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**(54) WATER DISPENSING DEVICE WITH RECIRCULATION**

(57) The present invention relates to a water dispensing device 1 comprising at least one water conducting path and a recirculation path 50, 51, which recirculation path is established by a controlling unit 10 configured to

selectively actuating a plurality of valves V1-V8 when it is detected that a selected type of filtered water has stagnated in a water conducting path 40-43 of the water dispensing device 1 over a predetermined period of time.

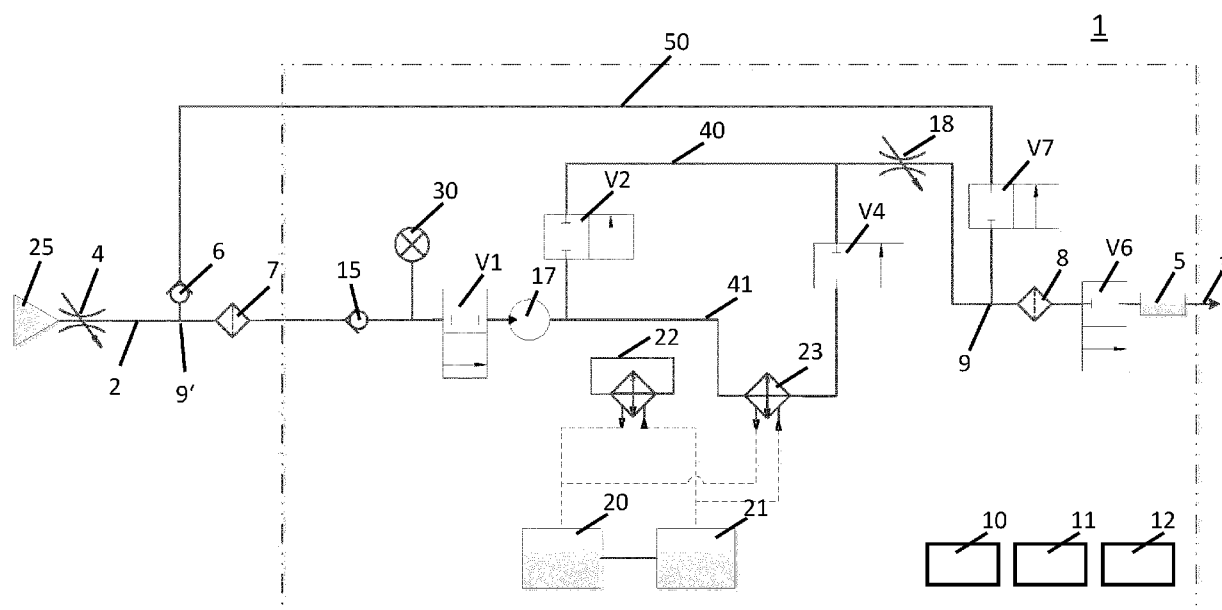


Fig. 1

## Description

### FIELD OF INVENTION

[0001] The present invention generally relates to a water dispensing device and relates more specifically to a water dispensing device that may be connected to a water supply system such as the tap in a household or office environment and is configured to dispense filtered water of different types upon request by a user.

### BACKGROUND OF INVENTION

[0002] Such water dispensing devices are generally known from the prior art and often include an input device, such as a touch panel, which, if operated by the user, causes the water dispensing devices to filter input water and dispense filtered water of a particular type, such as ambient or cooled water, which may be carbonated to a certain degree.

[0003] Typically, such a water dispensing device is operated at irregular time intervals, which causes water to stagnate at various parts inside the water dispensing device. Stagnation of water may cause problems such as the creation of an undesired germ load of the stagnation water or the formation of bio-films inside the water dispensing device, taste impairment and even nutrient release enhancing germ growth. For preventing such undesired effects, water dispensing devices usually include a circulation line through which at least one type of water is circulated via a sterilization unit at regular time intervals during stagnation.

[0004] However, such sterilization units often solely rely on the use of certain chemical agents that dissociate after a certain time or on the use of UV-C-LED modules, which may result in additional bio-films enhancing subsequent germ growth.

[0005] US 6,235,191 B1 discloses a water purifying apparatus comprising a filter for filtering raw water to produce filtered water, and a sterilization unit that irradiates the filtered water with ultraviolet rays to produce treated water. A recirculation path is provided for recirculating the treated water through the sterilization unit. Opening and closing of the recirculation path is controlled in response to presence and absence of a supply detection signal. The filtered water flows through the sterilization unit within the recirculation path.

[0006] DE 10 2006 009 351 B3 discloses a device for processing and discharge of fresh water and carbonated water. A sterilization unit is provided within a recirculation path of the device.

[0007] EP 2 706 042 A1 discloses a line bound water dispenser comprising at least one water supply inlet and at least one water dispensing outlet, which is connected via an internal device-water supply network with the water supply inlet, and at least one purifying device configured to produce hypochlorite, which is supplied and added to the water for cleaning and disinfecting water

including any water possibly stagnating inside the water dispenser.

[0008] Accordingly, there is a need for reliable and gentle measures for ensuring a high quality of the filtered water to be dispensed by such water dispensing devices.

### SUMMARY OF INVENTION

[0009] It is an object of the present invention to provide a water dispensing device that reliably ensures a high quality of the filtered water to be dispensed, using a simple but cost-effective set-up.

[0010] According to the present invention, this problem is solved by a water dispensing device as claimed in claim 1. Further advantageous embodiments are the subject-matter of the dependent claims.

[0011] According to the present invention there is provided a water dispensing device comprising: A water supply inlet and a water dispensing outlet, which are in fluid communication, a filtering unit disposed in a path between the water supply inlet and the water dispensing outlet, for filtering water supplied by the water supply inlet to the water dispensing device, a plurality of valves for defining at least two water conducting paths between the water supply inlet and the water dispensing outlet for conducting different types of filtered water to be dispensed by said water dispensing outlet, said different types of filtered water at least including still filtered water and carbonated filtered water, or filtered water of different temperatures, such as ambient and chilled still filtered water, and/or carbonated filtered water of different carbon dioxide concentration and said plurality of valves including an outlet valve provided upstream of said water dispensing outlet, and a controlling unit configured for causing the water dispensing device to dispense a particular type of filtered water by selectively actuating said plurality of valves corresponding to an input by a user, wherein a recirculation path is provided, for circulating filtered water that has stagnated in at least one of the at least two water conducting paths. Here, the input by the user may include actuating a button of the water dispensing device, which may be a touch-sensitive region on a display of the water dispensing device, for selection of a particular type of filtered water to be dispensed, or simply actuating a tap at the outlet of the water dispensing device. The input by the user means the choice of the type of filtered water which is desired to be dispensed, e.g. chilled still filtered water, ambient still filtered water, or carbonated filtered water.

[0012] The at least two water conducting paths defined by the plurality of valves between the water supply inlet and the water dispensing outlet for conducting different types of filtered water are defined such that each of the at least two water conducting paths respectively conducts one type of said different types of filtered water. For example, a first water conducting path for still water may be defined by said plurality of valves, while a second water conducting path for carbonated water may be

defined by said plurality of valves. Generally, the different types of filtered water of the water dispensing device include at least a) still filtered water and carbonated filtered water, or b) filtered water of different temperatures and/or carbonated filtered water of different carbon dioxide concentration, and for each of these types of filtered water the water dispensing device includes a separate water conducting path. Here, preferably, different water conducting paths may merge into a single water conducting path (a short distance) upstream of the outlet valve, more preferably, different water conducting paths may merge into a single water conducting path (a short distance) upstream of the first junction.

**[0013]** According to the present invention the recirculation path is configured for establishing a fluid communication between a first junction provided upstream of said outlet valve and a second junction provided upstream of said filtering unit, for recirculating water of a selected type of filtered water to the filtering unit via the recirculation path, wherein the controlling unit is configured for selectively actuating said plurality of valves to establish the recirculation path when it is detected that the selected type of filtered water has stagnated in a water conducting path of the water dispensing device over a predetermined first period of time.

**[0014]** As used herein, the term "selected type of filtered water" means that the controlling unit selects a type of filtered water when it detects that said water has stagnated over a predetermined period of time, e.g. the predetermined first period of time and optionally further predetermined periods of time, such as the below described second, third and fourth predetermined period of time. Said selected type of filtered water is selected for recirculating in which either a partial replacement of the internal volume of water of the water conducting path and/or the internal volume of water of the recirculation path, or a complete recirculating or flushing of the internal volume of water of the water conducting path and/or the internal volume of water of the recirculation path is achieved.

**[0015]** In an embodiment in which complete recirculation or flushing of the internal volume of water of the water conducting path or the internal volume of water of the recirculation path is achieved, the internal volume (of water) of the recirculation path is preferably at least one times the internal volume (of water) of the water conducting path, more preferably the internal volume (of water) of the recirculation path 1.05 to 1.45 times the volume (of water) of the water conducting path, 1.07 to 1.4 times the volume (of water) of the water conducting path, yet even more preferably 1.09 to 1.3 times the volume (of water) of the water conducting path, most preferably 1.1 to 1.2 times the volume (of water) of the water conducting path. The aforementioned dimensioning of the recirculation path provides for temporarily storing at least the volume (of water) of the water conducting path within the recirculation path such that in a cyclic path formed by the respective water conducting

path and the respective recirculation path, said water conducting path is completely flushed, i.e. the total volume (of water) of the water conducting path is replaced by filtered water recirculated or flushed.

**[0016]** In a preferred embodiment in which complete recirculation or flushing of the internal volume of water of the water conducting path or the internal volume of water of the recirculation path is achieved, the internal volume (of water) of the recirculation path is smaller than the internal volume (of water) of the water conducting path, preferably the internal volume (of water) of the recirculation path is at most 0.5 times the volume (of water) of the water conducting path, more preferably 0.05 to 0.45 times the volume (of water) of the water conducting path, even more preferably 0.07 to 0.4 times the volume (of water) of the water conducting path, yet even more preferably 0.09 to 0.3 times the volume (of water) of the water conducting path, most preferably 0.1 to 0.2 times the volume (of water) of the water conducting path. By means of the aforementioned dimensioning of the internal volume of the recirculation path, e.g. by suitable dimensioning of inner cross section(s) of its cavity through which the filtered water is conducted and/or suitable dimensioning of length(s) of line(s), tubing(s), pipe(s) and hose(s) forming the recirculation path compared with the inner cross section(s) of the water conducting path's cavity through which the filtered water is conducted and/or length(s) of line(s), tubing(s), pipe(s) and hose(s) forming the water conducting path. With the aforementioned preferred dimensioning of the recirculation path, upon flushing at least 1 + the aforementioned times of the volume of the respective water conducting path, the cyclic path formed by the respective water conducting path and the respective recirculation path is flushed completely, whereby the total internal volume (of water) of the cyclic path is passed through the filtering unit. E.g., if the recirculation path has 0.05 to 0.45 times the volume (of water) of the water conducting path, upon flushing at least  $[1 + (0.05 \text{ to } 0.45)]$  times of the volume of the respective water conducting path, the cyclic path formed by the respective water conducting path and the respective recirculation path is flushed completely.

**[0017]** As used herein, the term "stagnated" means that filtered water in at least one water conducting path and/or at least one recirculation path stands still or isn't sufficiently moved for a certain period of time depending on the conditions such as temperature of the water and whether or not the water is carbonated.

**[0018]** Because the selected type of filtered water is recirculated via the recirculation path to the second junction, which is provided upstream of the filtering unit, preferably in the direct vicinity of this filtering unit, generally no additional sterilizing unit is required. Rather, the water dispensing device according to the present invention may use a single filtering unit, which is preferably of the kind ensuring a high quality of the filtered water to be dispensed. Most preferably, the filtering unit comprises a hollow fiber membrane (microfiltration) and optionally a

carbon block as pre-filter. Due to its positioning relatively close to the water supply inlet downstream the second junction of the water dispensing device, the filtering unit can be monitored easily and reliably. Furthermore, is preferred that the filtering unit is located at an easily accessible position, which may be located within the water dispensing device, e.g. in an easily accessible cavity located close to the outside of the water dispensing device which cavity may be closed by a closing cover such as a flap, or at the outside of the water dispensing unit, e.g. in a optionally releasable holder which may be attached to the outside of the water dispensing unit, and which holder optionally at least partially covers the filtering unit. This easy accessibility of the filtering unit provides for easy replacement in a cost-efficient manner. Moreover, such a filtering unit is available at low costs, does not consume electrical energy like e.g. UV-C modules, and safeguards that contaminations critical to the health of the user, such as bacteria or viruses, are reliably removed from the water, while e.g. UV-C modules merely kill bacteria or viruses, which are then however still present in the water in dead form, or the use of chemical agents killing bacteria or viruses may give rise to the problem that at least traces of the chemical agent may stay in the water, while killed bacteria or viruses are still present in the water.

**[0019]** It is preferred that the filtering unit has a filtering performance in terms of particle retention of at least  $\geq 0.15 \mu\text{m}$ , more preferably  $\geq 0.10 \mu\text{m}$ . To accomplish said filtering performance, the pore diameter of the filtering means of the filtering unit, such as hollow fiber membrane(s), has a dimension suitable to remove microorganisms like germs like viruses and bacteria from the water supplied by the water inlet, or may even have such a dimension to enable an ultrafiltration capable of removing not only bacteria, but also viruses from the water supplied by the water inlet, e.g., the pore diameter of the filtering means of the filtering unit may be of the order of  $0.1 \mu\text{m}$  or even smaller. Therefore, it is preferred that the filtering unit comprises filtering means, such as hollow fiber membrane(s), having pores with a pore diameter of at least  $< 0.15 \mu\text{m}$ , more preferably  $\leq 0.10 \mu\text{m}$ .

**[0020]** The pre-filter in form of a carbon block, which is e.g. formed of charcoal and a binder suitable for binding the charcoal while still providing sufficient porosity within the carbon block, provides for filtering out more coarse contaminants. For this purpose, it is preferred that the carbon block has a filtering performance in terms of particle retention of at least  $\geq 0.5 \mu\text{m}$ , more preferably at least  $\geq 0.5 \mu\text{m}$ . That is, it is preferred that the carbon block has pores with a pore diameter of at least  $< 0.5 \mu\text{m}$ , more preferably  $\leq 0.4 \mu\text{m}$ .

**[0021]** According to the present invention, the filtered water that has possibly stagnated in the various water conducting paths of the water dispensing device, is not circulated at fixed, regular time intervals. Rather, any recirculation is triggered by the central controlling unit in correspondence to the actual input by the user. More

specifically, the controlling unit is configured to track at which time and for how long a respective type of filtered water was last tapped or dispensed. If it is detected that the last dispensing of a respective type of filtered water was a certain period of time ago, or that a certain critical minimum quantity of filtered water was not tapped or dispensed during the last dispensing, the recirculation of this selected type of filtered water is initiated or triggered for a certain time period. This holds in particular if this selected type of filtered water is ambient (room temperature) still water or also chilled (cooled) filtered water, because the water conducting paths for still filtered water are more prone to the formation of contaminants, bio-films and germs than water conducting paths for other types of filtered water, particularly for carbonated filtered water.

**[0022]** On the other hand, if it is detected on the basis of the user input that the critical minimum quantity of filtered water has actually been tapped or dispensed during the last dispensing, then the controlling unit does not trigger recirculation of the selected type of filtered water, because it can be assumed that the quality of filtered water inside the water conducting paths of the water dispensing device are of sufficient quality. This procedure helps to make the whole operation of the water dispensing more efficient and to reduce energy consumption and loads of components. Assuming e.g. that it is detected that filtered water is dispensed by the water dispensing device relatively often over an extended period of time, no recirculation is required at all over this period of time.

**[0023]** In general, the critical minimum quantity of filtered water preferably corresponds to the internal volume of water of the water conducting path for conducting the selected type of filtered water or the internal volume of water of the recirculation path, optionally plus a certain safety margin, as this corresponds to the complete flushing of the volume of water contained in the internal volume of water of the water conducting path or the recirculation path selected by the control unit. More preferably, the critical minimum quantity of filtered water may correspond to a volume of water resulting at least from the sum of the internal volume of water of the water conducting path for conducting the selected type of filtered water plus the internal volume of water of the recirculation path, optionally plus a certain safety margin, as this corresponds to the complete flushing of the volume of water contained in both said water conducting path for the selected type filtered water and the recirculation path. The term "internal volume" used in this context means the cavity of the respective path, through which cavity the filtered water is conducted and/or recirculated, wherein in operation mode of the water dispensing device, said cavity is completely filled with water, and thus the volume of said cavity corresponds to the internal volume of water of the respective path. The cavity of the respective path may be formed in at least one of line(s), tubing(s), pipe(s) and hose(s) forming the respective path. The term "respective path" as used herein

means a water conducting path or a recirculation path selected by the controlling unit for flushing or recirculation, or expressed in other words, the path in which the type of filtered water has stagnated and which is therefore selected by the controlling unit. The term "flush" or "flushing" in this context means moving the filtered water within a cyclic path formed by one water conducting path and one recirculation path, for moving or recirculating the filtered water to, i.e. in direction of, the filtering unit, preferably through the filtering unit. It is understood that while upon flushing, the water in the respective recirculation path is mandatorily moved through the filtering unit, while the water in the respective water conducting path may only be moved in direction to the filtering unit but not necessarily through it - it may be said that said water flushed from the respective water conducting path is at least partially temporarily stored in the recirculation path in order to allow to exchange the water in the respective water conducting path without generating waste water. However, it is preferred that upon flushing, the total internal volume of water of the respective water conducting path and the total internal volume of water of the respective recirculation path are flushed without generating water, since it is preferred that during flushing, no water is released from the cyclic path formed by the respective water conducting path and the respective recirculation path. It is particularly preferred that during said "flush" or "flushing", no water is released from the cyclic path formed by the respective water conducting path and the respective recirculation path, e.g. released as waste water by dispensing it via the water dispensing outlet or a waste water outlet provided within said cyclic path, and thus no waste water is generated by "flush" or "flushing".

**[0024]** It is preferred that if the predetermined periods of time for the different kinds of waters are identical and said different kinds of water stagnated in the water conducting path(s) over the same period of time, then said water conducting path(s) are flushed subsequently, wherein the order of flushing may be defined by the control unit, for example first ambient still water may be flushed, and then chilled still water may be flushed.

**[0025]** According to a further embodiment, the plurality of valves are selectively actuated to establish the recirculation path each time the predetermined first period of time has expired without dispensing a predetermined amount of filtered water via the water dispensing outlet, for recirculating the selected type of filtered water that has stagnated in a water conducting path of the water dispensing device over the predetermined first period of time. Accordingly, stagnation of water in the water dispensing device is reliably prevented by observing whether predetermined fixed and predetermined criteria are fulfilled or not.

**[0026]** The term "predetermined amount of filtered water" as used herein is preferably within a range of 1.0 to 2.0 times the total internal volume of the water conducting path for a selected type of filtered water inside

the water dispensing device. It may be larger than 200 ml, more preferably larger than 350 ml and even more preferably larger than 500 ml, and is generally of the order of 1.0 to 2.0 times the total internal volume of the water conducting path for a selected type of filtered water inside the water dispensing device.

**[0027]** According to a further embodiment, the controlling unit is configured for selectively actuating said plurality of valves to establish the recirculation path over a time period that is sufficient to flush the water conducting path of the water dispensing device, in which the selected type of filtered water has stagnated, completely.

**[0028]** The complete flushing of the water conducting path, in which the selected type of filtered water has been detected having stagnated, and filtering of the recirculated water by means of the filtering unit helps to ensure a complete removal of any source of contaminants, bio-films and germs inside the water dispensing device. If stagnation of filtered water is detected only for one of the water conducting paths it may be sufficient if only this water conducting path is flushed.

**[0029]** According to a further embodiment, the controlling unit is configured for selectively actuating said plurality of valves to establish the recirculation path and flush the recirculation path at regular time intervals or when it is detected that the selected type of filtered water has stagnated in the recirculation path over a predetermined third period of time.

**[0030]** Preferably, the time ranges selected predetermined third period of time is within identical ranges as indicated below for the aforementioned first period of time. Furthermore, it is preferred that after the predetermined third period of time has expired, the controlling unit opens the recirculation path for time ranges identical with those indicated below in the context of the predetermined first period of time.

**[0031]** Preferably, the recirculation path is flushed completely to ensure a complete removal of any source of contaminants, bio-films and germs inside the recirculation path. For this purpose, one of the water conducting paths is connected to the recirculation path and by actuating a pump inside the water dispensing device the water inside this water conducting path flushes the recirculation path. It is noted that the pump ensures a sufficient flow for dispensing the water through the water dispensing outlet and optionally it provides for filling the carbonator. Preferably, said pump is the only pump of the water dispensing device and thus it is also used for recirculation. However, optionally, a further pump may be arranged in the water dispensing device for recirculation.

**[0032]** The water expelled out of the recirculation path then reaches the filtering unit to be filtered and is then input again to the water dispensing device, preferably to the aforementioned selected water conducting path.

**[0033]** As ambient still filtered water is most prone to the formation of contaminants, bio-films and germs than other types of filtered water, particularly carbonated fil-

tered water, the recirculation of ambient still filtered water via a dedicated recirculation path may be triggered much earlier, e.g. after about one hour of stagnation after the last dispensing, as compared to other types of filtered water, in order to filter out any nutrients and germs that may have been added with the fresh water supplied via water supply inlet. Subsequently, the time interval between recirculation of the selected type of filtered water (in particular of ambient and still filtered water) via the dedicated recirculation path may be increased again to a standard time interval, which may be of the order of four hours.

**[0034]** In this embodiment, it may also be distinguished between the first ever dispensing of the selected type of filtered water after turning-on the water dispensing device or since non-use over an extended period, such as one or two days (e.g. over a week-end), and the dispensing during standard operation conditions, which usually imply relatively short time periods of non-use and which are usually of the order of only a few hours, e.g. of about four hours.

**[0035]** Preferably, the predetermined first period of time is in the range between 2.5 hours and 5.5 hours, more preferably in the range between 3.0 hours and 5.0 hours and most preferably in the range between 3.75 hours and 4.25 hours. It is preferred that the aforementioned ranges for the predetermined first period are applied in case still water stagnates within the respective water conducting path or the respective recirculation path. After expiry of the predetermined first period of time, the controlling unit may open the recirculation path for a relatively short time period for recirculating the filtered water to the filtering unit via the recirculation path, namely preferably between 40 seconds and 80 seconds, more preferably for a time period in the range between 50 seconds and 70 seconds and even more preferably for a time period in the range between 55 seconds and 65 seconds, depending on the total internal volume of the selected water conducting path and/or total internal volume of the selected recirculation path which is to be flushed by recirculation. It is preferred that the aforementioned time periods are applied in case still water stagnates within the respective water conducting path or the respective recirculation path.

**[0036]** The aforementioned time periods for recirculating or flushing will also depend on the actual flow rates that can be accomplished inside the water dispensing device, which depend particularly on the power and pump rate of the pump, as well as on the dimensioning of the respective water conducting path and the respective recirculation path, i.e. both on the cross section(s) and length(s) of line(s), tubing(s), pipe(s) and hose(s) installed in the water dispensing device. It is preferred that the time periods for flushing after expiry of the predetermined first period of time are chosen such that at least 1.0 times, more preferably at least 1.25 times, even more preferably between 1.3-2 times the volume of the respective path to be flushed, yet even more preferably

between 1.35-1.8 times the volume, most preferably between 1.4-1.6 times the volume will be circulated. With a flushing or recirculating of at least 1.0 times the volume of the respective path to be flushed, so that it is safeguarded that the respective path is flushed completely, wherein the respective path may be the respective water conducting path, the respective recirculation path or a cyclic path formed by the respective water conducting path and the respective recirculation path, preferably the respective path is respective water conducting path or said cyclic path, most preferably said cyclic path. According to a particular preferred embodiment, the time periods for flushing after expiry of the predetermined first period of time are chosen according to the aforementioned times the volume of the aforementioned cyclic path to be flushed, in which cyclic path the internal volume (of water) of the recirculation path is smaller than the internal volume (of water) of the water conducting path, preferably the internal volume (of water) of the recirculation path is at most 1 times the volume (of water) of the water conducting path the internal volume (of water) of the recirculation path is at most 0.5 times the volume (of water) of the water conducting path, more preferably 0.05 to 0.45 times the volume (of water) of the water conducting path, even more preferably 0.07 to 0.4 times the volume (of water) of the water conducting path, yet even more preferably 0.09 to 0.3 times the volume (of water) of the water conducting path, most preferably 0.1 to 0.2 times the volume (of water) of the water conducting path. Owing to the aforementioned dimensioning of the respective water conducting path and the respective recirculation path forming said cyclic path, it is ensured that in the recirculation path, a smaller volume of water stagnates than in the water conducting path, since during operation of the water dispensing device, the normally, the water conducting paths will be in use due to selection of a type of water to be dispensed by the users, while the recirculation path only provides a means for moving and filtering stagnated water without generating waste water, i.e. generally, during operation, the risk of water stagnation is higher for the recirculation path compared to the water conducting path, and therefore, it is advantageous to dimension the recirculation path's internal volume (of water) smaller than the internal volume (of water) of the water conducting path, in order to minimize the amount of stagnating water and thereby minimize electrical energy required for moving stagnant water.

**[0037]** Preferably, the time period for which the controlling unit opens the recirculation path after expiry of the predetermined first period of time and the time period for which the controlling unit opens the recirculation path after expiry of the predetermined second period of time are chosen such that identical volumes of internal volumes of water of the selected water conducting path and the selected recirculation path are flushed or circulated, or at least the complete internal volume of the selected water conducting path and the selected recirculation path are flushed or circulated.

**[0038]** According to a further embodiment, the water dispensing device further comprises a carbonating unit for carbonating the filtered water and generating carbonated filtered water, wherein the controlling unit is configured for selectively actuating said plurality of valves to establish the recirculation path when it is detected that carbonated water has stagnated in one of the at least two water conducting paths of the water dispensing device over a predetermined second period of time, which is longer than the aforementioned predetermined first period of time for still filtered water. This predetermined second period of time may be at least 16 hours, more preferably at least 20 hours and even more preferably at least 24 hours long.

**[0039]** According to a further embodiment, a ratio between the predetermined second period of time and the predetermined first period of time may be in the range between 2.0 and 6.0, more preferably in the range between 3.0 and 5.0 and even more preferably in the range between 3.75 and 4.25, which turned out to be an efficient measure to significantly reduce the risk of formation of contaminants, bio-films and germs inside the water conducting paths of the water dispensing unit. Said carbonating unit may be an inline carbonating unit or a batch carbonating unit. The term "inline carbonating unit" means a carbonating unit where carbon dioxide is added to the water in a line of the dispenser, and the carbonated water is either transported to a vessel for storing and e.g. cooling, or the carbonated water is introduced from said line into at least one of the at least two water conducting paths. The term "batch carbonating unit" means a carbonating unit in which carbon dioxide is added to the water in a vessel in which the carbonated water is stored and e.g. cooled. In the cases where carbonated water is stored in a vessel, the carbonated water is transported into at least one of the at least two water conducting paths when the user's input is that carbonated water shall be dispensed.

**[0040]** After expiry of the predetermined second period of time, the controlling unit may open the recirculation path for a relatively short time period for recirculating the carbonated water to the filtering unit via the recirculation path, preferably for a time period of up to 20 seconds, more preferably for a time period in the range between 1 seconds and 12 seconds, even more preferably for a time period in the range between 2 seconds and 10 seconds, yet even more preferably for a time period in the range between 3 seconds and 8 seconds, and most preferably for a time period in the range between 4 seconds and 6 seconds. The aforementioned "time period of up to 20 seconds" means that it may even be dispensed with opening the recirculation path for carbonated water under certain circumstances, e.g. when the carbonated water has a certain carbon dioxide concentration and is cooled to a certain temperature. However, for safeguarding hygienic conditions in the water dispensing device, it is preferred that the recirculation path is opened for recirculating carbonated water.

**[0041]** It is preferred that the ratio between the time

period for which the controlling unit opens the recirculation path after expiry of the predetermined first period of time and the time period for which the controlling unit opens the recirculation path after expiry of the predetermined second period of time is in the range between 8.0 and 16.0, more preferably in the range between 10.0 and 14.0 and even more preferably in the range between 11.5 and 12.5.

**[0042]** When opening the recirculation path for carbonated water for a longer time period as defined above, e.g. 30 seconds, it was experimentally found that an undesired carbon dioxide concentration, which can be determined by user's senses, can be found in subsequently dispensed still water. By contrast, when opening the recirculation path for carbonated water for only a short time, e.g. 5 seconds, it was surprisingly found that this opening of the recirculation path over a relatively short time period is already sufficient for safeguarding hygienic conditions. Hence, it is not necessary to recirculate the carbonated water over the whole length of circulation path, but it's already sufficient to just move the carbonated water a bit in the recirculation path. Hence, it was surprisingly found by the inventors that for safeguarding hygienic conditions, it is sufficient to open the recirculation path for carbonated water for the aforementioned time periods, whereby the water dispensing device consumes less energy, while it is also ensured that the degree of carbonation/sparkling cannot be determined by user's senses in subsequently dispensed still water.

**[0043]** It is preferred that the time periods for flushing after expiry of the predetermined second time period are chosen such that at most 1/8 to 1/16 times, more preferably 1/10 to 1/14 times, even more preferably between 1/11.5 to 1/12.5 times the volume of the respective path, will be circulated, wherein the respective path may be the respecting recirculation path or a cyclic path formed by the respective water conducting path and the respective recirculation path, preferably the respective path is the respective water conducting path. With a flushing or recirculating for the aforementioned times the volume of the respective path, sufficient movement is provided for carbonated water within the respective water conducting path for avoiding hygienic problems due to stagnation.

**[0044]** Due to the lower pH-value of carbonated water the risk of formation of contaminants, bio-films and germs is much lower for carbonated filter water than for all other types of filtered water, in particular for ambient still filtered water, the time intervals for triggering recirculation of carbonated filtered water may be set to be much longer than for all other types of filtered water, in particular for ambient still filtered water. Moreover, also the time period for recirculation of carbonated filtered water may be set to be much shorter than for all other types of filtered water, in particular for ambient still filtered water. This helps to make operation of the water dispensing device even more efficient.

**[0045]** However, in an alternative embodiment of the

water dispensing device comprising an inline carbonization unit which adds the carbon dioxide into at least one of the at least two water conducting paths, for recirculating the carbonated water to the filtering unit via the recirculation path, the controlling unit may open the recirculation path for a time period in a time range identical to the aforementioned time period indicated in relation with the predetermined first period of time, namely preferably between 40 seconds and 80 seconds, more preferably for a time period in the range between 50 seconds and 70 seconds and even more preferably for a time period in the range between 55 seconds and 65 seconds, depending on the total internal volume of the selected water conducting path, which is to be flushed by recirculation. This is because said inline carbonization unit allows to enrich carbonated water, which was (partially) degassed due to the recirculation, in the line of at least one of the at least two water conducting paths. Hence, thereby, the problem that (partially) degassed water may be dispensed instead of water having carbon dioxide concentration demanded by the user's input is solved, while a longer recirculation time is made possible for a more intensive recirculation, if need be.

**[0046]** According to a further embodiment, a valve may be associated to the carbonating unit and the controlling unit is configured to actuate the valve associated to the carbonating unit, to shut-off a supply of CO<sub>2</sub> to the carbonating unit when it is detected that carbonated water is stagnating in one of the at least two water conducting paths and while the carbonated water is recirculating to the filtering unit via the recirculation path, which helps to reduce CO<sub>2</sub>-consumption of the water dispensing device and make it even more efficient.

**[0047]** According to a further embodiment, a first recirculation path is provided for recirculating still filtered water to the filtering unit, a second recirculation path is provided for recirculating carbonated filtered water to the filtering unit, said second recirculation path being separate to said first recirculation path, and the controlling unit is configured to selectively actuate the plurality of valves such that either the first recirculation path for recirculating still filtered water or the second recirculation path for recirculating carbonated filtered water is established. In other words: the water dispensing device has a separate recirculation path intended only for recirculation of carbonated filtered water but not of still, un-carbonated filtered water. This efficiently helps to reduce any cross-contamination between water conducting and recirculation paths for still filtered water and water conducting and recirculation paths for carbonated filtered water. Moreover, this helps to make the water dispensing device more efficient, because the water conducting and recirculation paths for still filtered water and the water conducting and recirculation paths for carbonated filtered water can be activated at different time intervals and over different time periods more efficiently.

**[0048]** According to a further embodiment, the controlling unit is configured to selectively actuate the plurality of

valves such that the first recirculation path for still filtered water is established over a longer period of time than the second recirculation path for carbonated filtered water, as the water conducting and recirculation paths for still filtered water are more prone to formation of contaminants, bio-films and germs than for carbonated filter water.

**[0049]** According to a further embodiment, the controlling unit is configured to selectively actuate said plurality of valves to establish and flush the first recirculation path for still filtered water when it is detected that still filtered water has stagnated in the first recirculation path over a predetermined third period of time and to establish and flush the second recirculation path for carbonated filtered water when it is detected that carbonated filtered water has stagnated in the second recirculation path for carbonated filtered water over a predetermined fourth period of time.

**[0050]** Preferably, the predetermined fourth period of time is within identical time ranges as indicated above for the aforementioned second period of time. Furthermore, it is preferred that after the predetermined fourth period of time has expired, the controlling unit opens the recirculation path for time ranges identical with those indicated above in the context of the predetermined second period of time.

**[0051]** Preferably, the predetermined third period of time is longer than the predetermined fourth period of time, because water that has stagnated in the recirculation path for still filtered water is more prone to formation of contaminants, bio-films and germs than water that has stagnated in the recirculation path for carbonated filtered water.

**[0052]** The ratio between the predetermined fourth period of time and the predetermined third period of time may be within identical ranges as indicated above for the ratio between the predetermined second time period and the predetermined first time period.

**[0053]** Preferably, the ratio between the time period for which the controlling unit opens the recirculation path after expiry of the predetermined third period of time and the time period for which the controlling unit opens the recirculation path after expiry of the predetermined fourth time period is within identical ranges as indicated above for the ratio between the time period for which the controlling unit opens the recirculation path after expiry of the predetermined first period of time and the time period for which the controlling unit opens the recirculation path after expiry of the predetermined second time period.

**[0054]** Preferably, during the time period for which the controlling unit opens the recirculation path after expiry of the predetermined third period of time and the time period for which the controlling unit opens the recirculation path after expiry of the predetermined fourth time period identical times the volume of the respective path are applied as indicated above in the context of the time period for which the controlling unit opens the recirculation path after expiry of the predetermined first period of time and

the time period for which the controlling unit opens the recirculation path after expiry of the predetermined second time period.

**[0055]** According to a further embodiment, the controlling unit is configured to selectively actuate the plurality of valves such that the recirculation path is established over a longer period of time for recirculating ambient still filtered water to the filtering unit than for chilled still filtered water, because ambient still filtered water is more prone to formation of contaminants, bio-films and germs than chilled still filtered water.

**[0056]** According to a further embodiment, each of the at least two water conducting paths may be configured to be in fluid communication with the first junction provided upstream of the outlet valve by selectively actuating selected ones of the plurality of valves. Hence, different types of water may also be mixed with each other, e.g. ambient still filtered water and chilled filtered water to adjust the water temperature as required, or sparkling filtered water and ambient still filtered water and/or chilled filtered water to adjust the CO<sub>2</sub>-concentration and/or temperature of the filtered water to be dispensed via the water dispensing outlet.

**[0057]** According to a further embodiment, the water dispensing device may further comprise an output filter, preferably a membrane filter, a UV-C module, ozone cell or a hot water module, disposed between the first junction and the outlet valve, and/or a thermal germ barrier disposed between the outlet valve and the water dispensing outlet. This measure helps to reduce any contamination also at or near the water dispensing outlet and thus further enhance the quality of the filtered water to be dispensed. Preferably, the UV-C module provides light with a wavelength within the range of 240-300 nm with, with which the water flowing through the UV-C module is irradiated, wherein it is preferred that the light is provided by a light emitting diode (LED). An ozone cell is a component in which ozone (O<sub>3</sub>) is generated electrically or by chemical reaction, wherein said ozone is contacted with the water flowing through said ozone cell. The hot water module is a flow heater which preferably heats the water flowing through it to a temperature of at least 55°C, more preferably at least 60°C, even more preferably at least 65°C and most preferably 80°C. The thermal germ barrier is preferably in the form of an electrical heating wire wound around a water conducting conduit arranged between the outlet valve and the water dispensing outlet.

**[0058]** According to a further embodiment, the water dispensing device may further comprise a flushing path for flushing filtered water that has stagnated between the first junction and the outlet valve and/or between the outlet valve and the water dispensing outlet, wherein the controlling unit is configured to activate the flushing of filtered water that has stagnated between the first junction and the outlet valve and/or between the outlet valve and the water dispensing outlet automatically, in particular at regular time intervals, or corresponding to an input by a user. This measure helps to reduce any con-

tamination also at or near the water dispensing outlet and thus further enhance the quality of the filtered water to be dispensed. In this context, "flushing" means that water located between the first junction and the outlet valve and/or between the outlet valve and the water dispensing outlet is released, e.g. via the dispensing outlet or via an optional waste water outlet located between the first junction and the outlet valve and/or between the outlet valve and the water dispensing outlet.

**[0059]** According to a further embodiment, a non-return valve may be provided in the recirculation path close to the second junction and upstream of the filtering unit, to prevent the flow of raw water supplied by the water supply inlet but not yet filtered by the filtering unit into the recirculation path of the water dispensing device, to thereby reliably prevent the intrusion of contaminants, bio-films and germs into the recirculation path.

**[0060]** According to a further embodiment, at least some of the plurality of valves are opened and closed several times in succession while the selected type of filtered water that has stagnated over a predetermined period of time is recirculated to the filtering unit via the recirculation path, for exchanging residual water in dead volumes of the respective valves.

**[0061]** According to a further embodiment, at least some of the plurality of valves and/or a non-return valve and/or a throttle for flow reduction are heated at regular time intervals to a temperature that is sufficient and effective for removing any contaminants, bio-films and germs in dead volumes of these components of the water dispensing device. This temperature may be above at least 55°C, more preferably above at least 60°C, even more preferably at least 65°C and most preferably at least 80°C. This elevated temperature may be applied over a time period sufficient for removal of such contaminants, bio-films and germs in dead volumes of these components, wherein this time period may be e.g. at least 1 min, more preferably about 3 to 7 min, more preferably about 4 to 6 min and even more preferably about 5 min.

**[0062]** According to a further embodiment, at least one of the at least two water conducting paths and of the recirculation path(s) are at least partially heated at regular time intervals to temperatures sufficient and effective for removing any contaminants, bio-films and germs in dead volumes of these components of the water dispensing device. Such temperatures may be above at least 55°C, more preferably above at least 60°C, even more preferably at least 65°C and most preferably 80°C and may be applied over a time period of at least 1 min, e.g. over a time period of about 3 to 7 min, more preferably over a time period over about 4 to 6 min and even more preferably for about 5 min.

**[0063]** According to a further embodiment, the controlling unit may be configured to selectively actuate said plurality of valves to circulate filtered water, which has stagnated in the recirculation path, via the recirculation path. In particular activation of the recirculation via the recirculation path may be performed at regular time

periods. This holds in particular for the recirculation of still filtered water, in particular of still ambient filtered water, but may not be necessary for carbonated filtered water because of its lower pH-value.

**[0064]** As will become apparent to the skilled person when studying the present specification, further related aspects of the present invention relate to a method of controlling operation of a water dispensing device as outlined above to be carried out by a controlling unit, in particular by a processor of such a controlling unit, and to a computer program comprising instructions which, when the program is executed by a processor of a controlling unit of a water dispensing device, cause the processor of the controlling unit of such a water dispensing device to carry out the controlling method as disclosed in the present specification.

**[0065]** Said method of controlling operation of a water dispensing device as outlined above may comprise a cleaning step in which a chemical cleaning agent suitable for cleaning water conducting paths is introduced into at least one of the water conducting paths and/or at least one of the recirculation paths, wherein the water in said paths is then recirculated such that at least the total internal volume of water of the water conducting path and the recirculation path is replaced by filtered water by circulating this volume back towards the filtering unit via recirculation path. Subsequent to the cleaning step, by actuating the plurality of valves, all filtered water comprising the chemical cleaning agent is dispensed, e.g. via the dispensing outlet, and said paths are flushed with new, fresh water provided by the water supply inlet.

**[0066]** According to state of the art cleaning methods, the water conducting paths of a water dispensing device are rinsed with a cleaning agent, which then stagnates for a certain period of time before the cleaning agent is rinsed out and the water conducting paths are rinsed out with new, fresh water from the water supply inlet. Compared to said state of the art cleaning methods, circular cleaning has the following advantages: An even concentration distribution of the cleaning agent is ensured, e.g. within the hydraulics of the valves, a mechanical effect on the surfaces to be cleaned is provided by the recirculation movement, the cleaning agent better penetrates into dead corners. Besides, pressure surges due to valve switching during circulation provide for a better penetration of the cleaning agent into dead corners.

## OVERVIEW ON DRAWINGS

**[0067]** Hereinafter, the preferred embodiments according to the present invention will be described in an exemplary manner and with reference to the accompanying drawings, wherein:

Fig. 1 shows a schematic diagram of a first embodiment of a water dispensing device according to the present invention;

Fig. 2

5 Fig. 3

Fig. 4

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Fig. 5

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Fig. 6

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Figs. 7a and 7b

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**[0068]** Throughout the drawings, the same reference numerals designate identical or technically equivalent elements or groups of elements.

## DETAILED DESCRIPTION OF EMBODIMENTS

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**[0069]** As shown in Fig. 1, the water dispensing device 1 is coupled via a throttle for flow reduction 4, which will usually include a non-return valve, to a water inlet 25, such as a water tap, for continuously supplying raw (fresh) water upon demand. At the inlet-side of the water dispensing device 1 there is provided a filtering unit 7, which is preferably a bacteria-proof filter including a hollow fiber membrane (microfiltration) and a carbon block as pre-filter. The filtering unit 7 is configured for filtering out bacteria and virus, as well as contaminations, residues of bio-films and germ in the water. Reference numeral 2 generally designates the water supply inlet of the water dispensing device 1, which is disposed upstream of the filtering unit 7. The filtering unit 7 may be disposed outside the housing of the water dispensing device 1, or integrated into the housing for a direct and easy replacement. At the outlet-side of the water dispensing device 1 there is provided a water dispensing outlet 3, such as a tap or an outlet pipe, tube or hose that can be opened and closed by means of an outlet valve V6 upstream from the water dispensing outlet 3. For preventing retrograde germination in the water to be dispensed via water dispensing outlet 3, a thermal germ barrier 5 may be provided downstream of outlet valve V6 and upstream

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of water dispensing outlet 3. A tap connected with a separate water outlet (not shown in the drawings) may be provided between the thermal germ barrier 5 and water dispensing outlet 3, for removal of contaminated water at the outlet-side of the water dispensing device 1. The region downstream of outlet valve V6 may be flushed e.g. at regular time intervals and/or depending on the input of a user of the water dispensing device 1.

**[0070]** The water dispensing device 1 may be installed in a building or office space and connected to a water supply line or water tap of the building or office space or to a water reservoir including a pump for supplying raw water. The water dispensing device 1 serves for providing at least two different types of filtered water in response to a user commanding or operating the device 1. For this purpose, the user may manually operate the outlet valve V6, e.g., by actuating a lever. As a preferred alternative, the water dispensing device 1 may be operated electrically by means of a power supply 12 under the central control of a controlling unit 10 that may receive input commands of a user via an input unit 11, such as a touch panel that may visualize a graphical user interface (GUI) or a keyboard, for controlling the whole operation of the water dispensing device 1.

**[0071]** Inside the water dispensing device 1 at least two water conducting paths 40, 41 are provided between the water supply inlet 2 and the water dispensing outlet 3, which serve for generating different types of filtered water from the filtered raw water supplied by the water supply inlet 2 and for selectively conducting the different types of filtered water to the water dispensing outlet 3 to be dispensed. The different types of filtered water may include at least filtered still water of different temperatures, such as ambient still water (generally of room temperature) and chilled still water (cooled to a predetermined temperature). According to further embodiments, different types of carbonated filtered water of different carbon dioxide concentration may be generated as well, such as moderately sparkling water (carbonated with about 1.5 g/l to about 2.5 g/l), medium sparkling water (carbonated with about 2.5 g/l to about 3.5 g/l) and standard sparkling water (carbonated with about 4.5 g/l to about 7.5 g/l). Preferably, the carbonated filtered water is cooled, e.g. by means of a heat exchanger. For this purpose, the water dispensing device 1 further comprises a temperature modifying unit, such as heat exchangers, and/or a carbonator, as outlined below in more detail.

**[0072]** During operation, the flow of filtered water through the water dispensing device 1 and its various water conducting paths 40-43 and recirculation paths 50, 51, to be outlined in more detailed hereinafter, is detected and monitored continuously, and on the basis of analysis of the flow of filtered water via the respective water conducting path 40-43 also stagnation of filtered water in the respective water conducting path 40-43 can be detected. Moreover, also stagnation of filtered water in any of the recirculation paths 50, 51 can be detected in the same manner. For detecting the flow of filtered water

through the water dispensing device 1 and its various water conducting paths 40-43 and recirculation paths 50, 51, flow sensors (not shown in the drawings) may be provided, e.g., one flow sensor for each of the flow paths. As an alternative, one single flow sensor may be provided at the inlet-side or outlet-side of the water dispensing device 1 to detect the total volume of raw water at the inlet-side or the total volume of filtered water dispensed via the water dispensing outlet 3, and in combination with a knowledge about which of the valves of the water dispensing device are open / closed, it is also possible to detect the flow of filtered water through the water dispensing device 1 and its various water conducting paths 40-43 and recirculation paths 50, 51. According to preferred embodiments valves, such as solenoid valves that are electrically actuated under the control of the controlling unit 10, may be included and the flow of filtered water through the water dispensing device 1 may be detected and monitored by means of timers (not shown in the drawings) that are triggered upon actuation of an associated valve, that count time intervals since the last opening / closing of the associated valve and that communicate their timer values for opening and closing times to the controlling unit 10 for further analysis and control of the water dispensing device 1.

**[0073]** Hereinafter, preferred embodiments of a water dispensing device 1 according to the present invention will be described with reference to Figs. 1 to 5. These embodiments include at least two water conducting paths for guiding different types of filtered water from the water supply inlet 25 to the water dispensing outlet 3 and at least one recirculation path for recirculating filtered water that has stagnated in at least one of the at least two water conducting paths, or in the at least one recirculation path, back to the filtering unit depending on the input by the user.

#### First Embodiment

**[0074]** As shown in Fig. 1, an optional non-return valve 15 is provided downstream of the filtering unit 7, which is followed by a pressure switch 30 that senses whether the water pressure inside the water dispensing device 1 is larger than a threshold pressure value and communicates the actual pressure value or the discrimination result to the controlling unit 10. A first electrically actuated valve V1 is disposed upstream of a central pump 17 that serves for pumping water through the water conducting paths 40, 41 and a recirculation path 50 under the control of the controlling unit 10. The pump 17 may be a vane pump or a diaphragm pump, but also other types of pumps are conceived. Downstream of pump 17 the flow path branches into a first water conducting path 40 for conducting ambient filtered water, i.e. water that has not been actively cooled but is at the temperature of the water supply inlet 2 or basically at ambient temperature, and a second water conducting path 41 for conducting chilled filtered water. For cooling the water in the second water

conducting path 41, a cooling unit is provided, comprising a compressor 20, a condenser 21 and two heat exchangers 22, 23, wherein one of the heat exchangers 23 is in thermal contact with the second water conducting path 41 for cooling the water. Electrically actuated valves V2 and V4 are associated to the first and second water conducting path 40, 41, respectively, for selectively opening the first or second water conducting path 40, 41 in accordance with the input of a user. It is also conceived that in a mixed operation both the first and second water conducting path 40, 41 is partially opened to adjust the temperature of the filtered water to be dispensed as desired by the user. Both water conducting paths 40, 41 are preferably for still, non-carbonated water and merge into a second throttle for flow reduction 18, which is followed by outlet valve V6. Upstream of the outlet valve V6, a second filter 8 may optionally be provided, which may be a membrane filter for further reducing the germ concentration in the filtered water by additionally filtering.

**[0075]** Upstream of the outlet valve V6 and upstream or downstream of optional filter 8 a first junction 9 is provided, which is in fluid communication with a recirculation path 50 which serves to recirculate water of a particular type of filtered water to the second junction 9' and the filtering unit 7 via the recirculation path 50 in correspondence to the input by the user. The recirculation path 50 may include a non-return valve 6, preventing water from water supply inlet 2 to enter the recirculation path 50. Non-return valve 6 is provided close to the second junction 9', i.e. directly upstream of a position where the recirculation path 50 is discharged into the pipe or tube connecting the water supply inlet 2 with the filtering unit 7. This second junction 9' preferably is provided as close as possible to the filtering unit 7 and the length of the aforementioned pipe or tube is preferably as small as possible, to reduce any contamination in this region. Opening and closing of the recirculation path 50 is controlled by actuating valve V7 under the control of controlling unit 10, which also activates pump 17 for recirculating the water via recirculation path 50. Water from the first or second water conducting path 40, 41 that is circulated via the recirculation path 50 to the second junction 9' and the filtering unit 7 is thus filtered by the filtering unit 7, before entering again the water conducting paths 40, 41 inside the water dispensing device 1. This simple measure turned out to be very effective for enhancing the water quality and effectively reducing the concentration of contaminants and germs in the filtered water inside the water dispensing device 1. It is conceived that an additional sterilization unit (not shown) may be provided in the recirculation path 50 and upstream of the filtering unit 7, such as an UV-C module, an ozone cell or a hot water module.

**[0076]** In general, the flow and recirculation of filtered water is controlled by the controlling unit 10 and by actuating selected ones of the valves V1-V7 based on the input of a user, as outlined below in more detail.

Alternatively, the control may also be solely time-dependent (at defined timings and time periods) during certain stages of the control.

**[0077]** More specifically, for dispensing still ambient filtered water, valves V1, V2 and V6 are opened while the other valves remain closed. On the other hand, for dispensing still chilled filtered water, valves V1, V4 and V6 are opened while the other valves remain closed.

**[0078]** For initializing the recirculation of still ambient filtered water, valves V1, V2 and V7 are opened while the other valves remain closed. For recirculation of still ambient filtered water at least the internal volume of water of the water conducting path 40 between pump 17 and junction 9 is pumped into the recirculation path 50. According to a preferred modification, at least the internal volume of water of the tubes, pipes and/or hoses between filtering unit 7 and junction 9 is pumped into the recirculation path 50. On the other hand, for initializing the recirculation of still chilled filtered water, valves V1, V4 and V7 are opened while the other valves remain closed. For recirculation of chilled filtered water at least the internal volume of water of the water conducting path 41 between pump 17 and junction 9 is pumped into the recirculation path 50. According to a preferred modification at least the internal volume of water of the tubes, pipes and/or hoses between filtering unit 7 and junction 9 is pumped into the recirculation path 50.

**[0079]** In the preferred embodiment, the controlling unit 10 tracks at which time and for how long a respective type of filtered water was tapped or dispensed for the last time. If the last (most recent) dispensing of a respective type of filtered water was a certain time period ago, or if a certain critical quantity of filtered water has not been tapped or dispensed during the last dispensing, the recirculation of this type of water is initiated for a certain period of time, as outlined below in more detail with respect to Fig. 6.

## Second Embodiment

**[0080]** The second embodiment shown in Fig. 2 additionally comprises a third water conducting path 42, which serves for conducting carbonated filtered water to water dispensing outlet 3. The third water conducting path 42 for carbonated filtered water may be opened by actuating valve V3, which is followed by a carbonator 36, which receives CO<sub>2</sub> from CO<sub>2</sub>-inlet 35, such as a pressurized CO<sub>2</sub>-reservoir. The pressure at the input side of carbonator 36 is monitored by pressure switch 31, which signals e.g. when the partial pressure of CO<sub>2</sub> at the input-side of carbonator 36 drops below a given threshold value. An additional non-return valve 15 may be provided upstream of valve V3. The carbonated filtered water in the third water conducting path 42 may be cooled by means of an additional heat exchanger 23 disposed upstream of valve V5 that is followed by a throttle for flow reduction 19. Pre-cooling of still water with subsequent carbonation is also possible and may be used in certain

modifications of this embodiment. In this embodiment, the pump 17 may additionally serve to fill the carbonator 36 and ensure a minimum flow of still water types.

**[0081]** On the other hand, the two water conducting paths 40, 41 for still water, namely path 40 for ambient still water and path 41 for chilled still water merge into a common line that may include a throttle for flow reduction 18.

**[0082]** Both water conducting paths 40, 41 for still filtered water and the water conducting path 42 for carbonated filtered water merge into a common line that is in fluid communication with outlet valve V6 and includes common first junction 9 to the recirculation path 50.

**[0083]** By selectively actuating the valves V1-V7, still ambient filtered water and still chilled filtered water or carbonated filtered water, that may additionally be chilled by heat exchanger 23, can be output, and according to a preferred embodiment the different types of filtered water may also be mixed at desired mixing ratios to provide a desired type of filtered water at the water dispensing outlet 3.

**[0084]** More specifically, for dispensing ambient still filtered water, valves V1, V2 and V6 are opened while the other valves remain closed. For dispensing chilled still filtered water, valves V1, V4 and V6 are opened while the other valves remain closed.

**[0085]** For dispensing medium carbonated filtered water, valves V1, V3, V4, V5 and V6 are opened while the other valves remain closed. For dispensing sparkling carbonated filtered water, valves V1, V3, V5 and V6 are opened while the other valves remain closed.

**[0086]** For initializing the recirculation of still ambient filtered water, valves V1, V2 and V7 are opened while the other valves remain closed. For recirculation of still ambient filtered water at least the internal volume of water of the water conducting path 40 between pump 17 and junction 9 is pumped into the recirculation path 50. According to a preferred modification at least the internal volume of water of the tubes, pipes and/or hoses between filtering unit 7 and junction 9 including water conducting path 40 is pumped into the recirculation path 50. For initializing the recirculation of still chilled filtered water, valves V1, V4 and V7 are opened while the other valves remain closed. For recirculation of chilled filtered water at least the internal volume of water of the water conducting path 41 between pump 17 and junction 9 is pumped into the recirculation path 50. According to a preferred modification at least the internal volume of water of the tubes, pipes and/or hoses between filtering unit 7 and junction 9 including water conducting path 41 is pumped into the recirculation path 50. For initializing the recirculation of sparkling filtered water, valves V1, V3, V5 and V7 are opened while the other valves remain closed. Actuating the valves V1-V7 is controlled by the central controlling unit 10.

**[0087]** For recirculation of sparkling filtered water at least the internal volume of water of the water conducting path 42 between pump 17 and junction 9 is pumped into

the recirculation path 50. According to a preferred modification at least the internal volume of water of the tubes, pipes and/or hoses between filtering unit 7 and junction 9 including water conducting path 42 is pumped into the recirculation path 50.

### Third Embodiment

**[0088]** As compared to the second embodiment, the third embodiment shown in Fig. 3 additionally comprises a valve V8 for allowing or preventing the supply of CO<sub>2</sub> to carbonator 36. More specifically, valve V8 is shut-off under the control of controlling unit 10 to temporarily interrupt the supply of CO<sub>2</sub> to the carbonator 36 when it is detected that carbonated water is stagnating in the third water conducting path 42, which serves for conducting carbonated filtered water to water dispensing outlet 3. Moreover, valve V8 is shut-off under the control of controlling unit 10 to temporarily interrupt the supply of CO<sub>2</sub> to the carbonator 36 while the carbonated filtered water is recirculating to the water supply inlet 2 via recirculation path 50. Moreover, valve V8 may also serve to stop CO<sub>2</sub> supply during circulation of filtered water via recirculation path 50. Temporarily shutting-off valve V8 further helps to prevent excessive input of CO<sub>2</sub> into other the water conducting path 42 for carbonated filtered water. In this way, CO<sub>2</sub> is saved and the load of CO<sub>2</sub> in the recirculation path, which consists of paths 42 and 50, is reduced.

**[0089]** Also in the third embodiment, by selectively actuating the valves V1-V8, still ambient filtered water and still chilled filtered water or carbonated filtered water, that may additionally be chilled by heat exchanger 23, can be output, and according to a preferred embodiment the different types of filtered water may also be mixed at desired mixing ratios to provide a desired type of filtered water at the water dispensing outlet 3.

**[0090]** More specifically, for dispensing ambient still filtered water, valves V1, V2 and V6 are opened while the other valves remain closed. For dispensing chilled still filtered water, valves V1, V4 and V6 are opened while the other valves remain closed.

**[0091]** The valves V1-V7 are actuated in the same manner as outlined above for the second embodiment. However, in the third embodiment valves V1, V3, V5 and V7 are opened and V8 closed while the other valves remain closed, for initializing the recirculation of sparkling filtered water.

### Fourth Embodiment

**[0092]** As compared to the second and third embodiment, the fourth embodiment shown in Fig. 4 comprises a specific recirculation path 50 exclusively for use for still filtered water and a separate recirculation path 51 exclusively for use for carbonated filtered water, to prevent a cross-contamination between both recirculation paths 50, 51.

**[0093]** For dispensing ambient still filtered water, valves V1, V2 and V6 are opened while the other valves remain closed. For dispensing chilled still filtered water, valves V1, V4 and V6 are opened while the other valves remain closed.

**[0094]** For dispensing medium carbonated filtered water, valves V1, V3, V4, V5 and V6 are opened while the other valves remain closed. For dispensing sparkling carbonated filtered water, valves V1, V3, V5 and V6 are opened while the other valves remain closed.

**[0095]** For initializing the recirculation of still ambient filtered water via recirculation path 50, valves V1, V2 and V7 are opened while the other valves remain closed. For initializing the recirculation of still chilled filtered water via recirculation path 50, valves V1, V4 and V7 are opened while the other valves remain closed. For initializing the recirculation of sparkling filtered water via recirculation path 51, valves V1, V3, V5 and V8 are opened while the other valves remain closed.

**[0096]** The fourth embodiment is based on the observation that the path 43 for carbonated filtered water is less prone for contamination, formation of bio-films and germ contamination than the paths 40, 41 for still filtered water because the carbon dioxide (CO<sub>2</sub>) content in path 43 results in a lower pH-value effectively preventing such contaminations. Therefore, also the time intervals and time periods for recirculation of filtered still water from paths 40, 41 via recirculation path 50 may be significantly shorter than for recirculation of filtered carbonated water from path 43 via recirculation path 51.

**[0097]** More specifically, inventors have observed that it may be sufficient to recirculate carbonated filtered water from path 42 via recirculation path 51 for carbonated filtered water only about once a day (every 24 hours), whereas a preferred time interval for recirculation of filtered still water from paths 40, 41 via recirculation path 50 may be about 4 hours, e.g. being in the range between 2.5 hours and 5.5 hours, more preferably in the range between 3.0 hours and 5.0 hours and even more preferably in the range between 3.75 hours and 4.25 hours.

**[0098]** Hence, the ratio between the time interval  $t_2$  (= predetermined second period of time) expiring before recirculating carbonated filtered water from path 42 via recirculation path 51 and the time interval  $t_1$  (= predetermined first period of time) expiring before recirculating filtered still water from paths 40, 41 via recirculation path 50 may be in the range between 2.0 and 6.0, more preferably in the range between 3.0 and 5.0 and even more preferably in the range between 3.75 and 4.25.

**[0099]** Moreover, inventors have observed that it may be sufficient to recirculate carbonated filtered water from path 42 via recirculation path 51 only for a short time period, e.g., for about 5 seconds, whereas a preferred time period for recirculation of filtered still water from paths 40, 41 via recirculation path 50 may last about 60 seconds, e.g. being in the range between 40 seconds and 80 seconds, more preferably being in the range

between 50 seconds and 70 seconds and even more preferably being in the range between 55 seconds and 65 seconds.

**[0100]** Hence, the ratio between the time period for recirculation of filtered still water from paths 40, 41 via recirculation path 50 and the time period for recirculation of carbonated filtered water from path 43 via recirculation path 51 may be in the range between 8.0 and 16.0, more preferably in the range between 10.0 and 14.0 and even more preferably in the range between 11.5 and 12.5.

**[0101]** Actuating the recirculation path 51 less frequently significantly reduces energy consumption and increases efficiency of the water dispensing device 1.

## 15 Fifth Embodiment

**[0102]** As compared to the third and fourth embodiment, the fifth embodiment shown in Fig. 5 uses an inline-carbonator 36 having a significantly smaller inner volume and virtually having no dead volume for carbonated water inside carbonator. Inline-carbonator 36 may be of the kind disclosed e.g., in DE 10 2007 016 143 A1, the whole content of which is hereby incorporated by reference. Inline-carbonator 36 additionally has the advantage of reduced CO<sub>2</sub>-consumption and reduced energy consumption, which may result in even longer time intervals for recirculation of carbonated filtered water from path 42 via recirculation path 51 as compared to the aforementioned fourth embodiment. Also in the fifth embodiment, valve V8 may serve for further reducing CO<sub>2</sub>-consumption by shutting-off the supply of CO<sub>2</sub> from CO<sub>2</sub>-input during recirculation of carbonated filtered water from path 42 via recirculation path 51.

**[0103]** For dispensing ambient still filtered water, valves V1, V2 and V6 are opened while the other valves remain closed. For dispensing chilled still filtered water, valves V1, V4 and V6 are opened while the other valves remain closed.

**[0104]** For dispensing medium carbonated filtered water, valves V1, V3, V4, V5 and V6 are opened while the other valves remain closed. For dispensing sparkling carbonated filtered water, valves V1, V3, V5 and V6 are opened while the other valves remain closed.

**[0105]** For initializing the recirculation of still ambient filtered water via recirculation path 50, valves V1, V2 and V7 are opened while the other valves remain closed. For initializing the recirculation of still chilled filtered water via recirculation path 50, valves V1, V4 and V7 are opened while the other valves remain closed. For initializing the recirculation of sparkling filtered water, i.e. either medium carbonated filtered water or sparkling carbonated filtered water, via recirculation path 50, valves V1, V3, V5 and V7 are opened while the other valves remain closed.

## 55 General Remarks

**[0106]** In the section "general remarks", features of preferred embodiments of a water dispensing device

according to claim 1 are described. Although for said preferred embodiments, reference signs are indicated for a better understanding in combination with the specific embodiments of Figures 1-5, this section is not limited to said specific embodiments.

**[0107]** The valves V1-V8 are preferably solenoid valves which are actuated under the central control of controlling unit 10. At least some of these valves V1-V8 may be opened and closed several times in succession while the selected type of filtered water is recirculated to the water supply inlet 2 via the respective recirculation path 50, 51, for exchanging residual water in dead volumes of the respective valves and prevent contamination and formation of germs and bio-films particularly in the dead volumes inside and in the direct vicinity of these valves V1-V8.

**[0108]** Extensive testing by the inventors showed that heating caused by electrically actuating valves, such as solenoid valves, may cause an additional source of water contamination inside the water dispensing device. As a further remedy, in preferred embodiments according to the present invention, the valves V1-V8 may be heated temporarily to temperatures above at least 55°C, more preferably to temperatures above at least 60°C, even more preferably at least 65°C and most preferably 80°C over a time period of at least 1 min, e.g. over about 3 to 7 min, more preferably over about 4 to 6 min and even more preferably for about 5 min. This holds in particular for all those valves exposed solely to still water during operation, more preferably for all those valves exposed solely to still ambient water during operation. Temporarily heating the valves is preferably performed during time periods when the control unit 10 detects that the water dispensing device 1 is not used and may be performed in regular time intervals, e.g., once per day. The same procedure may also be applied to one or more of the throttles for flow reduction provided in the water dispensing device.

**[0109]** According to a preferred embodiment, the controlling unit 10 may selectively actuate the plurality of valves V1-V8 to circulate also filtered water, which has stagnated in the recirculation paths 50, 51, via the recirculation path 50, 51 back to the filtering unit 7 at regular time intervals or depending on user input. Here, most critical regarding formation of bio-films and germs inside the water dispensing device 1 is the stagnation of ambient water in path 40 for ambient still filtered water and in recirculation path 50 for still filtered water, since this water is not cooled and hence more prone to contamination and is usually less often demanded by users, in particular during summer-time. According to preferred embodiments, in particular in case of a first ever dispensing of the selected type of filtered water after turning-on the water dispensing device, recirculation of ambient still filtered water via recirculation path 50 is initialized at regular intervals, as outlined below in more detail, and for a time period of at least 10 seconds, more preferably for about 15 seconds. Generally, this time period is dependent on the volume of the recirculation path 50

and is selected so that at least the total volume of the recirculation path 50 is replaced by fresh filtered water by circulating this volume back towards the filtering unit 7 via recirculation path 50. A certain safety margin may be provided to circulate a little more than this total volume.

**[0110]** Less critical to this regard is the stagnation of chilled still filtered water in path 41. However, the problem with stagnation of still filtered water in recirculation path 50 remains, and is solved according to preferred embodiments, in particular in case of a first ever dispensing of the selected type of filtered water after turning-on the water dispensing device, by initializing recirculation of still filtered water via recirculation path 50 at regular intervals, as outlined below in more detail, and for a time period of at least 10 seconds, more preferably for about 15 seconds, in order to ensure that at least the total volume of the recirculation path 50 is replaced by fresh filtered water, possibly plus a certain safety margin.

**[0111]** Least critical to this regard is the stagnation of carbonated water, regardless of carbon dioxide concentration, in recirculation path 51 due to the lower pH-value, which effectively hinders the formation of contaminants. Therefore, it may be sufficient, if recirculation of sparkling filtered water via recirculation path 51 is initialized at regular intervals which are significantly longer as compared to the time intervals used for still filtered water, e.g., every 24 hours after the most recent use of sparkling filtered water by the user, and for this purpose a shorter time period of e.g., about 5 seconds may be sufficient. This time period may even be shorter than the time period needed for replacement of the total volume of carbonated filtered water stagnating in recirculation path 51 by fresh carbonated water.

**[0112]** According to the present invention, the controlling unit 10 tracks at which time and for how long a respective type of filtered water was last tapped or dispensed. If the last dispensing of a respective type of filtered water was a certain period of time ago, or if a certain critical quantity of filtered water has not been tapped or dispensed during the last dispensing, the recirculation of this type of water is initiated for a certain time.

**[0113]** In preferred embodiments, recirculation for about 60 seconds is triggered for the non-carbonated filtered water types, i.e. ambient or chilled still filtered water, after about 4 hours of stagnation. For carbonated water, the preferred embodiments utilize a recirculation for about 5 seconds after a stagnation time of about 24 hours, since microbial growth in carbonated water is inhibited significantly by carbonic acid. Preferably, a timer for the next stagnation is only reset when a predetermined minimum amount of filtered water is dispensed within a given period of time. The predetermined amount of filtered water may be larger than 200 ml, more preferably larger than 350 ml and even more preferably larger than 500 ml, depending on the actual total volume of the respective water conducting path a the selected type of filtered water and is generally of the order of 1.0 to

2.0 times the total internal volume of water of the water conducting path for a selected type of filtered water inside the water dispensing device. The given period of time may be of the order of one hour, e.g. may be in the range between 50 minutes and 70 minutes and more preferably in the range between 55 minutes and 65 minutes.

**[0114]** According to preferred embodiments, the controlling unit 10 may distinguish between the first ever dispensing of ambient still filtered water after turning-on the water dispensing device 1 or since non-use over an extended period, such as one or two days (e.g., over a week-end), and the dispensing during standard operation conditions, which usually imply relatively short time periods of non-use of the order of about 4 hours. According to such preferred embodiments, the recirculation of ambient and still filtered water via recirculation path 50 is already triggered after about one hour of stagnation after the last dispensing in order to filter out any nutrients and germs that may have been added with the fresh water supplied via water supply inlet 2. Subsequently, the time interval between recirculation of ambient and still filtered water via recirculation path 50 is increased again to the standard time interval outlined above, which is preferably of the order of four hours.

**[0115]** During operation, the flow of filtered water through the water dispensing device and its various water conducting paths and recirculation paths is detected and monitored continuously, and on the basis of analysis of the flow of filtered water via the respective water conducting path also stagnation of filtered water in the respective water conducting path can be detected. Moreover, also stagnation of filtered water in any of the recirculation paths can be detected in the same manner. For detecting the flow of filtered water through the water dispensing device and its various water conducting paths and recirculation paths flow sensors may be provided, e.g., one flow sensor for each of the flow paths. As an alternative, one single flow sensor may be provided at the inlet-side or outlet-side of the water dispensing device to detect the total volume of raw water at the inlet-side or the total volume of filtered water dispensed via the water dispensing outlet, and in combination with a knowledge about which of the valves of the water dispensing device are open / closed, it is also possible to detect the flow of filtered water through the water dispensing device 1 and its various water conducting paths 40-43 and recirculation paths 50, 51. According to preferred embodiments valves, such as solenoid valves that are electrically actuated under the control of the controlling unit 10, may be included and the flow of filtered water through the water dispensing device 1 may be detected and monitored by means of timers (not shown in the drawings) that are triggered upon actuation of an associated valve, that count time intervals since the last opening / closing of the associated valve and that communicate their timer values for opening and closing times to the controlling unit 10 for further analysis and control of the water dispensing device 1.

**[0116]** As will become apparent to the skilled person when studying this present specification, the aforementioned time periods for flushing or recirculation the paths 40-43 and 50, 51 will depend on the actual flow rates that can be accomplished inside the water dispensing device, which depend particularly on the power and pump rate of pump 17 and the relevant cross sections of tubing, pipes and hoses installed in the water dispensing device 1. Most preferably, such time periods for flushing are chosen such that at least 1.0 times, more preferably at least 1.25 times the total internal volume of water of the respective water conducting path 40-43 and/or respective recirculation path 50, 51 will be circulated.

#### 15 Controlling the operation of water dispensing device

**[0117]** Although in this section the features are explained for the embodiments Figures 6, 7a and 7b using reference numbers of the embodiments of Figures 1 to 5, this section is not limited to said specific embodiments, but the features described therein may serve as preferred features of a water dispensing device according to claim 1 are described.

**[0118]** Hereinafter, specific embodiments of operating a water dispensing device depending on the input by a user of a water dispensing device according to the present invention will be described with reference to the schematic flow-diagram of Figs. 6 to 7b. It is noted that the following description only relates to exemplary embodiments that shall not be construed to delimit the scope of protection of the present invention as defined in the appended claims.

**[0119]** In the sequence of steps shown in Fig. 6, the dispensing of water via water dispensing outlet 3 is continuously detected after initialization of the water dispensing device. For this purpose, e.g. electric signals corresponding to the opening of outlet valve V6 or to the supply of fresh water via water supply inlet 2 may be analyzed by controlling unit 10. If such a start or water dispensing is detected, a timer associated to the particular type of filtered water dispensed is started. In the embodiment shown in Fig. 6, separate timers are used for ambient still filtered water, for chilled still filtered water, for carbonated filtered water and for water that has stagnated in the recirculation path for still filtered water (in Fig. 6 from left to right).

**[0120]** After initialization of the water dispensing device (S1), four timers are initialized in steps S11, S21, S31 and S41, namely a timer for recirculation of ambient still filtered water (S11), a timer for recirculation of chilled still filtered water (S21), a timer for recirculation of carbonated filtered water, in particular for sparkling filtered water, (S31) and a timer for recirculation of water that has stagnated in a recirculation path, in particular in recirculation path 50 for still water (S41).

**[0121]** If it is detected in step S12 that ambient still filtered water has been dispensed within one hour after initialization and for a minimum amount of water (corre-

sponding to a minimum dispensing time of e.g., 20s), then the controlling unit considers fulfillment of these conditions as an indication for sufficient hygienic conditions in the path 40 for ambient still filtered water and the process returns to step S11 where the timer for recirculation of ambient still filtered water is reset. From this timing onwards, the criterion for expiry of the timer for recirculation of ambient still filtered water is a much shorter period of time  $t_1$  of e.g., 4 hours compared to the period of time  $t_2$  applied for carbonated filtered water. On the other hand, if the detection result in step S12 is negative, then the controlling unit considers nonfulfillment of these conditions as an indication for insufficient hygienic conditions in the path 40 for ambient still filtered water and the process continues with step S13 where ambient still filtered water is recirculated via recirculation path 50 for a given time period of e.g., 60s (corresponding to replacement of the total volume of path 40 for ambient still filtered water inside the water dispensing device) and it is detected whether the timer for recirculation of ambient still filtered water has expired, and the process returns to step S11.

**[0122]** If it is detected in step S22 that chilled still filtered water has been dispensed within one hour after initialization and for a minimum amount of water, which is larger as that considered in step S12 (corresponding to a minimum dispensing time of e.g., 40s), then the controlling unit considers fulfillment of these conditions as an indication for sufficient hygienic conditions in the path 41 for chilled still filtered water and the process returns to step S21 where the timer for recirculation of chilled still filtered water is reset. From this timing onwards, the criterion for expiry of the timer for recirculation of chilled still filtered water is a much longer period of time  $t_1$  of e.g., 4 hours compared to the aforementioned one hour after initialization. On the other hand, if the detection result in step S22 is negative, then the controlling unit considers nonfulfillment of these conditions as an indication for insufficient hygienic conditions in the path 41 for chilled still filtered water and the process continues with step S23 where chilled still filtered water is recirculated via recirculation path 50 for a given time period of e.g., 60s (corresponding to replacement of the total volume of path 41 for chilled still filtered water inside the water dispensing device) and it is detected whether the timer for recirculation of chilled still filtered water has expired, and the process returns to step S21.

**[0123]** If it is detected in step S32 that carbonated filtered water has been dispensed within one hour after initialization and for a minimum amount of water, which is larger as that considered in step S12 (corresponding to a minimum dispensing time of e.g., 60s), then the controlling unit considers fulfillment of these conditions as an indication for sufficient hygienic conditions in the path 43 for carbonated filtered water and the process returns to step S31 where the timer for recirculation of carbonated filtered water is reset. From this timing onwards, the criterion for expiry of the timer for recirculation of carbo-

nated filtered water is a much longer period of time  $t_2$  of e.g., 24 hours, compared to the aforementioned one hour after initialization. On the other hand, if the detection result in step S32 is negative, then the controlling unit considers nonfulfillment of these conditions as an indication for insufficient hygienic conditions in the path 43 for carbonated filtered water and the process continues with step S33 where carbonated filtered water is recirculated via recirculation path 51 (or via the single recirculation path 50 used for both still and carbonated water in the embodiments shown in Figs. 2 and 3) for a much shorter time period of e.g., 5s and it is detected whether the timer for recirculation of carbonated filtered water has expired, and the process returns to step S31.

**[0124]** If it is detected in step S42 that ambient or chilled still filtered water has been recirculated within a given period of time of e.g., one hour after initialization and for a minimum amount of water (corresponding to replacement of the total volume of the recirculation path 50 for still filtered water), then the controlling unit considers fulfillment of these conditions as an indication for sufficient hygienic conditions in the recirculation path 50 for still filtered water and the process returns to step S41 where the timer for recirculation of stagnated still filtered water is reset. On the other hand, if the detection result in step S42 is negative, then the controlling unit considers nonfulfillment of these conditions as an indication for insufficient hygienic conditions in the recirculation path 50 for still filtered water and the process continues with step S43 where ambient or chilled still filtered water is recirculated via recirculation path 50 for still filtered water for a much shorter time period of e.g., 15s (corresponding to replacement of the total volume of the recirculation path 50 for still filtered water) and it is detected whether the timer for recirculation of still filtered water has expired, and the process returns to step S41.

**[0125]** Fig. 7a relates to a simpler embodiment of a water dispensing device for dispensing still filtered water and carbonated (medium or sparkling) filtered water, which both may be ambient or chilled filtered water, configured for preventing stagnation of filtered water in the recirculation paths for still filtered water and carbonated filtered water, which may be identical, such as in the embodiments shown in Figs. 2, 3 and 5, or which may be different, such as the embodiment shown in Fig. 4. The embodiment of Fig. 7a distinguishes between flushing the recirculation path for still filtered water and flushing the recirculation path for carbonated filtered water, and for both types of filtered water recirculation is triggered at regular but different time intervals. Here it is assumed that flushing the recirculation path for still filtered water is triggered e.g., every hour whereas flushing the recirculation path for carbonated filtered water e.g., every twenty-four hours.

**[0126]** After initialization of the water dispensing device (S1), timers are initialized in steps S41, and S51, namely a timer for recirculation of still filtered water (S41) and a timer for recirculation of carbonated filtered water

(S51).

**[0127]** If it is detected in step S42 that still filtered water has been recirculated via the recirculation path for still filtered water within one hour after initialization of the water dispensing device or during the last hour, then the controlling unit considers fulfillment of these conditions as an indication for sufficient hygienic conditions in the recirculation path for still filtered water and the process returns to step S41 where the timer for recirculation of still filtered water is reset. On the other hand, if the detection result in step S42 is negative, then the controlling unit considers nonfulfillment of these conditions as an indication for insufficient hygienic conditions in the recirculation path for still filtered water and the process continues with step S43 where the recirculation path for still filtered water is flushed over a predetermined time period, which may be identical for ambient still filtered water and chilled still filtered water, as indicated in step S43, which may be e.g., 15s (corresponding to replacement of the total volume of the recirculation path for still filtered water inside the water dispensing device), but which may also be longer for ambient still water than for chilled still filtered water. After it is detected that the timer for the recirculation path for still filtered water has expired, the process returns to step S41 again.

**[0128]** On the other hand, if it is detected in step S52 that carbonated filtered water has been recirculated via the recirculation path for carbonated filtered water within twenty-four hours after initialization of the water dispensing device or during the last twenty-four hours, then the controlling unit considers fulfillment of these conditions as an indication for sufficient hygienic conditions in the recirculation path for carbonated filtered water and the process returns to step S51 where the timer for recirculation of carbonated filtered water is reset. On the other hand, if the detection result in step S52 is negative, then the controlling unit considers nonfulfillment of these conditions as an indication for insufficient hygienic conditions in the recirculation path for carbonated filtered water and the process continues with step S53 where the recirculation path for carbonated filtered water is flushed over a predetermined time period, which may last for e.g., 5s, as indicated in step S53, but which may also be longer than 5s. Moreover, the time period for flushing the recirculation path may be dependent on the temperature of the water, and may be longer in case of stagnation of ambient carbonated filtered water than for stagnation of chilled carbonated filtered water. After it is detected that the timer for the recirculation path for carbonated filtered water has expired, the process returns to step S51 again.

**[0129]** Fig. 7b relates to another embodiment of a water dispensing device for dispensing ambient and chilled still filtered water and which distinguishes whether the filtered water is dispensed for the first time after initialization of the water dispensing device or after an extended period of non-use, such as a weekend or an extended week-end. The embodiment of Fig. 7b distinguishes between the dispensing of ambient still filtered

water and chilled still filtered water.

**[0130]** After initialization of the water dispensing device (S1), timers are initialized in steps S61, and S71, namely a timer for recirculation of ambient still filtered water (S61) and a timer for recirculation of chilled still filtered water (S71).

**[0131]** If it is detected in step S62 that a minimum amount of ambient still filtered water has been dispensed within one hour after initialization of the water dispensing device, e.g. over a minimum time period of 20s (corresponding to an amount of ambient still filtered water of, e.g., more than 200 ml, more preferably of more than 350 ml and even more preferably of more than 500 ml), then the controlling unit continues with step S63 to open the recirculation path for still filtered water over a predetermined time period of e.g. 60s, which should be sufficient for complete replacement of the water in the water conducting path 40 for ambient still filtered water inside the water dispensing device by recirculation. Then the process continues with step S64, where the timer for recirculation of ambient still filtered water is reset. Then, the process continues with step S65, where it is detected whether a minimum amount of ambient still filtered water has been dispensed during the last hour, e.g. by detecting whether filtered water has been dispensed over a minimum time period of e.g., 20s (corresponding to an amount of ambient still filtered water of more than 200 ml, more preferably of more than 350 ml and even more preferably of more than 500 ml). If the conditions are met in step S65, then the process returns to step S61. If the conditions are not met in step S65, then the process continues with step S66, where the controlling unit opens the recirculation path for still filtered water over a time period of e.g. 15s, which is shorter than in step S63 and is usually only sufficient for a partial replacement of the water in the path 40 for ambient still filtered water inside the water dispensing device by recirculation. Extensive testing of the inventors has shown that such a partial replacement of the water in the water conducting path 40 for ambient still filtered water may be sufficient to ensure hygienic conditions in the path for ambient still filtered water in case of continuous operating conditions, e.g. for use of the water dispensing device during normal office hours. After step S66, the process returns to step S64.

**[0132]** On the other hand, if it is detected in step S72 that a minimum amount of chilled still filtered water has been dispensed within one hour after initialization of the water dispensing device, e.g. over a minimum time period of 40s (corresponding to an amount of chilled still filtered water of more than 400 ml, more preferably of more than 700 ml and even more preferably of more than 1,000 ml), then the process continues with step S73 where the controlling unit opens the recirculation path for chilled filtered water over a predetermined time period of e.g. 60s, which should be sufficient for complete replacement of the water in the water conducting path 41 for chilled still filtered water inside the water dispensing device by recirculation. Then the process continues with step S74,

where the timer for recirculation of chilled still filtered water is reset. Then, the process continues with step S75, where it is detected whether a minimum amount of chilled still filtered water has been dispensed during the last hour, e.g. by detecting whether filtered water has been dispensed over a minimum time period of e.g., 40s (corresponding to an amount of chilled still filtered water of more than 400 ml, more preferably of more than 70 ml and even more preferably of more than 1,000 ml). If the conditions are met in step S75, then the process returns to step S71. If the conditions are not met in step S75, then the process continues with step S76, where the controlling unit opens the recirculation path for chilled filtered water over a time period of e.g. 15s, which is the same as in step S73, but which may also be shorter and only sufficient for a partial replacement of the water in the path 41 for chilled still filtered water inside the water dispensing device by recirculation. Since chilled still water is less prone to formation of contaminants, bio-films and germs compared to ambient still water, the aforementioned relatively short time period of e.g. 15s may be sufficient for safeguarding hygienic conditions, in particular during use of the water dispensing device within normal office hours. After step S76, the process returns to step S74.

### List of Reference Numerals

#### [0133]

|    |                                      |         |                                 |
|----|--------------------------------------|---------|---------------------------------|
| 1  | water dispenser                      | 30      | pressure switch                 |
| 2  | water supply inlet                   | 31      | pressure switch                 |
| 3  | water dispensing outlet              |         |                                 |
| 4  | throttle for flow reduction          |         |                                 |
| 5  | thermal germ barrier                 | 35      | CO <sub>2</sub> -input          |
| 6  | non-return valve                     | 5 36    | carbonator                      |
| 7  | filtering unit                       |         |                                 |
| 8  | output filter / membrane filter      | 40      | path for ambient still water    |
| 9  | first junction                       | 41      | path for chilled still water    |
| 9' | second junction                      | 42      | path for medium sparkling water |
| 10 | control device                       | 10 43   | path for sparkling water        |
| 11 | input device                         | 50      | first recirculation path        |
| 12 | power supply                         | 51      | second recirculation path       |
|    |                                      |         |                                 |
| 14 | filter                               | V1 - V8 | valves                          |
| 15 | non-return valve                     | 15      |                                 |
|    |                                      |         |                                 |
| 17 | pump                                 |         |                                 |
| 18 | throttle for flow reduction          |         |                                 |
| 19 | throttle for flow reduction          |         |                                 |
|    |                                      |         |                                 |
| 20 | compressor                           |         |                                 |
| 21 | condenser                            |         |                                 |
| 22 | first heat exchanger                 |         |                                 |
| 23 | cooling unit / second heat exchanger | 55      |                                 |
|    |                                      |         |                                 |
| 25 | water inlet / water tap              |         |                                 |

### Claims

1. A water dispensing device (1) comprising:

- 20 a water supply inlet (2) and a water dispensing outlet (3), which are in fluid communication, a filtering unit (7) disposed in a path (40-43) between the water supply inlet (2) and the water dispensing outlet (3), for filtering water supplied by the water supply inlet (2) to the water dispensing device (1),
- 25 a plurality of valves (V1-V8) for defining at least two water conducting paths (40-43) between the water supply inlet (2) and the water dispensing outlet (3) for conducting different types of filtered water to be dispensed by said water dispensing outlet (3), said different types of filtered water at least including still filtered water and carbonated filtered water, or filtered water of different temperatures and/or carbonated filtered water of different carbon dioxide concentration and said plurality of valves (V1-V8) including an outlet valve (V6) provided upstream of said water dispensing outlet (3), and
- 30 a controlling unit (10) configured for causing the water dispensing device (1) to dispense a particular type of filtered water by selectively actuating said plurality of valves (V1-V8) corresponding to an input by a user, wherein
- 35 a recirculation path (50, 51) is provided, for circulating filtered water that has stagnated in at least one of the at least two water conducting paths (40-43);
- 40 **characterized in that**
- 45 the recirculation path (50, 51) is configured for establishing a fluid communication between a first junction (9) provided upstream of said outlet valve (V6) and a second junction (9') provided upstream of said filtering unit (7), for recirculating water of a selected type of filtered water to the filtering unit (7) via the recirculation path (50, 51), wherein
- 50 the controlling unit (10) is configured for selec-

- tively actuating said plurality of valves (V1-V8) to establish the recirculation path (50, 51) when it is detected that the selected type of filtered water has stagnated in a water conducting path (40-43) of the water dispensing device (1) over a predetermined first period of time. 5
2. The water dispensing device as claimed in claim 1, wherein the controlling unit (10) is configured for selectively actuating said plurality of valves (V1-V8) to establish the recirculation path (50, 51) each time the predetermined first period of time has expired without dispensing a predetermined amount of filtered water via the water dispensing outlet (3), for recirculating the selected type of filtered water that has stagnated in a water conducting path (40-43) of the water dispensing device (1) over the predetermined first period of time. 10 15 20
  3. The water dispensing device as claimed in claim 2, wherein the controlling unit (10) is configured for selectively actuating said plurality of valves (V1-V8) to establish the recirculation path (50, 51) over a time period that is sufficient to flush the water conducting path (40-43) of the water dispensing device (1), in which the selected type of filtered water has stagnated, completely. 25
  4. The water dispensing device as claimed in any of the preceding claims, wherein the controlling unit (10) is configured for selectively actuating said plurality of valves (V1-V8) to establish the recirculation path (50, 51) and flush the recirculation path (50, 51) at regular time intervals or when it is detected that the selected type of filtered water has stagnated in the recirculation path (50, 51) over a predetermined third period of time. 30 35
  5. The water dispensing device as claimed in any of the preceding claims, further comprising a carbonating unit (35, 36) for carbonating the filtered water and generating carbonated filtered water, wherein the controlling unit (10) is configured for selectively actuating said plurality of valves (V1-V8) to establish the recirculation path (50, 51) when it is detected that carbonated filtered water has stagnated in a water conducting path (40-43) of the water dispensing device (1) over a predetermined second period of time, said predetermined second period of time being longer than said predetermined first period of time for still filtered water. 40 45 50
  6. The water dispensing device as claimed in claim 5, wherein a valve (V8) is associated to the carbonating unit (35, 36), and
- the controlling unit (10) is configured to actuate the valve (V8) associated to the carbonating unit (36), to shut-off a supply of CO<sub>2</sub> to the carbonating unit (36) when it is detected that carbonated filtered water is stagnating in a water conducting path (42) of the water dispensing device (1) and while the carbonated filtered water is recirculated to the filtering unit (7) via the recirculation path (50, 51).
7. The water dispensing device as claimed in claim 5 or 6, wherein a first recirculation path (50) is provided for recirculating still filtered water to the filtering unit (7), a second recirculation path (51) is provided for recirculating carbonated filtered water to the filtering unit (7), said second recirculation path (51) being separate to said first recirculation path (50), and the controlling unit (10) is configured to selectively actuate the plurality of valves (V1-V8) such that either the first recirculation path (50) for recirculating still filtered water or the second recirculation path (51) for recirculating carbonated filtered water is established.
  8. The water dispensing device as claimed in claim 7, wherein the controlling unit (10) is configured to selectively actuate the plurality of valves (V1-V8) such that the first recirculation path (50) for recirculating still filtered water is established over a longer time period than the second recirculation path (51) for recirculating carbonated filtered water.
  9. The water dispensing device as claimed in claim 7 or 8, wherein the controlling unit (10) is configured to selectively actuate said plurality of valves (V1-V8) to establish and flush the first recirculation path (50) for recirculating still filtered water when it is detected that still filtered water has stagnated in the first recirculation path (50) over a predetermined third period of time and to establish and flush the second recirculation path (51) for recirculating carbonated filtered water when it is detected that carbonated filtered water has stagnated in the second recirculation path (51) for carbonated filtered water over a predetermined fourth period of time, wherein the predetermined third period of time is longer than the predetermined fourth period of time.
  10. The water dispensing device as claimed in any of the preceding claims, wherein the controlling unit (10) is configured to selectively actuate the plurality of valves (V1-V8) such that the recirculation path (50, 51) is established over a longer time period for recirculating ambient still filtered water to the filtering

unit (7) than for recirculating chilled still filtered water to the filtering unit (7).

55°C, preferably over a time period of at least 1 min, more preferably over a time period of about 3 to 7 min, and most preferably over a time period of about 4 to 6 min.

11. The water dispensing device as claimed in any of the preceding claims, further comprising 5

an output filter (8), preferably a membrane filter, a UV-C module, ozone cell or a hot water module, disposed between the first junction (9) and the outlet valve (V6), and/or 10  
a thermal germ barrier disposed between the outlet valve (V6) and the water dispensing outlet (3).

12. The water dispensing device as claimed in claim 11, further comprising a flushing path for flushing filtered water that has stagnated between the first junction (9) and the outlet valve (V6) and/or between the outlet valve (V6) and the water dispensing outlet (3), wherein 20  
the controlling unit (10) is configured to activate the flushing of filtered water that has stagnated between the first junction (9) and the outlet valve (V6) and/or between the outlet valve (V6) and the water dispensing outlet (3) automatically, in particular at regular 25  
time intervals, or corresponding to an input by a user.

13. The water dispensing device as claimed in any of the preceding claims, wherein a non-return valve (6) is provided in the recirculation path (50, 51) close to the second junction (9') and upstream of the filtering unit (7). 30

14. The water dispensing device as claimed in any of the preceding claims, wherein at least some of the plurality of valves (V1-V8) are opened and closed several times in succession while the selected type of filtered water that has stagnated over a predetermined period of time is recirculated to the filtering unit (7) via the recirculation path (50, 51), for exchanging residual water in dead volumes of the respective valves. 35  
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15. The water dispensing device as claimed in any of the preceding claims, wherein 45

at least some of the plurality of valves (V1-V8) and/or a non-return valve (6, 15) and/or a throttle (18, 19) for flow reduction are heated at regular time intervals to temperatures above at least 50  
55°C, preferably over a time period of at least 1 min, more preferably over a time period of about 3 to 7 min, and most preferably over a time period of about 4 to 6 min, and/or  
at least one of the at least two water conducting paths (40-43) and of the recirculation paths (50,51) are at least partially heated at regular 55  
time intervals to temperatures above at least

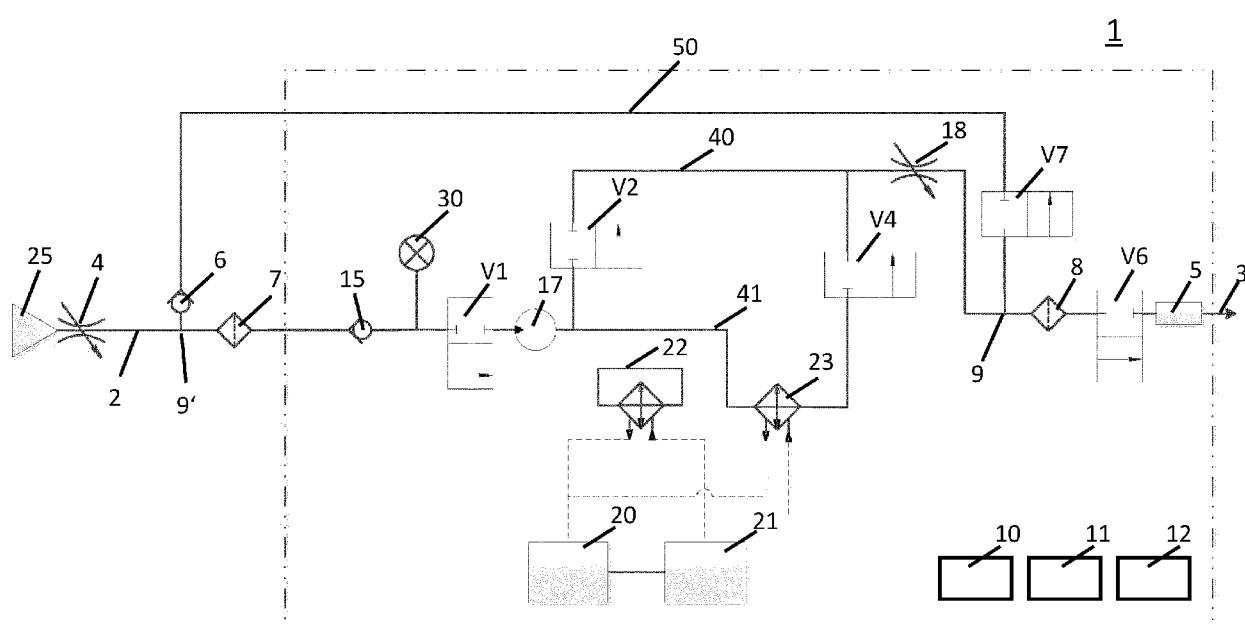


Fig. 1

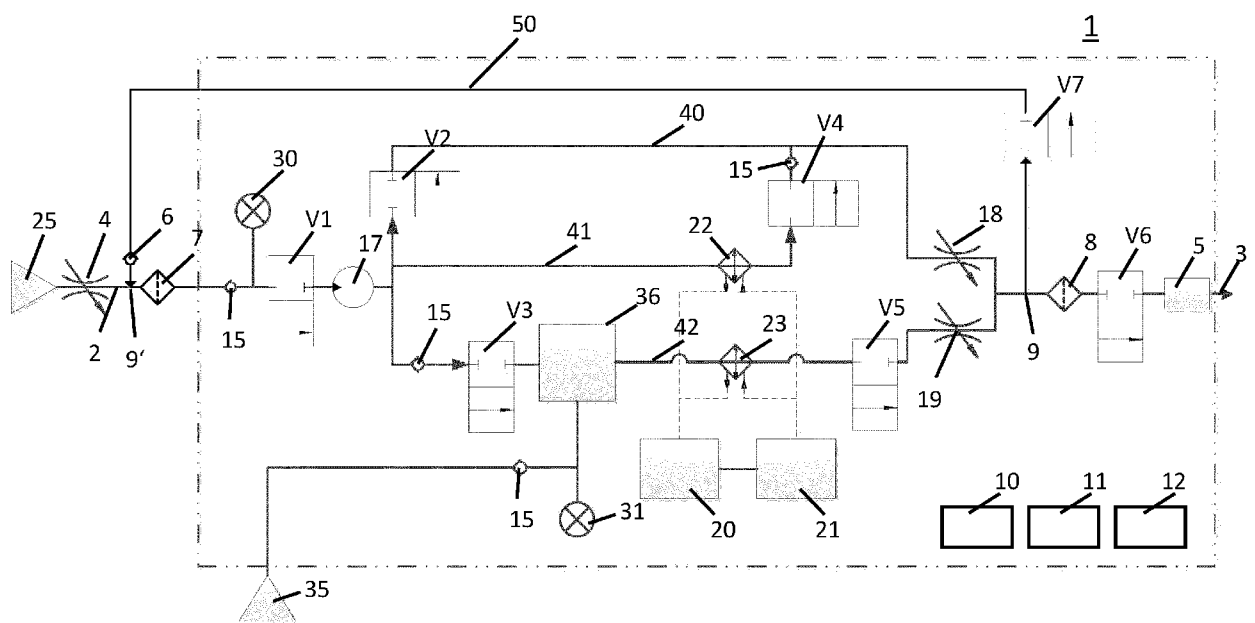


Fig. 2

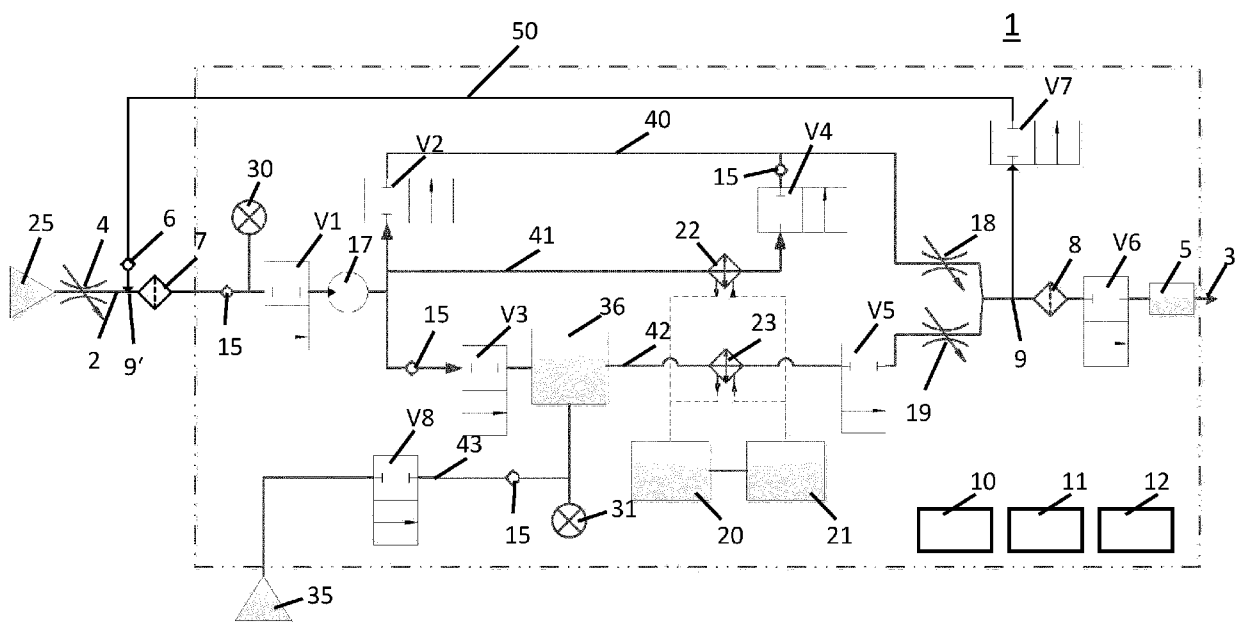


Fig. 3

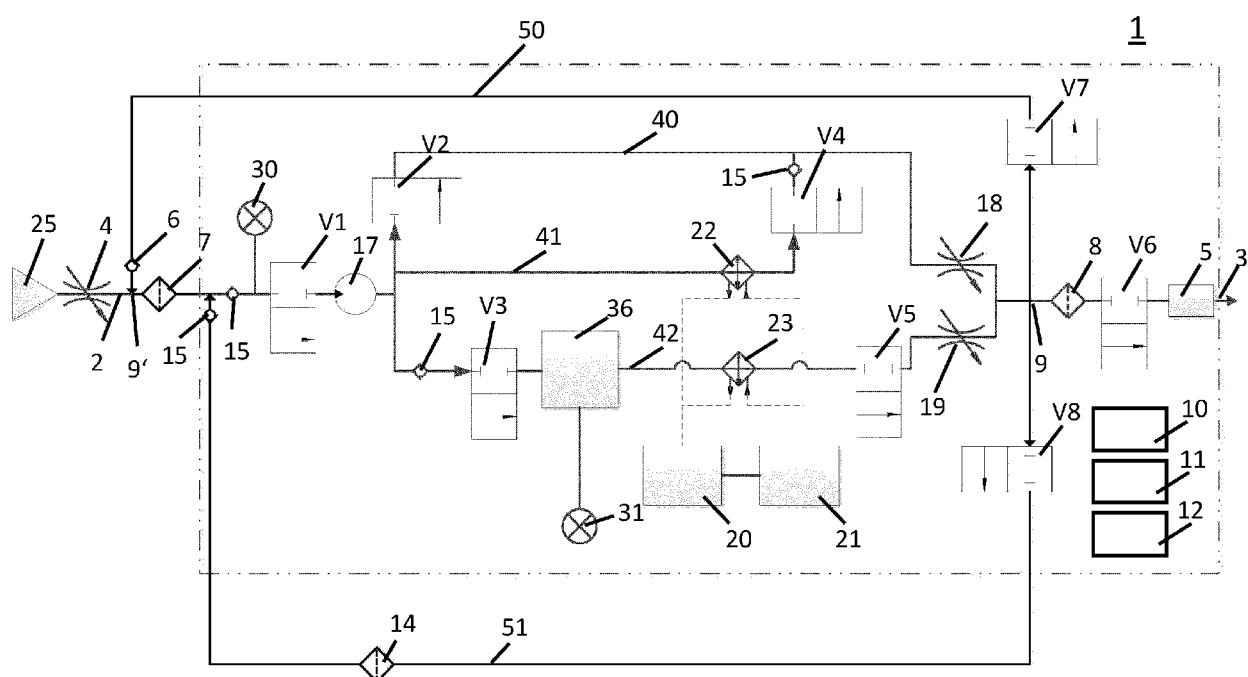


Fig. 4

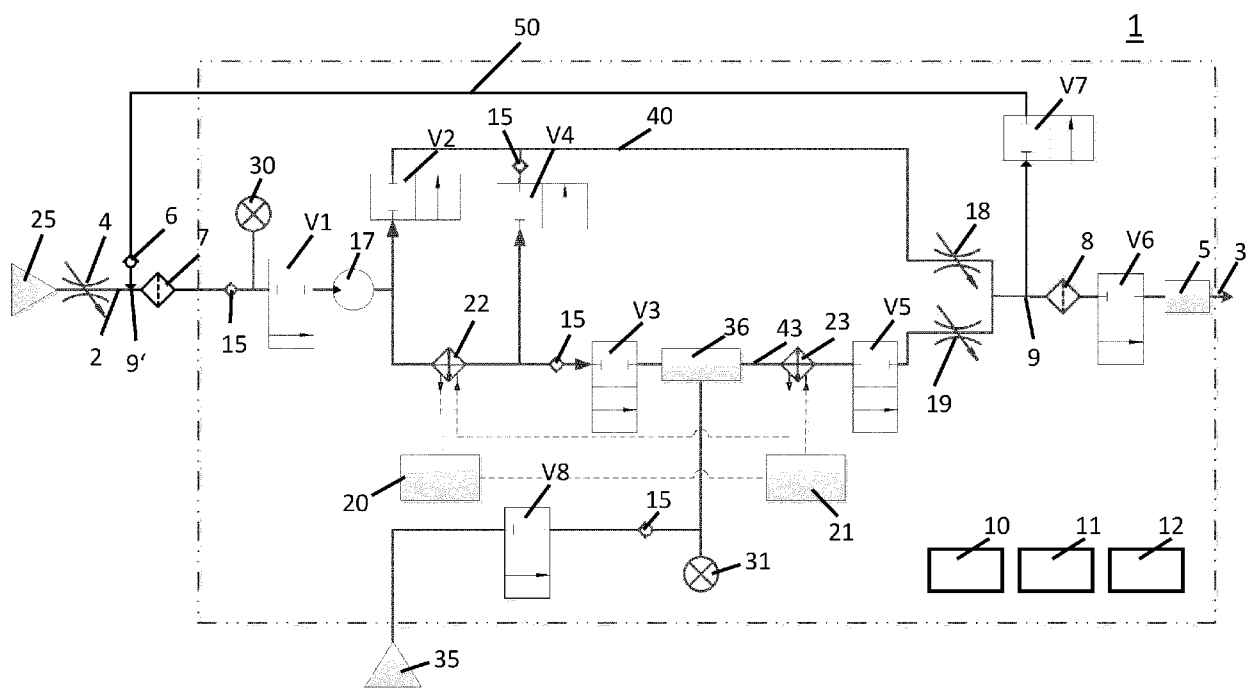


Fig. 5

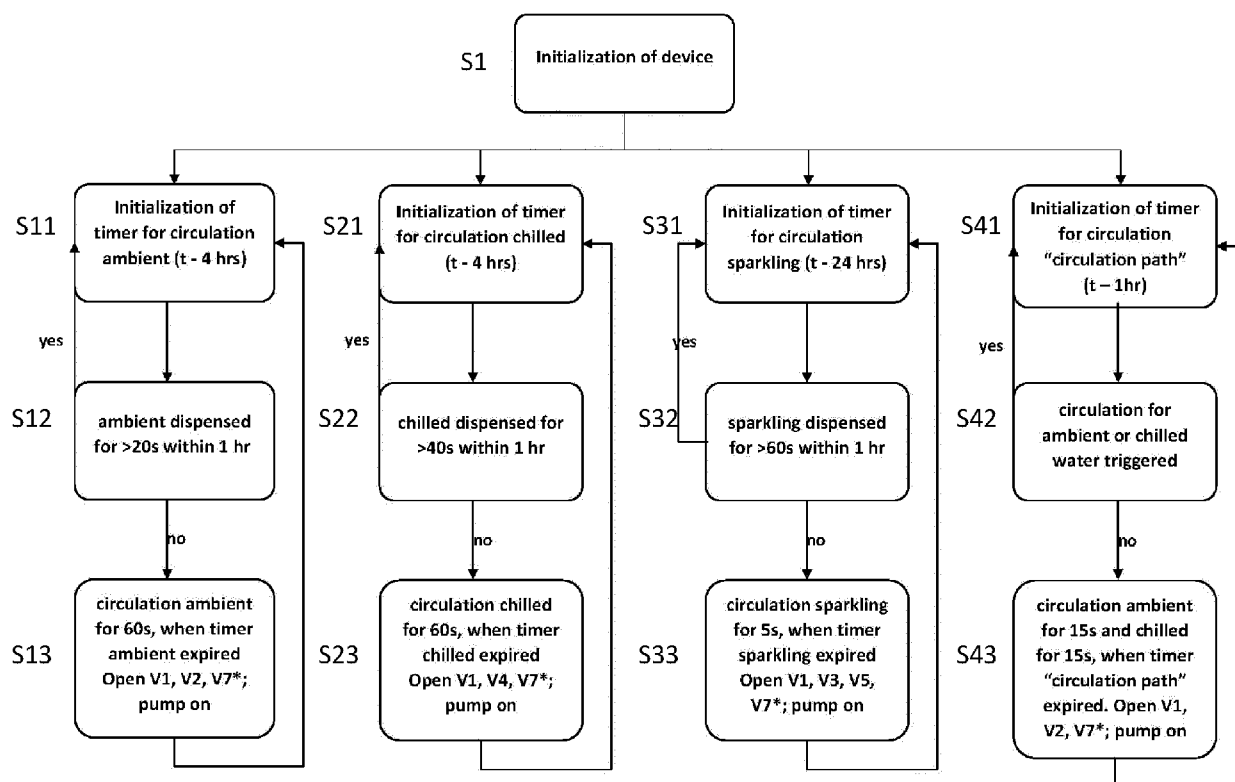


Fig. 6

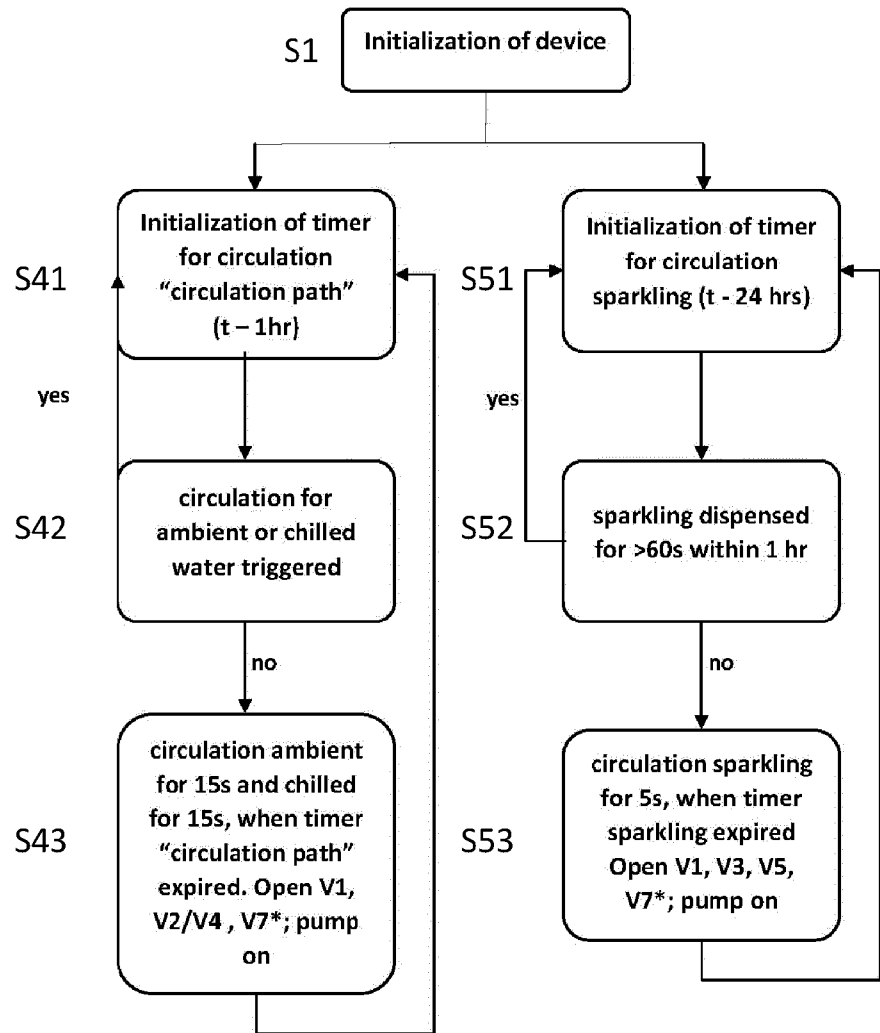


Fig. 7a

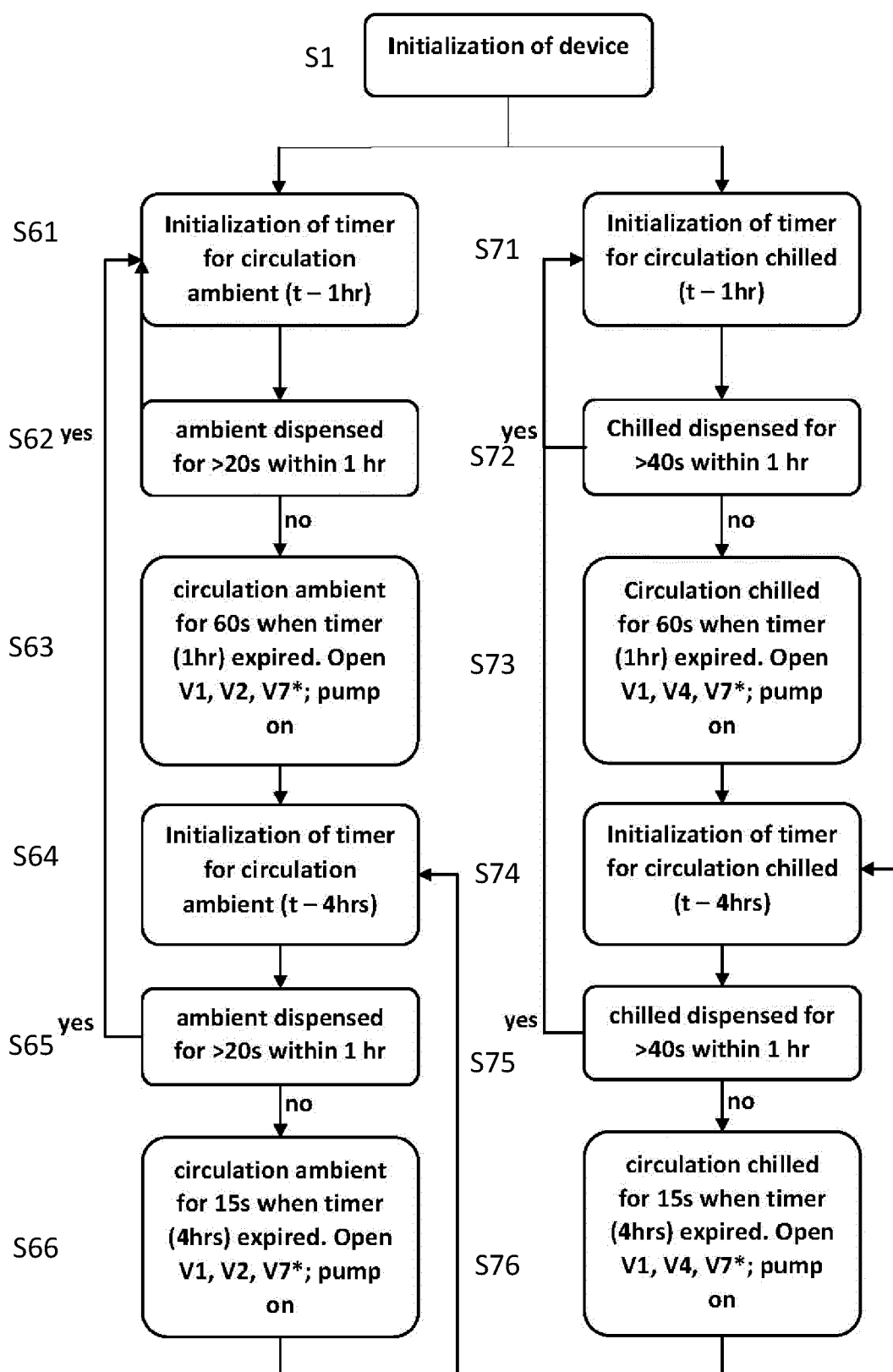


Fig. 7b



## EUROPEAN SEARCH REPORT

Application Number

EP 23 21 9736

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| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                                                                                                                  | Relevant to claim                                     | CLASSIFICATION OF THE APPLICATION (IPC)                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------------|
| <b>X</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>WO 2023/218337 A1 (ONN WATER S R L [IT])</b><br><b>16 November 2023 (2023-11-16)</b><br>* page 13, line 14 - line 21 *<br>* page 15, line 6 - page 17, line 22 *<br>* page 21, line 17 - line 33 *<br>----- | <b>1-5, 7-9, 13</b>                                   | <b>INV.</b><br><b>B67D1/00</b><br><b>B67D1/07</b><br><b>B67D1/08</b><br><b>B67D1/12</b> |
| <b>A</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>US 2018/125100 A1 (BAYSAL KUDRET [DE] ET AL)</b> 10 May 2018 (2018-05-10)<br>* paragraph [0076] - paragraph [0089] *<br>-----                                                                               | <b>1-15</b>                                           |                                                                                         |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                |                                                       | <b>TECHNICAL FIELDS SEARCHED (IPC)</b>                                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                |                                                       | <b>B67D</b>                                                                             |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                |                                                       |                                                                                         |
| Place of search<br><b>Munich</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                | Date of completion of the search<br><b>8 May 2024</b> | Examiner<br><b>Desittere, Michiel</b>                                                   |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                                                                                                                |                                                       |                                                                                         |

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08-05-2024

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