozone generator that allows discharging the ozone generated into the flush water of the toilet. A controller controls generating the ozone and discharging the ozone into the flush water. A sensor detects the presence or the actuation of a user, the sensor being communicated with the controller. The controller controls the ozone generator depending on a signal received from the sensor. The sterilizing device also includes an ion plasma generator for discharging ion plasma directly into the air adjacent the toilet. The ion plasma generator being controlled by the controller.

[0020] US 2018/112317 A1 discloses an electrolytic ozone generator that includes an anode with a longitudinal edge, a cathode with a longitudinal edge spaced apart from the cathode, and an isolator. The isolator electrically separates the cathode from the anode and is semi-impermeable. The anode and cathode are impermeable for generating ozone in a flow area fluidly coupling longitudinal edges of the anode and the cathode. Ozone water apparatus, methods of making electrolytic ozone generators, and methods of generating ozone using electrolytic ozone generators are also described.

Summary

[0021] The invention provides a plumbing fixture sanitising system according to claim 1 and a method of sanitising a plumbing fixture according to claim 10. Embodiments of the invention are defined in the dependent claims.

[0022] The system allows a large concentration of ozone to be generated in water to be used in a flush event, before entering the cistern to clean and wash the plumbing fixture. The ozonated water effectively reduces bacteria on the plumbing fixture, and eliminates malodour. The arrangement of the electrochemical cell assembly upstream of the cistern improves the ozone generation, and allows for the cistern itself to be cleaned. As a result, traditional cleaning chemicals do not have to be used in the system. The plumbing fixture sanitising system is therefore more environmentally friendly than known systems.

[0023] The plumbing fixture sanitising system may further comprise one or more further plumbing fixtures, each comprising a water inlet arranged to receive water from the cistern. The ozonated water can thereby be used to clean a plurality of plumbing fixtures, for example in a commercial lavatory set-up.

[0024] The plumbing fixture sanitising system further comprises a control system comprising: an inlet valve arranged on the supply pipe, moveable between: an open position where water can flow through the supply pipe; and an inhibited position where water is inhibited from flowing through the supply pipe; and a controller configured to control operation of the inlet valve between the open and inhibited positions. The inhibited position may be a fully closed position, or may allow a trickle flow therethrough. This valve can selectively allow a full flushing flow of water through the system. As a result, flushing of the system can be triggered when appropriate.

[0025] The controller is further configured to control operation of the electrochemical cell assembly to produce ozone when the inlet valve is in the open position, and cease production of ozone when the inlet valve is in the inhibited position. This prevents the electrochemical cell from operating when there is insufficient water for it to do so, or for when it is unnecessary for it to do so. This may allow the controller to optimise the operation of the electrochemical cell assembly to deliver the required concentration of ozone to the plumbing fixture.

[0026] The controller may be configured to move the inlet valve to the open position after a predetermined time period. This may ensure that water is not wasted by flush events which are unnecessary.

[0027] The control system may further comprise a sensor arranged to generate a signal indicative of the presence of a person. This can further reduce the wastage of water in the system.

[0028] The controller may be configured to adjust the predetermined time period based upon the signal indicative of the presence of a person. This allows the system to adjust based upon the use of the plumbing fixture.

[0029] The inlet valve may be arranged upstream of the electrochemical cell assembly in the supply pipe. This prevents water from flowing past the electrochemical cell when a flush event is not desired.

[0030] The control system further comprises a cistern valve for selectively inhibiting flow of water from the cistern to the plumbing fixture, wherein the controller is configured to: actuate the inlet valve at a first time to allow a flow of water through the supply pipe to the cistern with the cistern valve in a closed position; and open the cistern valve a predetermined delay period after the first time to provide water to the plumbing fixture. Again, the cistern valve may completely prevent a flow of water from the cistern to any of the attached plumbing fixtures. Alternatively, a trickle flow therethrough may be permitted. This allows the cistern to fill and thereby build up a head pressure. The head pressure results in the water entering the sanitary fixture with a greater force and thus producing a stronger mechanical cleaning action. The flow of water through the electrochemical cell assembly can be slowed, thereby increasing the contact time and hence the concentration of ozone generated. This slower water flow would normally have a weaker mechanical cleaning action, but the filling of the cistern first ensures this is not the case.

[0031] The predetermined delay period may be between two and five minutes. This may allow a suitable pressure level for a reasonable mechanical cleaning force.

[0032] The controller may be configured to control operation of the electrochemical cell assembly based upon the position of the inlet valve and/or the cistern valve. This may allow the controller to optimise the operation of the electrochemical cell assembly to deliver the required concentration of ozone to the plumbing fixture.

[0033] The controller may be configured to activate the electrochemical cell assembly to generate ozone when the inlet valve and/or the cistern valve is in the open position, and deactivate the electrochemical cell assembly when the inlet valve and/or the cistern valve is in the inhibited position. This may mean that the ozone does not spend a significant amount of time in the cistern, where it would decay. As a result, ozone at a higher concentration may be delivered to the plumbing fixture.

[0034] The electrochemical cell assembly is arranged to produce ozone at a concentration of at least 0.7 ppm. The electrochemical cell assembly may be arranged to produce ozone at a concentration of at least 0.8 ppm, more preferably a concentration of at least 1 ppm, most preferably a concentration of at least 1.1 ppm. The present system has shown particular effectiveness with these concentration levels, particularly in the ozone level delivered to the plumbing fixture when balanced with the difficulty of achieving these higher concentrations.

[0035] Each plumbing fixture may be a urinal or a toilet. These are typically installed in commercial lavatory set-ups where the present system may be particularly effective.

[0036] A method of sanitising a plumbing fixture is provided according to claim 10. This method may be particularly effective for cleaning the plumbing fixture, particularly in breaking down uric acid crystals and hence removing malodour.

[0037] The ozonated water is generated having a concentration of at least 0.7 ppm. The ozonated water may be generated having a concentration of at least 0.8 ppm, more preferably a concentration of at least 1 ppm, most preferably a concentration of at least 1.1 ppm. The present system has shown particular effectiveness with these concentration levels, particularly in the ozone level delivered to the plumbing fixture when balanced with the difficulty of achieving these higher concentrations.

[0038] The plumbing fixture may be a urinal or a toilet. These are typically installed in commercial lavatory set-ups where the present system may be particularly effective.

Brief Description of the Drawings

[0039]

Figure 1 shows a schematic of a first plumbing fixture sanitising system; and
Figure 2 shows a schematic of a second plumbing fixture sanitising system.

Detailed Description of the Drawings

[0040] A plumbing fixture sanitising system 100 is depicted in Figure 1. A plurality of plumbing fixtures 20 are provided, in this embodiment the plumbing fixtures 20 are urinals 20. However, the system 100 may be applied to any suitable plumbing fixture 20 including, but not limited to, urinals, toilets and bidets. Each of the plumbing fixtures 20 comprises a water inlet 22 which is supplied with water from a cistern, or reservoir 40. This may be, for example, via a conduit that branches into a plurality of supply conduits 23. Alternatively, each supply conduit 23 may connect directly to the cistern 40. The water inlet 22 may be, for example, a nozzle or other spray device arranged to distribute the supply water over an area.

[0041] The cistern 40 is connected via a supply pipe 42 to a source of water 1. The source of water 1 may be, for example, a mains water supply or a larger supply tank. In use, water is supplied from the source 1 to fill the cistern 40. The water stored in the cistern 40 is then used to flush the plumbing fixtures 20. That is, the water from the cistern is released to flow through each supply conduit 23 to the water inlets 22, where it is then dispersed around an inner surface 21 of the plumbing fixture 20. This may be referred to as a *"flush event*". The dispersal of water around the inner surface

21 acts to wash the plumbing fixture. This washing produces a mechanical cleaning effect by dislodging debris on the inner surface. The inner surface 21 may be, for example, a toilet bowl 21 which is arranged to receive a user's waste in use. The water flowing from the water inlets 22 acts to clean the inner surface 21 and remove any debris.

[0042] At a lower end when installed of each plumbing fixture 20 is a waste water outlet 24. The waste water outlet 24 connects to a waste water return 2. The waste water outlet 24 includes a bottle trap which the water exiting the plumbing fixture 20 flows through. The bottle trap acts to collect debris from the water exiting the plumbing fixture 20. The waste water outlet 24 may return the waste water to a mains waste water system, or any other suitable disposal method such as to a cesspit or a septic tank. In use, the water is drawn via gravity through this waste water outlet 24. An enzyme mat or sleeve 26 may be provided in the region of the waste water outlet 24. The enzyme mat 26 may generally be formed as a grill or lattice extending across a portion of the plumbing fixture 20. Preferably, the enzyme mat 26 substantially extends over the waste water outlet 24 such that any water must pass through the enzyme mat 26 before it exits the plumbing fixture 20 via the waste water outlet 24 and the bottle trap. Additionally, or alternatively, an enzyme may be applied to the bottle trap such that the bottle trap provides some of the performance of the enzyme mat 26.

[0043] An electrochemical cell assembly 10 is provided in the flow between the water supply 1 and the cistern 40. Collectively, the electrochemical cell assembly 10 and the water supply pipe 42 define a water supply assembly. The electrochemical cell assembly 10 may be provided in-line with the water supply pipe 42. The electrochemical cell assembly 10 is operable to produce ozone via the electrolysis of water. Any suitable electrochemical cell assembly 10 may be used..

[0044] The electrochemical cell assembly 10 may have a cell input and a cell output. Water is received by the cell input, flows through the electrochemical cell assembly 10, and out of the cell output. The electrochemical cell assembly 10 may further comprise a power input for receiving electrical power to drive the electrochemical cell assembly 10. The electrochemical cell assembly 10 may include an anode and cathode, and the water flowing through the electrochemical cell assembly 10 may flow over the anode and cathode. This results in ozone being continuously produced.

[0045] As the water flows from the water supply 1 to the cistern 40 it passes through the electrochemical cell assembly 10 such that ozone is generated in the flow of water. The ozone is generated via electrolysis and generates ozone which is dissolved in the flow of water. As a result, almost no gaseous ozone is produced.

[0046] The electrochemical cell assembly 10 may be configured such that ozone is generated in the water flowing therethrough at a concentration of at least 0.7 parts per million (ppm). It is noted that, at least in the current field, 1 ppm is generally equivalent to 1 mg/L. Preferably, the ozone is generated at a concentration of at least 0.8 ppm, more preferably at least 0.9 ppm. In particular embodiments the ozone may be generated at a concentration in the region of 1 to 1.1 ppm.

[0047] The ozone concentration of the water may be tested, for example, by using an activator solution, which is added to the liquid to be tested. This liquid is then drawn into an ampoule, and after 1 minute, this is matched against a colour comparator to identify the ozone reading. Immediately on generation, ozone will start to decay. This decay will be quicker if it is in contact with bacteria and organic matter. Additionally the ozone will decay faster if the liquid is subject to turbulence. The colour comparator gives a reading of ozone levels using parts per million, ppm.

[0048] The ozonated water may then collect in the cistern 40. When the plumbing fixtures 20 are to be cleaned, the ozonated water is released from the cistern to flow to the plumbing fixtures 20. The exact concentration of ozone delivered to the plumbing fixtures 20 will depend upon the length of the water supply pipes 23, and their cleanliness. In particular, if the system 100 is used to sanitise the plumbing fixture 20 for a first time after a period of non-use, more of the ozone will react with matter in the supply pipe 23 and thereby reduce the concentration delivered to the plumbing fixture 20. However, the inventors have found that following a number of flushing cycles (known as *"commissioning"* cycles), the system 100 has typically settled into a relatively stable operating mode. In particular testing embodiments the number of commissioning cycles may be five.

[0049] Following the commissioning cycles, ozonated water may be delivered to the plumbing fixture 20 with a concentration of at least 0.7 ppm of ozone. Such a concentration of ozonated water should allow for effective cleaning of the plumbing fixture 20, in particular the breaking-down of uric acid crystals (uric salts).

[0050] The ozone concentration in the water collected in the waste water outlet 24, for example in the bottle trap, will also depend upon the cleanliness of the supply pipe 23, as well as the cleanliness of and amount of debris on the inner surface 21. Again, after a number of commissioning cycles the system 100 will have settled into a relatively stable operating mode. Ozonated water may be delivered to the waste water outlet 24, such as to the bottle trap, with a concentration of at least 0.6 ppm. Again, this allows for effective breaking-down of uric acid crystals (uric salts) which may otherwise build up in these regions.

[0051] The ozonated water then is drawn via gravity through the waste water outlet 24 and bottle trap into the waste water return 2. The remaining ozone in the water will act to provide a cleaning effect to the waste water return 2, though this is merely ancillary to the purpose of the present disclosure to sanitize the plumbing fixture 20.

[0052] The system 100 further includes a control system 30 as a part of the water supply assembly. The control system 30 comprises an inlet valve arranged on the supply pipe 42. The inlet valve selectively allows water to flow between the water source 1 and the cistern 40. The inlet valve is moveable between an open position where water can flow through

the supply pipe; and an inhibited position (or closed position) where water from the water source 1 is inhibited from flowing through the supply pipe 42. In the inhibited position, water may be completely prevented from flowing into and filling the cistern 40. Alternatively, a trickle-flow of water may be allows past the inlet valve in the inhibited position.

[0053] The system 100 is controlled by a controller which is a part of the control system 30. This controller is configured to control operation of the inlet valve between the open and closed positions. That is, the controller may send a control signal to the inlet valve to instruct it to move to the open position in order to fill the cistern 40 in order to prepare the system for a flush event. This signal may be triggered, for example, by a user input requesting a flush event. The user input may be those conventionally associated with flushing a toilet or urinal including, but not limited to, actuating a lever, pulling a chain, activating an optical sensor (such as a motion or light sensor, for example by waving their hand over the sensor), pressing a button, or voice activated.

[0054] Alternatively, the system 100 may further comprise a sensor arranged to generate a signal indicative of the presence of a user. The controller may receive this signal and trigger opening of the inlet valve a predetermined time period after receipt of this signal. The sensor may be able to determine the number of people detected in a given period and the controller may adjust the predetermined time period accordingly. For example, if there are a lot of users detected the time period may be reduced to trigger a flush event sooner.

[0055] In preferred embodiments, the inlet valve may be arranged upstream of the electrochemical cell assembly 10. As a result, water does not flow past the electrochemical cell assembly 10 until the inlet valve has been opened in the prelude to a flush event.

[0056] In order to increase the mechanical force of the water passing through the plumbing fixture 20 during a flush event, the cistern 40 includes a cistern valve which is arranged on the water outlet of the cistern 40. The cistern valve is moveable between a closed position where water is unable to flow from the cistern 40 to the water inlet pipes 23, and an open position where water is able to flow from the cistern 40 to the water inlet pipes 23 (i.e. during a flush event). In the closed position the cistern valve may allow a trickle flow of water. Thus, with the cistern valve closed a head of water is able to build in the cistern 40 by the flow of water from the water source 1.

[0057] Once a sufficient head of water has built up in the cistern 40, the cistern valve is opened to allow the flow of water through the water inlet pipes 23 into the plumbing fixtures 20. The head of water in the cistern 40 results in the water being delivered at a pressure caused by the weight of the water in the cistern 40. As a result, the water will have a greater momentum and will collide with any debris on the inner surface 21 to dislodge the debris. The opening of the cistern valve is triggered by the controller.

[0058] The opening may be in response to a signal detected by a sensor which is indicative of the presence of users of the plumbing fixture 20. For example, the plumbing fixture 20 may be installed in a bathroom and the sensor may detect the number of people entering the bathroom.

[0059] The controller actuates the cistern valve to the open position a predetermined delay period after opening the water inlet valve. This predetermined delay period allows enough time for the cistern 40 to fill to produce the necessary head pressure for mechanical cleaning. The length of time for the predetermined delay period may be programmed into the controller, such as stored in a memory unit attached to the controller. This predetermined delay period may be selected based upon a number of variables such as the flow rate of water through the inlet pipe 42, the number and/or type of plumbing fixtures 20 supplied with water by the cistern 40, the capacity of the cistern 40, the intended users of the plumbing fixtures 20, etc.. In particular embodiments, the predetermined delay period may be between 2 and 5 minutes.

[0060] The controller may be configured to control operation of the electrochemical cell assembly based upon the position of the cistern valve. For example, the controller may be configured to activate the electrochemical cell assembly to generate ozone when cistern valve is in the open position, and deactivate the electrochemical cell assembly when the cistern valve is in the inhibited position.

[0061] In further embodiments, the predetermined delay period may be adjusted by the controller in response to a signal indicative of users of the plumbing fixtures 20 from a sensor. For example, the plumbing fixture 20 may be installed in a bathroom and the sensor may detect the number of people entering the bathroom. The sensor may indicate to the controller that there has been no visitors to the bathroom since the previous flush event. In order to maintain cleanliness in the plumbing fixture 20, for example so that sufficient ozone is provided during a later flush event, it may still be necessary to trigger a flush event despite there being no use of the plumbing fixture 20. As the plumbing fixture 20 has not been used, there will not be any significant debris in the plumbing fixture 20. Accordingly, a significant head pressure will not be necessary as there is not much mechanical cleaning required. The controller may therefore adjust the predetermined delay period to a shorter time, potentially even down to having a 0 second predetermined delay period if appropriate for the particular system 100. The adjustment may be between a plurality of discrete levels, or may be a continuous adjustment.

[0062] In a similar manner, if a low footfall in the bathroom is detected by the sensor, the controller may adjust the predetermined delay period to a shorter time as there will likely be less debris requiring mechanical cleaning. Conversely, if the sensor detects a large number of users the controller may extend the predetermined delay period so that more water collects in the cistern 40 before a flush event. The greater amount of water in the cistern 40 will increase the head

pressure and hence the effectiveness of mechanical cleaning. The controller may increase the delay period such that the cistern 40 is completely filled if the sensor detects a number of users greater than a threshold.

[0063] The cistern valve may be manually actuated between the open and closed positons. For example, the cistern valve may be moved to the open position in response to a user input.

[0064] The user input may be those conventionally associated with flushing a toilet or urinal including, but not limited to, actuating a lever, pulling a chain, activating an optical sensor (such as a motion or light sensor, for example by waving their hand over the sensor), pressing a button, or voice activated.

[0065] For example, the sensor may detect that the number of users of the plumbing fixture 20 has exceeded a threshold and a sanitising flush event is now required. This may trigger the controller opening the water inlet valve to begin the ozonation of water filling the cistern 40. Then, once the user of the plumbing fixture 20 leaves the area, the sensor (or a different presence sensor) may detect that the user has left and initiate the flush event by opening the cistern valve. If the user leaves too quickly and a sufficient water head has not built up in the cistern 40, the controller may apply the predetermined delay period until the cistern 40 is sufficiently full for the degree of mechanical cleaning desired.

[0066] The controller may further include a water sensor arranged to generate a signal indicative of the amount of water in the cistern 40. The water sensor may include, for example, a flow sensor in the water supply pipe 42 (or in any other part of the water supply assembly), a float sensor in the cistern 40, and/or a balance arranged to detect the mass of water in the cistern 40. In this sense, the predetermined delay period may not be defined as a period of time directly, but as a trigger event when a certain amount of water has entered the cistern 40. That is, the predetermined delay period may be *"the period in which the cistern receives 5 litres of water*". Of course, the exact volume of water required will depend upon the particular system 100 and can be selected and adjusted accordingly.

[0067] Any reference to a predetermined delay period must be interpreted to include such an arrangement. The adjustment of such a predetermined delay period by the controller is then achieved by the adjustment of the amount of water necessary to trigger the flush event. For example, for a low-use flush event the delay period may be *"the period in which the cistern receives 2 litres of water",* and for a high-use flush event the delay period may be *"the period in which the cistern receives 8 litres of water".* Of course, the exact volume of water required for different use levels will depend upon the particular system 100 and can be selected and adjusted accordingly. The adjustment may be between a plurality of discrete levels, or may be a continuous adjustment.

[0068] As the water first builds up in the cistern 40 before the flush event, the rate of water flow can be reduced. The reduction in the water flow rate means that the water has a longer effective contact time with the electrochemical cell assembly 10. As such, a greater concentration of ozone in the water can be achieved compared to using the same electrochemical cell assembly 10 with water flowing at a faster rate therethrough. Thus, the arrangement allows water to have both a high ozone concentration (and hence a high chemical cleaning effect) and a high mechanical cleaning effect due to the head pressure.

[0069] The controller selectively controls operation of the electrochemical cell assembly 10.

[0070] The present disclosure may also be applied to systems 100 where a single plumbing fixture 20 is supplied by a cistern 40, such as shown in Figure 2. For example, the single plumbing fixture 20 may be an elongated urinal 20 (also known as a trough or slab urinal) which is designed to be used simultaneously by multiple users. Essentially, multiple users may use the same urinal 20, with a shared trough for collecting fluids provided at a lower edge (when installed). A back wall and the trough collectively form the inner surface 21 or toilet bowl 21.

[0071] Such an arrangement is generally the same as the system 100 shown in Figure 1 and unless otherwise expressly stated any arrangements disclosed in relation to the system 100 of Figure 1 also apply to the system 100 of Figure 2.

[0072] The plumbing fixture 20 may include a plurality of water supply inlets 22. Alternatively, the plumbing fixture 20 may include a single water supply inlet 22 which is arranged to suitably direct the incoming water around the entire inner surface 21. In embodiments with a plurality of water inlets 22, the supply pipes 23 may collectively form a header pipe with the inlets extending therefrom or attached thereto. In the simplest form the water supply inlets 22 may be formed as holes in the header pipe.

[0073] The water supply assembly and cistern 40 of this embodiment may operate in accordance with any of the disclosure relating to the embodiment of Figure 1. At a lower (when installed) end of the plumbing fixture 20, a water outlet (not shown) is formed. There may be a single water outlet, or there may be multiple water outlets provided along a length of the plumbing fixture 20. A lower surface in the trough region may be angled with respect to a horizontal so as to encourage fluids towards the water outlet under gravity. An enzyme mat may be provided in the region of each water outlet in the same manner as discussed above in relation to Figure 1. Likewise, each water outlet may include a bottle trap as discussed above in relation to Figure 1.

[0074] While each of depicted examples are urinals, the present disclosure may also be applied to any plumbing fixture. Particular examples may include urinals designed for multiple users.

[0075] In this sense, a system 100 according to the present disclosure can effectively clean and sanitise a plumbing assembly. At its broadest level, the disclosure may be defined as the use of ozonated water having at least 0.7 ppm of

ozone to clean a plumbing fixture.

Trial Data

[0076] A system 100 in accordance with the present invention was tested. The system 100 included an electrochemical cell 10 installed downstream of an inlet flow valve and upstream of a cistern 40 for a urinal. The urinal included a left-hand and a right-hand urinal. Each of these urinals had a bottle trap. The bottle trap of the left-hand urinal was replaced with a new bottle trap the start of testing, while the right-hand urinal was left with its old bottle trap.

[0077] Prior to the start of this test, the urinal was used with a conventional sanitising system to establish a comparative baseline. The urinal was regularly urinated in before the test and during the test.

[0078] The primary results being tested were odour and cleanliness. Odour is not readily measurable in a quantitative manner. Instead, multiple members of the trial team smelt the respective areas and reached a consensus on the smell.

[0079] Cleanliness was monitored via Adenosine Triphosphate (ATP) monitoring. ATP monitoring is a rapid testing method used in Food and Beverage, Hospitality, Healthcare and many other where the need to quickly assess the cleanliness of surfaces or liquid samples is needed.

[0080] ATP is present in all organic material and is produced and/or broken down in metabolic processes in all living systems. ATP drives processes such as photosynthesis in plants, muscle contraction in humans, respiration in fungi, and fermentation in yeast. Therefore, most foods and microbial cells will contain some level of naturally occurring ATP.

[0081] Luminometers (in conjunction with ATP swabs) use bioluminescence to detect residual ATP as an indicator of surface cleanliness. The presence of ATP on a surface indicates improper cleaning and the presence of contamination, including food residue, allergens and/or bacteria. This implies a potential for the surface to harbour and support bacterial growth leading to malodours.

[0082] ATP is measured using Relative Light Unit's (RLU's) When a test swab is activated a bioluminescent reaction occurs, generating light output, the luminometer device then measures and quantifies the light with an RLU output. The RLU reading is directly proportional to the amount of ATP collected. Any dirt or debris collected on the swab will have an effect on the RLU reading leading to a high RLU output.

Odour

[0083] The odour testing was carried out at three locations, outside the testing location, inside the testing location and immediately above the urinal.

	Outside the testing location	**Inside the testing location**	**Immediately above the urinal**
Pre-trial baseline	Noticeable unpleasant odour	Noticeable unpleasant odour	Strong unpleasant odour
Day 1	No noticeable odour	Faint odour	Faint uric acid odour
Day 7	No noticeable odour	No noticeable odour	No noticeable odour
Day 14	No noticeable odour	No noticeable odour	No noticeable odour
Day 23	No noticeable odour	No noticeable odour	No noticeable odour
Day 28	No noticeable odour	No noticeable odour	No noticeable odour
Day 65	No noticeable odour	No noticeable odour	No noticeable odour

[0084] Thus a clear decrease in the odour was achieved in the testing.

Cleanliness

[0085] ATP readings were taken at a number of locations in the urinal and system. The base of the urinals were swabbed for ATP testing just prior to the urinal flushing. This would be between 25 and 30 minutes since the last flush. An ATP reading was also taken from an internal wall of the bottle trap for each of the left-hand and right-hand urinals. As a reminder, the left-hand bottle trap was brand new, while the right-hand bottle trap was an old trap.

	ATP Reading /RLU's			
	Back of the urinal		Internal wall of the bottle trap	
	Left-hand	Right-hand	Left-hand	Right-hand
Pre-trial baseline	Not taken	32	Trap brand new	6044
Day 7	65	7	269	5910
Day 14	10	3	Not taken	Not taken
Day 23	0	29	375	6797
Day 28	0	2	667	6802
Day 65	1	5	449	5294

[0086] The right-hand trap was not replaced and so had a significant build-up of hardened uric acid (and/or uric salt) on its surfaces. At the start of the testing this was completely solid with no residue within the water of the bottle trap. The right-hand trap showed considerable deterioration in the hardened uric acid as the testing progressed, this debris has been in the water in the trap and has thus tainted the ATP swab with dirt leading to high readings. During the last sampling it was noted that the areas on the right-hand trap that had previously been clear as the uric salt disintegrated were developing a residue believed to be calcium (i.e. limescale). The left-hand bottle trap was visibly clean at the end of the testing.

[0087] The data shows the ATP readings being maintained low for new equipment, and a general improvement for old equipment after an initial dislodgement of built-up debris.

Claims

1. A plumbing fixture sanitising system (100) comprising:

a cistern (40) for storing water;
a supply pipe (42) arranged to supply water to the cistern (40);
a first plumbing fixture (20) comprising a water inlet (22) arranged to receive water from the cistern (40); and
an electrochemical cell assembly (10) arranged in the supply pipe (42), the electrochemical cell assembly (10) operable to produce ozone from the electrolysis of water, wherein the electrochemical cell assembly (10) is arranged to produce ozone at a concentration of at least 0.7 ppm;
a control system (30) comprising:

an inlet valve arranged on the supply pipe (42), moveable between:

an open position where water can flow through the supply pipe (42); and
an inhibited position where water is inhibited from flowing through the supply pipe (42);

a cistern valve for selectively inhibiting flow of water from the cistern (40) to the first plumbing fixture (20); and
a controller configured to:

control operation of the inlet valve between the open and inhibited positions;
actuate the inlet valve at a first time to allow a flow of water through the supply pipe (42) to the cistern (40) with the cistern valve in a closed position;
control operation of the electrochemical cell assembly (10) to produce ozone when the inlet valve is in the open position, and cease production of ozone when the inlet valve is in the inhibited position; and
open the cistern valve a predetermined delay period after the first time, the predetermined delay period for filling the cistern (40) to produce a head pressure for mechanical cleaning of the first plumbing fixture (20).

2. The plumbing fixture sanitising system (100) of claim 1, further comprising one or more further plumbing fixtures (20), each comprising a water inlet (22) arranged to receive water from the cistern (40).

3. The plumbing fixture sanitising system (100) of any preceding claim, wherein the controller is configured to move the inlet valve to the open position after a predetermined time period.

4. The plumbing fixture sanitising system (100) of any preceding claim, wherein the control system (30) further comprises a sensor arranged to generate a signal indicative of the presence of a person.

5. The plumbing fixture sanitising system (100) of claim 4 when dependent upon claim 3, wherein the controller is configured to adjust the predetermined time period based upon the signal indicative of the presence of a person.

6. The plumbing fixture sanitising system (100) of any preceding claim, wherein the inlet valve is arranged upstream of the electrochemical cell assembly (10) in the supply pipe (42).

7. The plumbing fixture sanitising system (100) of any preceding claim, wherein the predetermined delay period is between two and five minutes.

8. The plumbing fixture sanitising system (100) of any preceding claim, wherein the controller is configured to control operation of the electrochemical cell assembly (10) based upon the position of the inlet valve.

9. The plumbing fixture sanitising system (100) of any preceding claim, wherein the electrochemical cell assembly (10) is arranged to produce ozone at a concentration of at least 0.8 ppm, preferably a concentration of at least 1 ppm, more preferably a concentration of at least 1.1 ppm.

10. A method of sanitising a plumbing fixture (20) comprising the steps of:

providing a plumbing fixture sanitising system (100) according to claim 1;
actuating the inlet valve at the first time to allow a flow of water through the supply pipe (42) to the cistern (40) with the cistern valve in a closed position;
generating ozonated water having a concentration of at least 0.7 ppm of ozone with the electrochemical cell assembly (10) when the inlet valve is in the open position; and
opening the cistern valve the predetermined delay period after the first time to provide water to the first plumbing fixture (20) to wash and mechanically clean the first plumbing fixture (20) with the ozonated water.

11. The method of claim 10, wherein the ozonated water is generated having a concentration of at least 0.8 ppm, preferably a concentration of at least 1 ppm, more preferably a concentration of at least 1.1 ppm.

Patentansprüche

1. Sanitärinstallationssystem (100), umfassend:

einen Spülkasten (40) zum Speichern von Wasser;
eine Versorgungsleitung (42), die eingerichtet ist, um dem Spülkasten (40) Wasser zuzuführen;
eine erste Sanitärarmatur (20), die einen Wassereinlass (22) umfasst, der eingerichtet ist, um Wasser aus dem Spülkasten (40) aufzunehmen; und
eine elektrochemische Zellenanordnung (10), die in der Versorgungsleitung (42) eingerichtet ist, wobei die elektrochemische Zellenanordnung (10) betreibbar ist, um Ozon aus der Elektrolyse von Wasser zu erzeugen, wobei die elektrochemische Zellenanordnung (10) eingerichtet ist, um Ozon mit einer Konzentration von mindestens 0,7 ppm zu erzeugen;
ein Steuersystem (30), umfassend:

ein an der Versorgungsleitung (42) angeordnetes Einlassventil, das verstellbar ist zwischen:

einer offenen Stellung, in der Wasser durch die Versorgungsleitung (42) fließen kann; und
einer gesperrten Stellung, in der kein Wasser durch die Zufuhrleitung (42) fließen kann;

ein Spülkastenventil zum selektiven Sperren des Wasserflusses von dem Spülkasten (40) zu der ersten Sanitärarmatur (20); und
eine Steuerung, die konfiguriert ist zum:

Steuern des Betriebs des Einlassventils zwischen der offenen und der gesperrten Position;
Betätigen des Einlassventils zu einem ersten Zeitpunkt, um einen Wasserfluss durch die Versorgungsleitung (42) zu dem Spülkasten (40) zu ermöglichen, wobei sich das Spülkastenventil in einer geschlossenen Position befindet;
Steuern des Betriebs der elektrochemischen Zellenanordnung (10), um Ozon zu erzeugen, wenn sich das Einlassventil in der offenen Position befindet, und die Erzeugung von Ozon zu beenden, wenn sich das Einlassventil in der gesperrten Position befindet; und
Öffnen des Spülkastenventils eine vorgegebene Verzögerungszeit nach der ersten Zeit, wobei die vorgegebene Verzögerungszeit zum Füllen des Spülkastens (40) dient, um einen Wasserdruck für die mechanische Reinigung der ersten Sanitärarmatur (20) zu erzeugen.

2. Sanitärinstallationssystem (100) nach Anspruch 1, das ferner eine oder mehrere weitere Sanitärarmaturen (20) umfasst, die jeweils einen Wassereinlass (22) umfassen, der eingerichtet ist, um Wasser aus dem Spülkasten (40) aufzunehmen.

3. Sanitärinstallationssystem (100) nach einem der vorhergehenden Ansprüche, bei dem die Steuerung konfiguriert ist, um das Einlassventil nach einer vorgegebenen Zeitspanne in die offene Position zu bewegen.

4. Sanitärinstallationssystem (100) nach einem der vorhergehenden Ansprüche, bei dem das Steuersystem (30) ferner einen Sensor umfasst, der eingerichtet ist, um ein die Anwesenheit einer Person anzeigendes Signal zu erzeugen.

5. Sanitärinstallationssystem (100) nach Anspruch 4, soweit von Anspruch 3 abhängig, bei dem die Steuerung konfiguriert ist, um die vorgegebene Zeitspanne auf der Grundlage des die Anwesenheit einer Person anzeigenden Signals anzupassen.

6. Sanitärinstallationssystem (100) nach einem der vorhergehenden Ansprüche, bei dem das Einlassventil in der Versorgungsleitung (42) stromaufwärts von der elektrochemischen Zellenanordnung (10) angeordnet ist.

7. Sanitärinstallationssystem (100) nach einem der vorhergehenden Ansprüche, bei dem die vorgegebene Verzögerungszeit zwischen zwei und fünf Minuten beträgt.

8. Sanitärinstallationssystem (100) nach einem der vorhergehenden Ansprüche, bei dem die Steuerung konfiguriert ist, um den Betrieb der elektrochemischen Zellenanordnung (10) auf der Grundlage der Position des Einlassventils zu steuern.

9. Sanitärinstallationssystem (100) nach einem der vorhergehenden Ansprüche, bei dem die elektrochemische Zellenanordnung (10) eingerichtet ist, Ozon in einer Konzentration von mindestens 0,8 ppm, vorzugsweise in einer Konzentration von mindestens 1 ppm, noch bevorzugter in einer Konzentration von mindestens 1,1 ppm zu erzeugen.

10. Verfahren zur Desinfektion einer Sanitärarmatur (20) mit den Schritten:

Bereitstellen eines Sanitärinstallationssystems (100) nach Anspruch 1;
Betätigen des Einlassventils zum ersten Zeitpunkt, um einen Wasserfluss durch die Versorgungsleitung (42) zum Spülkasten (40) zu ermöglichen, wobei sich das Spülkastenventil in einer geschlossenen Position befindet;
Erzeugen von ozonisiertem Wasser mit einer Konzentration von mindestens 0,7 ppm Ozon mit der elektrochemischen Zellenanordnung (10), wenn sich das Einlassventil in der offenen Stellung befindet; und
Öffnen des Spülkastenventils mit der vorgegebenen Verzögerungszeit nach dem ersten Zeitpunkt, um der ersten Sanitärarmatur (20) Wasser zuzuführen, um die erste Sanitärarmatur (20) mit dem ozonisierten Wasser zu spülen und mechanisch zu reinigen.

11. Verfahren nach Anspruch 10, bei dem das ozonisierte Wasser mit einer Konzentration von mindestens 0,8 ppm, vorzugsweise einer Konzentration von mindestens 1 ppm, noch bevorzugter einer Konzentration von mindestens 1,1 ppm erzeugt wird.

Revendications

1. Système de désinfection d'accessoire de plomberie (100) comprenant :

une cuve (40) pour stocker de l'eau ;
un tuyau d'alimentation (42) agencé pour alimenter en eau la cuve (40) ;
un premier accessoire de plomberie (20) comprenant une entrée d'eau (22) agencée pour recevoir de l'eau de la cuve (40) ; et
un ensemble cellule électrochimique (10) agencé dans le tuyau d'alimentation (42), l'ensemble cellule électrochimique (10) étant opérationnel pour produire de l'ozone à partir de l'électrolyse d'eau, dans lequel l'ensemble cellule électrochimique (10) est agencé pour produire de l'ozone à une concentration d'au moins 0,7 ppm ;
un système de commande (30) comprenant :

une vanne d'entrée disposée sur le tuyau d'alimentation (42), mobile entre :

une position ouverte dans laquelle de l'eau peut s'écouler à travers le tuyau d'alimentation (42) ; et
une position inhibée dans laquelle l'écoulement d'eau à travers le tuyau d'alimentation (42) est inhibé ;

une vanne de cuve pour inhiber sélectivement l'écoulement d'eau depuis la cuve (40) vers le premier accessoire de plomberie (20) ; et
un dispositif de commande configuré pour :

commander le fonctionnement de la vanne d'entrée entre les positions ouverte et inhibée ;
actionner la vanne d'entrée à un premier instant pour permettre un écoulement d'eau à travers le tuyau d'alimentation (42) vers la cuve (40) avec la vanne de cuve dans une position fermée ;
commander le fonctionnement de l'ensemble cellule électrochimique (10) pour produire de l'ozone lorsque la vanne d'entrée est dans la position ouverte, et arrêter la production d'ozone lorsque la vanne d'entrée est dans la position inhibée ; et
ouvrir la vanne de cuve pendant une période de retard prédéterminée après le premier instant, la période de retard prédéterminée étant destinée à remplir la cuve (40) afin de produire une pression de refoulement pour le nettoyage mécanique du premier accessoire de plomberie (20).

2. Système de désinfection d'accessoire de plomberie (100) selon la revendication 1, comprenant en outre un ou plusieurs accessoires de plomberie (20), comprenant chacun une entrée d'eau (22) agencée pour recevoir de l'eau de la cuve (40).

3. Système de désinfection d'accessoire de plomberie (100) selon l'une quelconque des revendications précédentes, dans lequel le dispositif de commande est configuré pour déplacer la vanne d'entrée dans la position ouverte après une période de temps prédéterminée.

4. Système de désinfection d'accessoire de plomberie (100) selon l'une quelconque des revendications précédentes, dans lequel le système de commande (30) comprend en outre un capteur agencé pour générer un signal indiquant la présence d'une personne.

5. Système de désinfection d'accessoire de plomberie (100) selon la revendication 4 lorsqu'elle dépend de la revendication 3, dans lequel le dispositif de commande est configuré pour ajuster la période de temps prédéterminée sur la base du signal indiquant la présence d'une personne.

6. Système de désinfection d'accessoire de plomberie (100) selon l'une quelconque des revendications précédentes, dans lequel la vanne d'entrée est agencée en amont de l'ensemble cellule électrochimique (10) dans le tuyau d'alimentation (42).

7. Système de désinfection d'accessoire de plomberie (100) selon l'une quelconque des revendications précédentes, dans lequel la période de retard prédéterminée est comprise entre deux et cinq minutes.

8. Système de désinfection d'accessoire de plomberie (100) selon l'une quelconque des revendications précédentes, dans lequel le dispositif de commande est configuré pour commander le fonctionnement de l'ensemble cellule électrochimique (10) sur la base de la position de la vanne d'entrée.

9. Système de désinfection d'accessoire de plomberie (100) selon l'une quelconque des revendications précédentes, dans lequel l'ensemble cellule électrochimique (10) est agencé pour produire de l'ozone à une concentration d'au moins 0,8 ppm, de préférence une concentration d'au moins 1 ppm, plus préférablement une concentration d'au

moins 1,1 ppm.

10. Procédé de désinfection d'un accessoire de plomberie (20) comprenant les étapes consistant à :

fournir un système de désinfection d'accessoire de plomberie (100) selon la revendication 1 ;
actionner la vanne d'entrée à un premier instant pour permettre un écoulement d'eau à travers le tuyau d'alimentation (42) vers la cuve (40) avec la vanne de cuve dans une position fermée ;
générer de l'eau ozonée ayant une concentration d'au moins 0,7 ppm d'ozone avec l'ensemble cellule électrochimique (10) lorsque la vanne d'entrée est dans la position ouverte ; et
ouvrir la vanne de cuve pendant la période de retard prédéterminée après le premier instant pour fournir de l'eau au premier accessoire de plomberie (20) afin de laver et nettoyer mécaniquement le premier accessoire de plomberie (20) avec l'eau ozonée.

11. Procédé selon la revendication 10, dans lequel l'eau ozonée est générée ayant une concentration d'au moins 0,8 ppm, de préférence une concentration d'au moins 1 ppm, plus préférablement une concentration d'au moins 1,1 ppm.

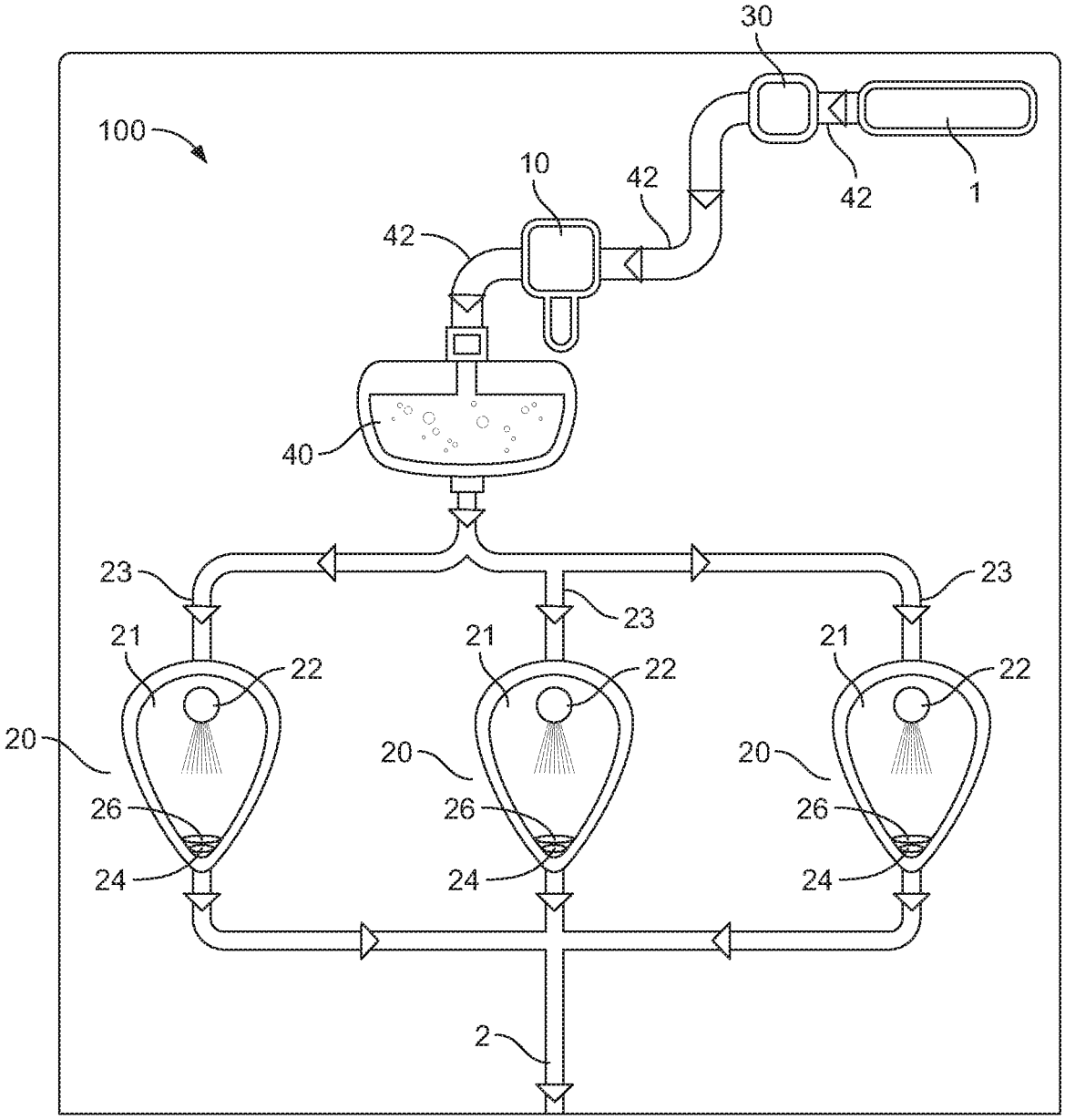
30
100
10
42
42
1
42
40
23
23
23
21
21
21
22
22
22
20
20
20
26
26
26
24
24
24
2

FIG. 1

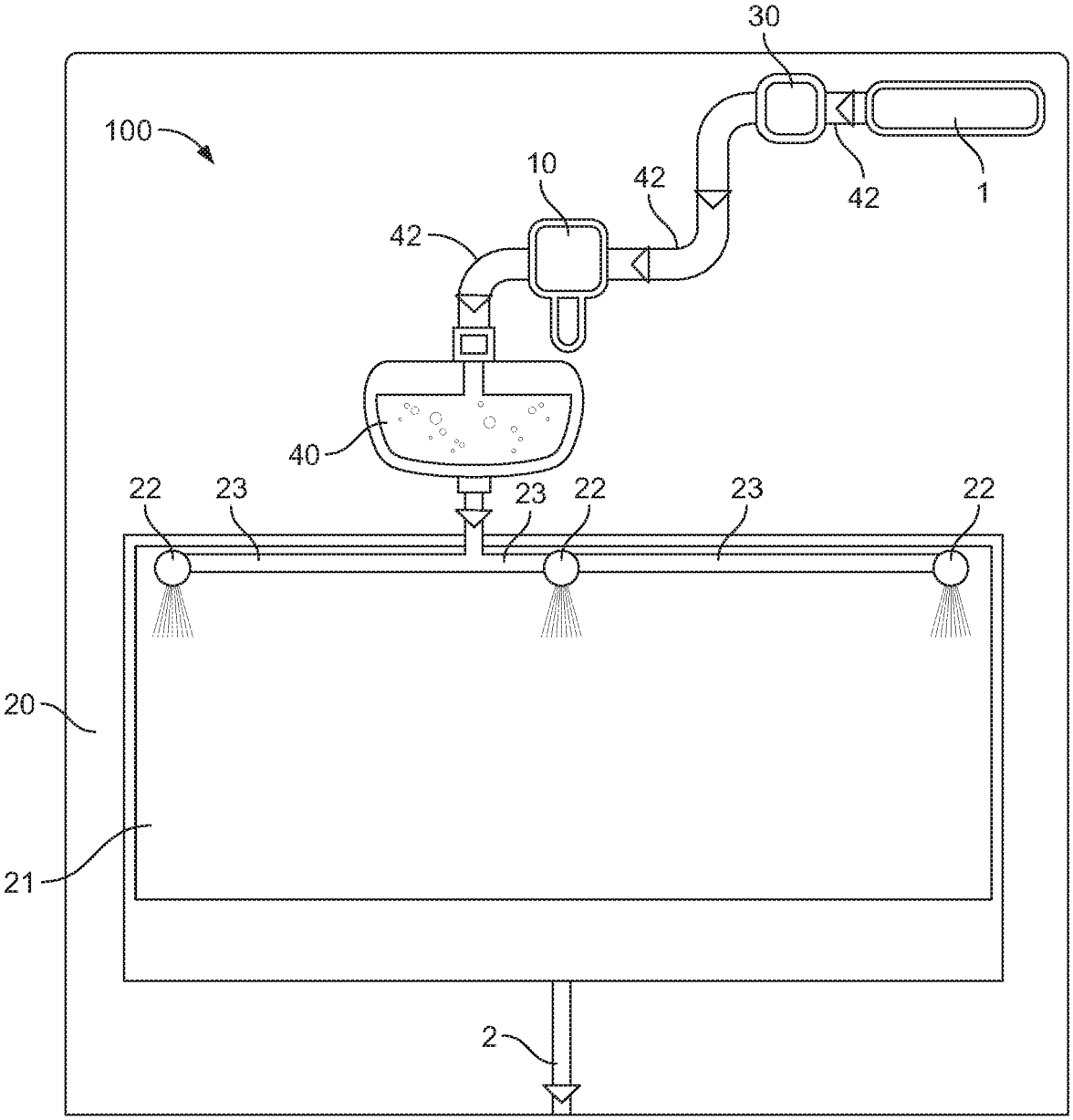

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2018100349 A1 **[0008] [0010]**
- US 20110277227 A1 **[0012]**
- US 20040133968 A1 **[0013]**
- US 20200131749 A1 **[0014]**
- JP H06158701 A **[0015]**
- EP 1939366 A1 **[0016]**
- DE 10048299 A1 **[0017]**
- US 6319390 B1 **[0018]**
- US 2018002910 A1 **[0019]**
- US 2018112317 A1 **[0020]**