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(54) Title: CONTROL UNIT AND METHOD OF OPERATING A FLUID TREATMENT DEVICE

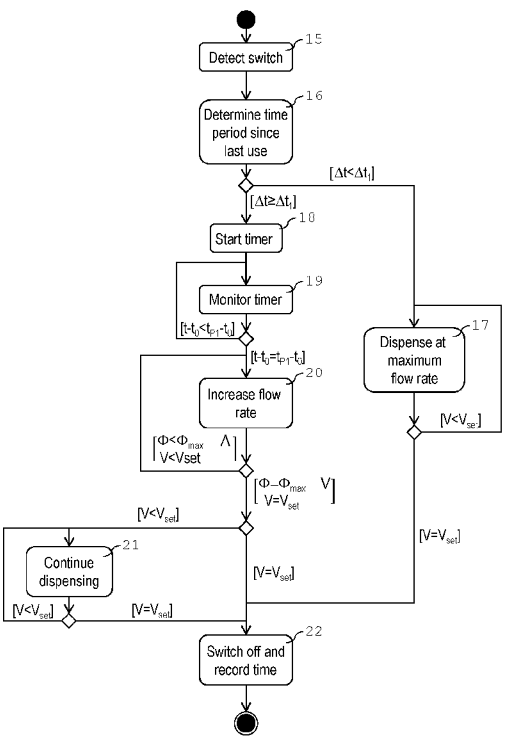

Fig. 3

(57) Abstract: A fluid treatment device (1) includes at least one fluid purification assembly (7) for purifying fluid flowing through the fluid purification assembly (7) to an outlet (10) of the fluid treatment device (1), the fluid purification assembly (7) switchable from and to an operative state in which it is powered to provide a purifying effect; and at least one flow adjustment device (4, 6) for adjusting a rate of flow of fluid through the fluid purification assembly (7). A method of operating the fluid treatment device includes, after a switch of the fluid purification assembly (7) to the operative state, setting the flow adjustment device(s) (4, 6) to establish at a first point in time (t_3,t_9) a rate of flow at a first value, the first value corresponding to a maximum over an interval from the switch of the fluid purification assembly (7) to the operative state to a point in time (t_4) at which the flow of fluid to the outlet (10) is cut off. After the switch of the fluid purification assembly (7) to the operative state, at least if subsequent to the fluid purification assembly (7)'s having been in a state other than the operative state for at least a certain period (Δt_1), settings of at least one of the flow adjustment devices (4, 6)are caused to adjust over a range of values to provide a rate of flow increasing from zero to the first value over a time interval preceding the first point in time.

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Control unit and method of operating a fluid treatment device

The invention relates to a method of operating a fluid treatment device,

the fluid treatment device including:

at least one fluid purification assembly for purifying fluid flowing through the fluid purification assembly to an outlet of the fluid treatment device, the fluid purification assembly switchable from and to an operative state in which it is powered to provide a purifying effect; and

at least one flow adjustment device for adjusting a rate of flow of fluid through the fluid purification assembly, the method including:

after a switch of the fluid purification assembly to the operative state, setting the flow adjustment device(s) to establish at a first point in time a rate of flow at a first value, the first value corresponding to a maximum over an interval from the switch of the fluid purification assembly to the operative state to a point in time at which the flow of fluid to the outlet is cut off.

The invention also relates to a fluid treatment device, including:

at least one fluid purification assembly for purifying fluid flowing through the fluid purification assembly to an outlet of the fluid treatment device, the fluid purification assembly switchable from and to an operative state in which it is powered to provide a purifying effect; and

at least one flow adjustment device for adjusting a rate of flow of fluid through the fluid purification assembly,

wherein the fluid treatment device is configured so that the at least one flow adjustment device is set to establish at a first point in time a rate of flow at a first value, the first value corresponding to a maximum over an interval from the switch of the fluid purification assembly to the operative state to a point in time at which the flow of fluid to the outlet is cut off.

The invention also relates to a control unit for a fluid treatment device.

The invention also relates to a computer program.

FR 2 414 480 discloses a device comprising successively along a water flow channel: a pipe system for connection to a municipal water source, a pressure reducer for reducing the water pressure to a tolerable level, for example 2 bar, an electric valve operating totally or not at all, a filter for retaining particles suspended in the water, a demineralisation cartridge containing ion exchange resin, a sterilisation device and a pipe system equipped with a dispensing outlet. The sterilisation device is of the type that generates ultraviolet radiation, comprising a tubular chamber through which the water to be sterilised passes longitudinally and containing at its centre a tube for generating ultraviolet rays. In order only to allow water to flow when the tube for generating ultraviolet rays is in an operative state, that is to say, to allow it to warm up before the water begins to flow through the chamber, the power supply of a coil of the electric valve is implemented via a timer that guarantees the timing necessary for the tube to warm up.

A problem of the known device is that it takes a relatively long time to draw a quantity of water (e.g. a quantity corresponding to the volume of a glass), unless the flow rate when the electric valve is open is made very high. There is a limit to the maximum rate of flow from a point of user-friendliness and higher maximum rates of flow require a stronger, more expensive lamp.

It is an object of the invention to provide a method, control unit and fluid treatment device of the types defined above in the opening paragraphs that allow a quantity of purified water to be dispensed within an acceptable time interval without requiring a high maximum rate of flow.

This object is achieved according to a first aspect by the method according to the invention, which is characterised by, after the switch of the fluid purification assembly to the operative state, at least if subsequent to the fluid purification assembly’s having been in a state other than the operative state for at least a certain period, causing settings of at least one of the flow adjustment devices to adjust over a range of values to provide a rate of flow increasing from zero to the first value over a time interval preceding the first point in time.

Because the fluid purification assembly is switchable from and to an operative state in which it is powered to provide a purifying effect and is arranged to purify fluid flowing through it, it can be switched to a state other than the operative state when no fluid is being drawn from the fluid treatment device or has been drawn from the fluid treatment device for a certain time period. The electrically powered fluid purification assembly consumes less power in this other state. In particular, it can be switched off to consume no power at all. However, most of these types of fluid purification assembly only reach their maximum purification capacity after a certain start-up time. For example, an ultraviolet light source does not immediately reach its maximum intensity of radiation. Similarly, an ozone generator does not immediately generate ozone at its maximum rate. The degree of purification of the fluid flowing through the assembly is not only dependent on the purification capacity of the fluid purification assembly but also depends on the amount of time the fluid is subjected to the effects of the fluid purification assembly. Rather than wait for the start-up phase to finish, the method according to the invention includes adjusting settings of the flow adjustment device over a range of values to provide a rate of flow increasing from zero to the first value over a time interval preceding the first point in time. Thus, intermediate flow rates are intentionally set during this time interval. The flow rate increases as the fluid purification assembly approaches its normal effectiveness. At the lower flow rates and lower levels of effectiveness, the overall degree of purification is still acceptable. As a consequence, the time required to draw a specific volume of fluid from the fluid treatment device following a switch of the fluid purification assembly to the operative state is shortened without increasing the first value of the flow rate. A further effect is that a user of the fluid treatment device is less likely to wonder whether the fluid treatment device is working at all, because purified fluid is provided at the outlet from an earlier point in time onwards.

It is observed that WO 82/01703 discloses an apparatus for the disinfection of liquids comprising a UV-source for irradiating the liquid, a photocell which reacts on UV-rays, togeth-together with a chamber through which liquid is led and where it is irradiated. A flow meter is coupled to the irradiation chamber. The flow meter is adapted to emit electrical pulses which cooperate with electrical pulses from the UV-photocell. The co-operating electrical pulses from the flow meter and from the photocell are indicated as a radiation dose on a meter. The flow dose meter is adapted via an alarm device to close or throttle a valve on not reaching a predetermined dose. There is no disclosure of adjusting the settings of the valve so as to increase from zero after a switch of a fluid purification assembly to an operative state.

In an embodiment, the settings of the flow adjustment device(s) are adjusted over a range of values to provide a rate of flow increasing continuously between zero and the first value over a time interval preceding the first point in time.

This increases the throughput of treated fluid.

In an embodiment, the time interval preceding the first point in time commences after a further time interval after the switch of the fluid purification assembly to the operative state.

An effect is to have no fluid flowing for the duration of the further time interval, which commences essentially with the switch of the fluid purification assembly to the operative state. This embodiment is based on the recognition that many types of fluid purification assembly will initially not be able to provide any purification effect, regardless of the rate of flow of the fluid through the fluid purification assembly. The risk of insufficiently purified fluid leaving the fluid treatment device is made relatively small in this way.

In an embodiment of the method, the settings of the flow adjustment device(s) are adjusted over a range of values to provide a rate of flow increasing between zero and the first value over a time interval preceding the first point in time only if the switch of the fluid purification assembly to the operative state is subsequent to the fluid purification assembly’s having been in a state other than the operative state for at least a certain period.

This increases the rate of flow of treated fluid in cases in which the fluid purification assembly is immediately ready to operate to full effect. This embodiment is appropriate for use with fluid purification assemblies including devices that must be at a certain temperature to operate fully. Where the last use of the fluid purification assembly was less than the certain period ago, a gradual increase in the rate of flow can be dispensed with. A quantity of treated fluid can be provided within a shorter time interval in this way.

An embodiment of the method includes determining at least one of a starting point of the time interval preceding the first point in time and a point in time within the time interval at which the settings of the flow adjustment device(s) are to have a certain value using a timing mechanism triggered by an event corresponding to the switch of the fluid purification assembly to the operative state.

An effect is that the method can be implemented without the use of sensors to determine the current capacity of the fluid purification assembly for treating fluid. Instead, knowledge of the start-up characteristics of at least a component of the fluid purification assembly is used to adjust the settings to provide the rate of flow appropriate to the current capacity of the fluid purification assembly to treat the fluid.

In an embodiment, the fluid purification assembly includes an irradiation device for irradiating fluid flowing through the fluid purification assembly, in particular an ultraviolet irradiation device.

Examples of such devices are gas discharge lamps and light-emitting semiconductor devices, both of which are characterised by a certain start-up period during which their output is less than the maximum for a given supply of electrical power. Instead of providing no treated fluid at all during the start-up period, fluid is provided at a reduced rate during the start-up period. Moreover, the method makes it possible to shorten the time required to dispense a certain quantity of treated fluid without having to resort to operating the irradiation device in an overdrive mode. This increases the useful life of the irradiation device.

In an embodiment of the method, wherein the fluid treatment device further includes a device containing a fluid treatment medium, the method includes leading fluid flowing through the fluid purification assembly through the device such as to contact the fluid treatment medium.

This allows for two types of treatment, e.g. softening water and killing germs in the water. Because the method allows the maximum flow rate to be lower for a given quantity of fluid to be dispensed, sufficiently long contact between the fluid and the medium is ensured.

In an embodiment of the method, wherein the fluid treatment device is arranged to dispense treated fluid in response to a user command and the fluid purification assembly is arranged to be switched to the operative state in response to the user command, the method includes receiving a signal corresponding to the user command and determining a point in time of the switch to the operative state on the basis of the signal.

This is a simple and effective way of timing the adjustment of the settings of the flow adjustment device.

An embodiment of the method includes receiving a signal from a sensor for measuring a parameter of the fluid purification assembly, wherein the settings of the flow adjustment device(s) are adjusted on the basis of the signal from the sensor.

This embodiment is relatively reliable, because it allows for detecting the state of the fluid purification assembly directly. Moreover, the rate at which the settings of the flow adjustment device are adjusted, and consequently the rate at which the rate of flow of the fluid is caused to increase, can be adapted to the speed at which the fluid purification assembly approaches its fully operative state.

In a variant of this embodiment, the fluid purification assembly is arranged to transform electrical energy into an output with germicidal properties, and the parameter is representative of a rate of delivery of the output.

The parameter can, for example, be a measure of at least one of radiant flux, radiant intensity and/or radiance, optionally within a particular range of the spectrum of electromagnetic radiation, where the device produces electromagnetic radiation with germicidal properties, e.g. short-wave ultraviolet light. The parameter could alternatively be the rate at which ozone is produced, where the device is arranged to produce ozone.

According to another aspect, the fluid treatment device according to the invention is characterised in that it includes a system for adjusting settings of the flow adjustment device(s) over a range of values to provide a rate of flow increasing from zero to the first value over a time interval preceding the first point in time, and is configured to cause the adjustment to be effected after the switch of the fluid purification assembly to the operative state, at least if subsequent to the fluid purification assembly's having been in a state other than the operative state for at least a certain period.

The fluid treatment device will generally be configured to switch the fluid purification assembly from the operative state in dependence on the occurrence of an interruption of a flow of fluid to at least one of the fluid purification assembly and the outlet.

The dependence may be such that the switch from the operative state is only effected after a pre-determined period in which the flows is interrupted has elapsed.

In the new state, the fluid purification assembly is arranged to consume less power than in the operative state, for example none at all, since it need not provide a purifying effect.

The system for adjusting settings of the flow adjustment device(s) over a range of values may be configured such that settings at values corresponding to a rate of flow higher than zero are set independently of a current state of the fluid purification assembly.

This means that closed-loop control based on a parameter of the fluid purification assembly linked to its current output or performance is not used during start-up, making the device relatively simple to implement and inexpensive. Some form of control may be used to determine the first value of the rate of flow, but this value need be adjusted only over longer time periods, so that a simple and relatively slow control loop would suffice.

In an embodiment, the control unit is configured to execute a method according to the invention.

According to another aspect, the fluid treatment device according to the invention includes a control unit according to the invention.

According to another aspect of the invention, there is provided a computer program including a set of instructions capable, when incorporated in a machine readable medium, of causing a system having information processing capabilities to perform a method according to the invention.

The invention will be explained in further detail with reference to the accompanying drawings, in which:

Fig. 1 is a schematic diagram of a device for treating a fluid that includes a fluid purification assembly;

Fig. 2 is a diagram showing the development of the output power of a device included in the fluid purification assembly;

Fig. 3 is a flow chart illustrating a first variant of a method of operating the fluid treatment device of Fig. 1;

Fig. 4 is a flow chart illustrating a second variant of a method of operating the fluid treatment device of Fig. 1; and

Fig. 5 is a schematic cross-sectional diagram of a delay valve for use in a modified version of the fluid treatment device of Fig. 1.

Fig. 1 shows a fluid treatment device 1 for dispensing a purified potable liquid. Drinking water will be used as an example in the following, but the device 1 can in principle be used to treat other types of potable liquid. A variant is conceivable in which the treated liquid is not directly dispensed but first treated further, in particular frozen to produce ice (e.g. ice cubes for chilled beverages).

In the illustrated example, the fluid treatment device 1 includes an inlet port 2 for connection to the water mains and a water tank 3. In a variant, the water tank 3 is dispensed with.

The illustrated fluid treatment device 1 includes a pump 4 for drawing water from the water tank 3. In the illustrated example, the water is pumped out of the water tank 3 through a water treatment cartridge 5 which includes a medium for treating water passing through it. The medium can include an ion exchange material (e.g. a weakly acidic cation exchange material), activated carbon or a similar sorbent, zeolites and particles coated with silver, alone or in any combination. The water treatment cartridge 5 is generally of the replaceable type. It is mechanically connected in a releasable fashion to a socket (not shown) on a bottom wall of the water tank 3. For the treatment by the medium for treating water passing through it to be effective, the rate of flow through the cartridge should not be excessive. Methods of achieving this without making the time required to dispense a given quantity of treated water very long are outlined herein.

In the embodiment of Fig. 1, water is pumped through a valve 6 to a fluid purification assembly 7. The valve 6 is not present in some alternative embodiments of the fluid treatment device 1, just as the pump 4 can be dispensed with if the valve 6 is present and there are alternative means of ensuring that there is sufficient pressure to lead the water through the fluid purification assembly 7.

The fluid purification assembly 7 is in one embodiment of a replaceable type, comprising a cartridge that can be releasably mounted in the fluid treatment device 1 and includes an adapter with inlet and outlet ports for receiving and delivering water, respectively, that co-operate mechanically with ports provided in an adapter mounted in a housing of the fluid treatment device 1. The adapter further includes electrical contacts for supplying power to the fluid purification assembly 7. In the illustrated embodiment, a power supply unit 8 provides electrical power to the fluid purification assembly 7.

The fluid purification assembly 7 includes a device for converting electrical power into an output with germicidal properties to which water flowing through the fluid purification assembly 7 is subjected. In the illustrated embodiment, this device comprises a lamp 9 for emitting short-wave ultra-violet light. This lamp 9 can be a low-pressure lamp of the type arranged to emit light with a wavelength of about 250 nm. Alternatively, the lamp 9 can be a medium-pressure lamp, arranged to emit light in a broader range of wavelengths. As another alternative, the lamp 9 can comprise one or more light-emitting diodes arranged to emit ultraviolet light.

In the illustrated embodiment, water is led through a helical conduit made of material transparent to ultraviolet light, which conduit surrounds the lamp 9. The length of the conduit determines the length of time the water is exposed to the ultraviolet radiation with germicidal properties.

It is observed that an alternative embodiment of the fluid purification assembly includes a device arranged to generate ozone in the water passing through it. The ozone can also be generated with a lamp or it can be generated electrolytically or by means of a gas discharge in air. This device is thus also arranged to transform electrical energy into an output with germicidal properties, namely ozone. In a start-up phase, the rate of production of ozone is lower than a maximum.

The water that has been treated in the fluid purification assembly 7 leaves the fluid treatment device 1 through a dispensing port 10. In an alternative embodiment, the dispensing port 10 is directly comprised in the fluid purification assembly 7. A further valve (not shown) may be provided between the dispensing port 10 and the fluid purification assembly 7 or in the dispensing port 10.

The fluid treatment device as illustrated in Fig. 1 includes a control unit 11 programmed to control the operation of the entire fluid treatment device 1, including the power supply unit 8, pump 4 and valve 6. It receives input signals from user controls 12 which can be as simple as a single button for requesting a quantity of treated water (e.g. corresponding in volume to the volume of a glass). It receives further input signals from one or more sensors. Two are shown here for illustrative purposes, namely a sensor 13 for monitoring the flow of water through the fluid purification assembly 7 and a sensor 14 for determining the value of a parameter representative of the output power of the lamp 9. It is noted that certain methods to be discussed below do not require any of these sensors 13,14.

In use, a user provides a command to dispense a quantity of treated water using the user controls 12. The pump 4 and/or the valve 6 are then operated to dispense this quantity, whereupon at least the valve 6, or another valve (not shown) between the water tank 3 and the dispensing port 10 is closed. Because the lamp 9 consumes electrical power and water is treated as it flows through the water purification assembly 7 , the lamp 9 is switched off when water is not being dispensed.

With reference to Fig. 2, the development of the output power P of the lamp 9 reaching the water in the helical conduit is shown. As can be seen, the lamp 9 generally has a start-up period, during which it has yet to reach its full output power. Thus, as shown in Fig. 2, at a first point in time t_1, the lamp 9 is switched on, and no light is emitted. The power increases until, at a second point in time t_2, it is at a level P_1 sufficient to provide a germicidal effect. At a third point in time t_3, the power is at a second level P_2 corresponding to a level that is sufficient to purify the water to a desired extent when the rate of flow of the water through the fluid purification assembly 7 is at a set maximum, this maximum being determined by the maximum permissible rate of flow through the water treatment cartridge 5 or considerations of user-friendliness, for example. At a fourth point in time t_4, the flow of water is interrupted and the lamp 9 is switched off.

If it is then switched on at a fifth point in time t_5 that is only a short time interval Δt_A removed from the fourth point in time t_4, then the power level will be at or above the second level P_2, so that there is effectively no start-up period. The lamp is switched off again at a sixth point in time t_6. If it is then switched on at a seventh point in time t_7 and there is a relatively large time interval between the sixth point in time t_6 and the seventh point in time t_7, then the power level will progress from the first level P_1 at an eighth point in time t_8 to the second level P_2 at a ninth point in time t_9.

The control unit 11 of the fluid treatment device 1 is arranged to implement a method in which the flow rate is set at a lower level than the maximum during time periods in which the power level is lower than that sufficient to treat the water at the maximum flow rate, i.e. between the second third points in time t_2,t_3 and between the eighth and ninth points in time t_8,t_9.

With reference to Fig. 3, in a first method, the control unit 11 first determines (step 15) the point in time at which the lamp 9 has been switched to an operative state in which it is powered to provide a purifying effect. Several implementations of this step 15 are conceivable.

In a simple embodiment, as shown here, the control unit 11 controls the entire operation of the fluid treatment device 1, and can thus rely on an input from the user controls 12, since it is itself responsible for switching on the power supply to the lamp 9.

Where the method of Fig. 3 is implemented by a separate control unit, the first step 15 can be implemented by relying on a signal from the sensor 14 in the fluid purification assembly that is arranged to provide an output signal representative of the output power of the lamp 9. Alternatively, the sensor 13 for monitoring the flow of water through the fluid purification assembly 7 can be used, in that it is inferred from the fact that water has started to flow or that a pressure drop (a valve in the dispensing port 10 has been opened) or pressure increase (the pump 4 has been switched on) has occurred that the lamp 9 has also been switched on. In yet another embodiment, the power supply to the lamp 9 is monitored directly.

In the illustrated embodiment, it is first determined (step 16) whether the switch of the lamp 9 to the operative state is subsequent to the lamp 9's having been switched off for at least a certain period Δt_1. If not, then the flow rate is immediately set (step 17) to a maximum value appropriate for the second power level P_2 (Fig. 2). In an embodiment in which the flow rate is adjusted by means of the valve 6, the valve 6 is switched to the fully open state essentially immediately.

If it is determined that the lamp has been switched off for at least this minimum period Δt_1, then a timing mechanism is triggered (step 18), to determine the amount of time that has elapsed since the point of time at which the switching of the lamp 9 to the operative state is determined to have occurred. This time period is monitored (step 19) until it is determined that a point in time t_{P1} corresponding to the first power level P_1 has been reached. It will be recalled that this power level P_1 is the minimum level at which the lamp 9 is able to provide a germicidal effect. Up to then, the flow of water is essentially completely interrupted, i.e. the valve 6 remains closed, although the pump 4 may already be started. The method as illustrated relies on a model of the lamp 9 or calibration data to determine the point in time t_{P1}, which is just a stored value. Indeed, depending on the lamp 9 or similar device for transforming electrical energy into an output of germicidal properties, it may be representative of a point in time at which some other characteristic of the output is appropriate to provide a germicidal effect, e.g. the wavelength of the emitted light.

Starting from the point in time t_{P1} corresponding to the stored value, the flow rate through the fluid purification assembly 7 is gradually increased (step 20) by adjusting settings of the valve 6 and/or the pump 4. This is done over a time interval up to a point in time at which the power level corresponds to the level P_2 at which the output of the lamp 9 is sufficient to purify the water to the required extent when the flow rate is at a maximum (e.g. a point in time corresponding to the third point in time t_3 in the diagram of Fig. 2). The length of this time interval can have a pre-determined value or the rate of adjustment of the settings of the valve 6 and/or pump 4 can be pre-set, so that the method requires only a timing signal for its implementation.

Water continues to be dispensed (step 21) at the maximum rate until the required quantity of treated water has been dispensed, whereupon the lamp 9 is switched off and the valve 6 or a further valve (not shown) is closed. The absolute point in time at which this occurs is recorded (step 22) in order to be able to repeat the second step 16 of the method.

Of course, if the required quantity of treated water has been dispensed before the point in time corresponding to the second level P_2 has been reached, then the step 21 of dispensing water at the maximum pre-set flow rate is omitted. The flow rate at the point in time at which the flow of water is cut off becomes the maximum over the time interval from the switch of the fluid purification assembly 7 to the operative state to the point in time at which the flow of fluid is cut off.

An alternative method (Fig. 4) uses the sensor 14 in the fluid purification assembly 7 instead of a timing mechanism in order to determine the settings of the valve 6 and/or pump 4 in the period in which the lamp 9 is not yet operating at full potential.

As in the method of Fig. 3, the fact that the lamp 9 has been switched on is detected (step 23) first. Then (step 24), the time period since the lamp 9 was last switched off is determined. If it is determined that the fluid purification assembly 7 has been in a state other than the operative state for less than a certain period, then the valve 6 and/or pump 4 are adjusted (step 25) to provide the maximum flow rate immediately.

Otherwise, the output of the lamp 9 is monitored (step 26) to determine whether it is at least equal to the first level P_1. Once this level has been reached, the rate of flow of the water through the fluid purification assembly 7 is adjusted (step 27) by altering the settings of the pump 4 and/or the valve 6. This step 27 is implemented using data representative of a relationship between the measured rate of output of the lamp 9 and a maximum flow rate that still provides sufficient purification at that rate of output. Once the flow rate has reached a certain maximum value, the adjustment is stopped. If the required quantity of treated water has not been dispensed yet, then the flow of water continues (step 28). Once the required quantity of treated water has been dispensed, the flow of water is cut off and the absolute point in time is recorded (step 29) to enable the second step 24 to be repeated at the next iteration of the method.

It is noted that a variant of the method is possible in which the first two steps 23,24 are omitted. In that case, the last step 29 is also simplified, and no timekeeping is necessary.

As with the method illustrated in Fig. 3, the flow of treated water commences (albeit at a relatively low rate) at an earlier point in time than would be the case if the flow of water were to be switched on only upon reaching the second power level P_2 of the lamp 9. Thus, the required quantity of water is dispensed within a shorter time period and the user’s patience is not put to too severe a test. During the interval when the power is below the second power level P_2 but still high enough to provide a germicidal effect, the settings of the valve 6 and/or the pump 4 are adjusted to provide a lower rate of flow through the fluid purification assembly 7, so that the water is in any case treated to a sufficient extent.

The fluid treatment device 1 of Fig. 1 can be modified by the addition of a delay valve 30 (Fig. 5). In a variant, the delay valve 30 is situated upstream of the dispensing port 10, which includes a valve (not shown) switchable between an open and a fully closed state.

The delay valve 30 includes an upstream port 31 and a downstream port 32 (from the perspective of the dispensing port 10).

This modified version of the fluid treatment device 1 carries out a method essentially like the one set out in Fig. 3, except that the delay valve is responsible for implementing the step 20 of increasing the flow rate. Assuming that the lamp 9 has been switched off for more than the certain period Δt_1, then a user command to start dispensing will lead to the switching on of the lamp 9. The valve in the dispensing port 10 is not immediately opened. Rather, it is opened after a timer has determined that a pre-determined time interval has elapsed or if the power sensor 14 has determined that the first power level P_1 has been reached.

The switching open of the valve in the dispensing port 10 causes a relatively large pressure drop to be established across the delay valve 30, which has up to then been held closed by a main spring 33 holding a valve element 34 in a valve seat. The valve element 34 includes a stem extending within a cylinder 35 in which a further plunger 36 is arranged. The stem pushes against the plunger 36, which must displace fluid in the cylinder 35 through apertures, causing a delayed opening of the delay valve 30. This arrangement thus forms a system for causing the delay valve 30 to adjust settings of the valve element 34 from a fully closed to a fully open configuration over a certain time interval. The rate of flow of the fluid through the fluid purification assembly 7 increases commensurately. The pressure drop across the delay valve 30 and the resistance provided by the cylinder 35 and plunger 36 determine the rate of increase of the flow rate through the fluid purification assembly 7. They are set so that the rate of increase is sufficiently low to ensure that the flow rates during the later part of the warm-up period of the lamp 9 are low enough to ensure adequate fluid treatment.

When a pre-determined quantity of fluid has been dispensed, the valve in the dispensing port 10 is closed. The main spring 33 returns the valve element 34 into the valve seat more or less instantly, because the stem of the valve element is hollow and provided with lateral apertures. A secondary spring 37 moves the plunger 36 back more slowly.

The invention is not limited to the embodiments described above, which can be varied within the scope of the accompanying claims. For example, it is possible to implement the methods outlined herein within a fluid purification assembly 7, which is itself also a fluid treatment device, provided with its own control unit and, for example, a valve 6 and a sensor. In such an embodiment, the switching on and off of the lamp 9 or other device in the fluid purification assembly would be governed by the control unit 11 of the fluid treatment device 1 containing the fluid purification assembly 7, but the flow of water through the fluid purification assembly 7 would be throttled during a certain interval in the course of the start-up period. The first step 15,23 could be implemented using the sensor to detect e.g. a pressure drop or increase, the first output of the lamp 9 or the start of supply of power to the lamp 9.

The fluid purification assembly need not necessary be a self-contained unit with its own housing. It can be any assembly of components accommodated with a housing of the fluid treatment device.

LIST OF REFERENCE NUMERALS

1	-	Fluid treatment device
2	-	Inlet port
3	-	Water tank
4	-	Pump
5	-	Water treatment cartridge
6	-	Valve
7	-	Fluid purification assembly
8	-	Power supply unit
9	-	Lamp
10	-	Dispensing port
11	-	Control unit
12	-	User controls
13	-	Fluid sensor
14	-	Power sensor
15	-	Step (Detect switch)
16	-	Step (Determine time period since last use)
17	-	Step (Dispense at maximum flow rate)
18	-	Step (Start timer)
19	-	Step (Monitor timer)
20	-	Step (Increase flow rate)
21	-	Step (Continue dispensing)
22	-	Step (Switch off and record time)
23	-	Step (Detect switch)
24	-	Step (Determine time period since last use)
25	-	Step (Dispense at maximum flow rate)
26	-	Step (Monitor output)
27	-	Step (Adapt flow rate)
28	-	Step (Continue dispensing)
29	-	Step (Switch off)
30	-	Delay valve
31	-	Upstream port
32	-	Downstream port
33	-	Main spring
34	-	Valve element
35	-	Cylinder
36	-	Plunger
37	-	Secondary spring

CLAIMS

1. Method of operating a fluid treatment device (1), the fluid treatment device (1) including:

at least one fluid purification assembly (7) for purifying fluid flowing through the fluid purification assembly (7) to an outlet (10) of the fluid treatment device (1), the fluid purification assembly (7) switchable from and to an operative state in which it is powered to provide a purifying effect; and

at least one flow adjustment device (4,6) for adjusting a rate of flow of fluid through the fluid purification assembly (7), the method including:

after a switch of the fluid purification assembly (7) to the operative state, setting the flow adjustment device(s) (4,6;30) to establish at a first point in time (t_3,t_9) a rate of flow at a first value, the first value corresponding to a maximum over an interval from the switch of the fluid purification assembly (7) to the operative state to a point in time (t_4) at which the flow of fluid to the outlet (10) is cut off, **characterised by,**

after the switch of the fluid purification assembly (7) to the operative state, at least if subsequent to the fluid purification assembly (7)'s having been in a state other than the operative state for at least a certain period (Δt_1), causing settings of at least one of the flow adjustment devices (4,6;30) to adjust over a range of values to provide a rate of flow increasing from zero to the first value over a time interval preceding the first point in time.

2. Method according to claim 1,

wherein the time interval preceding the first point in time (t_3,t_9) commences after a further time interval after the switch of the fluid purification assembly to the operative state.

3. Method according to claim 1 or 2,

wherein the settings of the flow adjustment device(s) (4,6;30) are adjusted over a range of values to provide a rate of flow increasing between zero and the first value over a time interval preceding the first point in time (t_3,t_9) only if the switch of the fluid purification assembly (7) to the operative state is subsequent to the fluid purification assembly (7)'s having been in a state other than the operative state for at least a certain period (Δt_1).

4. Method according to any one of the preceding claims, including

determining at least one of a starting point (t_2,t_8) of the time interval preceding the first point in time (t_3,t_9) and a point in time within the time interval at which the settings of the flow adjustment device(s) (4,6) are to have a certain value using a timing mechanism triggered by an event corresponding to the switch of the fluid purification assembly (7) to the operative state.

5. Method according to any one of the preceding claims,

wherein the fluid purification assembly (7) includes an irradiation device (9) for irradiating fluid flowing through the fluid purification assembly (7), in particular an ultraviolet irradiation device.

6. Method according to any one of claims 1-5,

wherein the fluid treatment device (1) further includes a device (5) containing a fluid treatment medium, the method including leading fluid flowing through the fluid purification assembly (7) through the device (5) such as to contact the fluid treatment medium.

7. Method according to any one of the preceding claims,

wherein the fluid treatment device (1) is arranged to dispense treated fluid in response to a user command, and

wherein the fluid purification assembly (7) is arranged to be switched to the operative state in response to the user command, the method including receiving a signal corresponding to the user command and determining a point in time (t_1,t_5,t_7) of the switch to the operative state on the basis of the signal.

8. Method according to any one of claims 1-6, including receiving a signal from a sensor (14) for measuring a parameter of the fluid purification assembly (7), wherein the settings of the flow adjustment device(s) (4,6;30) are adjusted on the basis of the signal from the sensor (14).

9. Method according to claim 8,

wherein the fluid purification assembly (7) is arranged to transform electrical energy into an output with germicidal properties, and wherein the parameter is representative of a rate of delivery of the output.

10. Fluid treatment device (1), including:

at least one fluid purification assembly (7) for purifying fluid flowing through the fluid purification assembly (7) to an outlet (10) of the fluid treatment device (1), the fluid purification assembly (7) switchable from and to an operative state in which it is powered to provide a purifying effect; and

at least one flow adjustment device (4,6;30) for adjusting a rate of flow of fluid through the fluid purification assembly (7),

wherein the fluid treatment device is configured so that the at least one flow adjustment devices (4,6;30) is set to establish at a first point in time (t_2,t_9) a rate of flow at a first value, the first value corresponding to a maximum over an interval from the switch of the fluid purification assembly (7) to the operative state to a point in time (t_4) at which the flow of fluid to the outlet (10) is cut off, **characterised in that**

the fluid treatment device includes a system (11; 33,35,36,37) for adjusting settings of the flow adjustment device(s) (4,6;30) over a range of values to provide a rate of flow increasing from zero to the first value over a time interval preceding the first point in time (t_2,t_9) ,

and is configured to cause the adjustment to be effected after the switch of the fluid purification assembly (7) to the operative state, at least if subsequent to the fluid purification assembly (7)'s having been in a state other than the operative state for at least a certain period (Δt_1).

11. Control unit for a fluid treatment device (1) according to claim 10, the control unit including:

an interface to at least one of the flow adjustment devices (4,6) for adjusting settings of the flow adjustment device(s) (4,6) to adjust the rate of flow;

an interface to a device (12,13,14) enabling the control unit to determine an occurrence of an event linked to a switch of the fluid purification assembly (7) to the operative state, wherein the control unit is configured to execute a method according to any one of claims 1-9.

12. Computer program including a set of instructions capable, when incorporated in a machine readable medium, of causing a system having information processing capabilities to perform a method according to any one of claims 1-9.

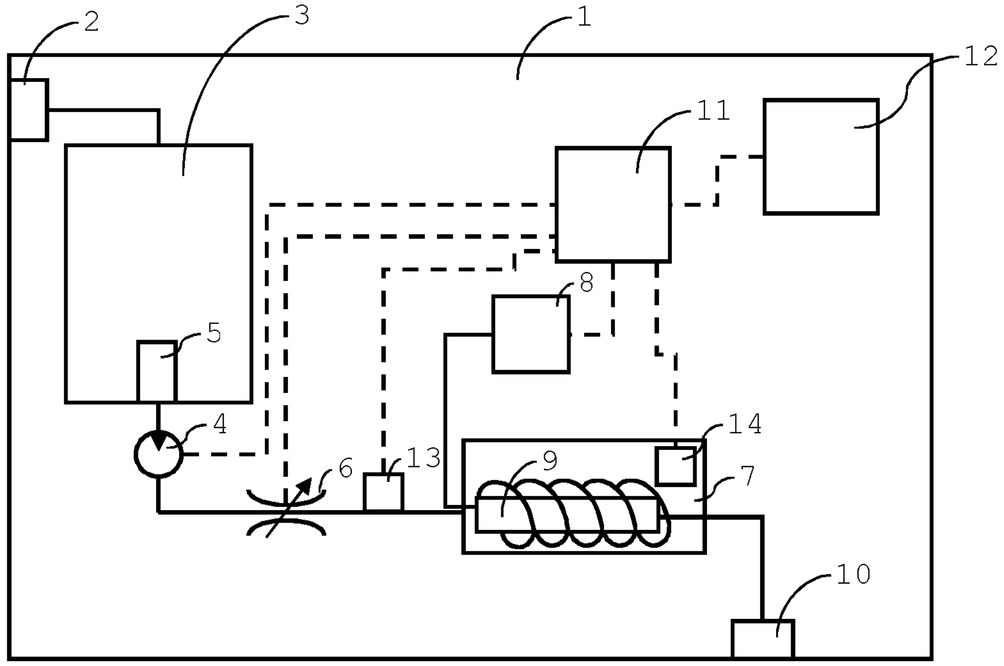

Fig. 1

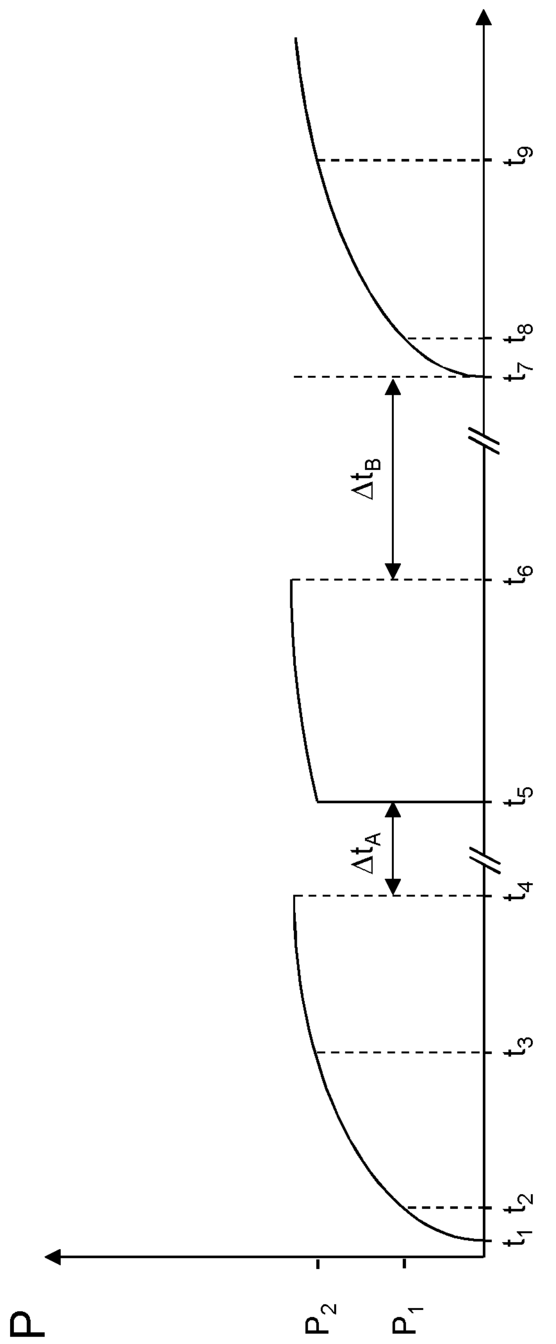

Fig. 2

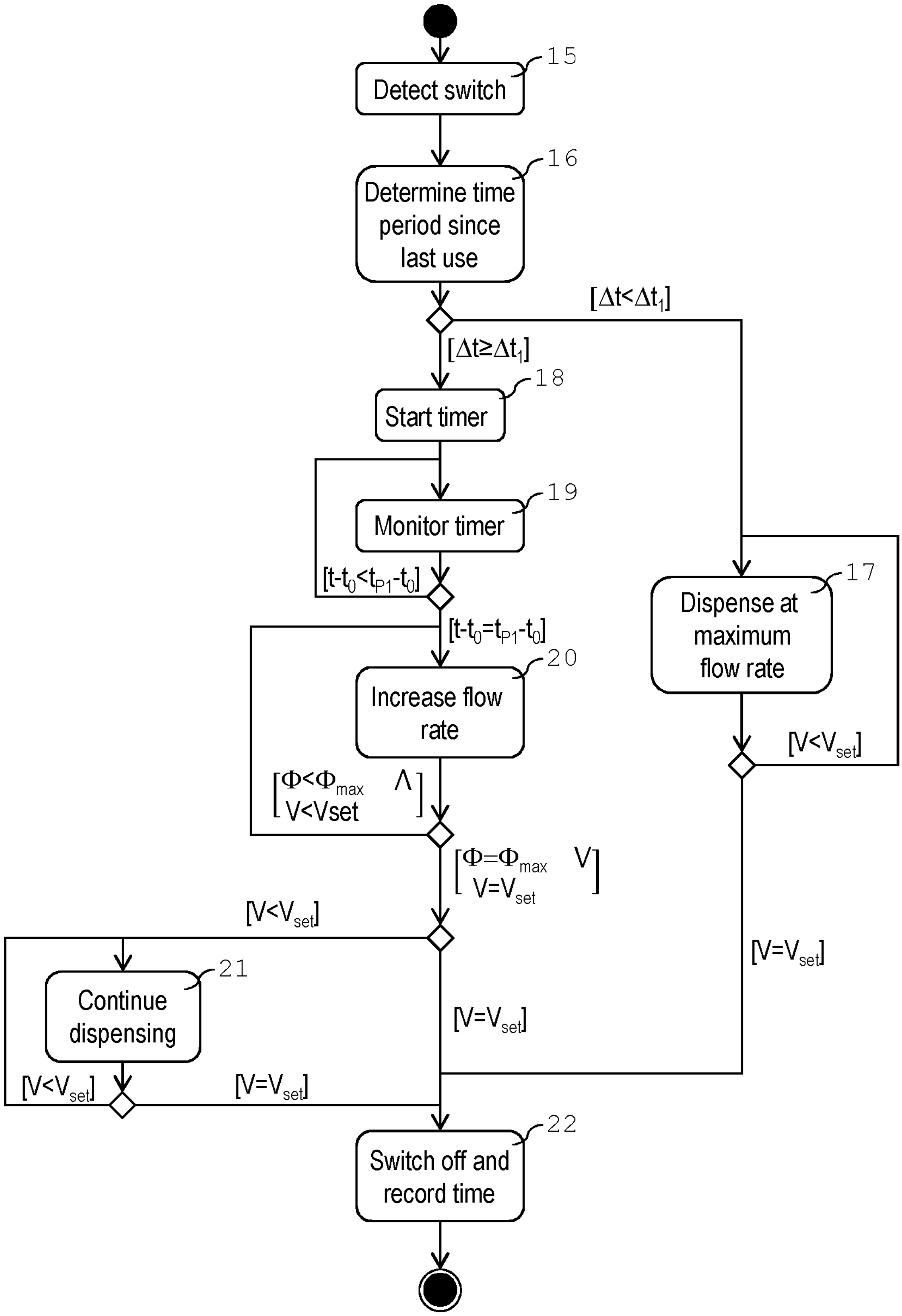
Detect switch
15
Determine time period since last use
16
[Δt<Δt1]
[Δt≥Δt1]
Start timer
18
Monitor timer
19
[t-t0<tP1-t0]
[t-t0=tP1-t0]
Increase flow rate
20
Dispense at maximum flow rate
17
[V<Vset]
[Φ<Φmax Λ V<Vset]
[Φ=Φmax V V=Vset]
[V<Vset]
[V=Vset]
Continue dispensing
21
[V=Vset]
[V<Vset]
[V=Vset]
Switch off and record time
22

Fig. 3

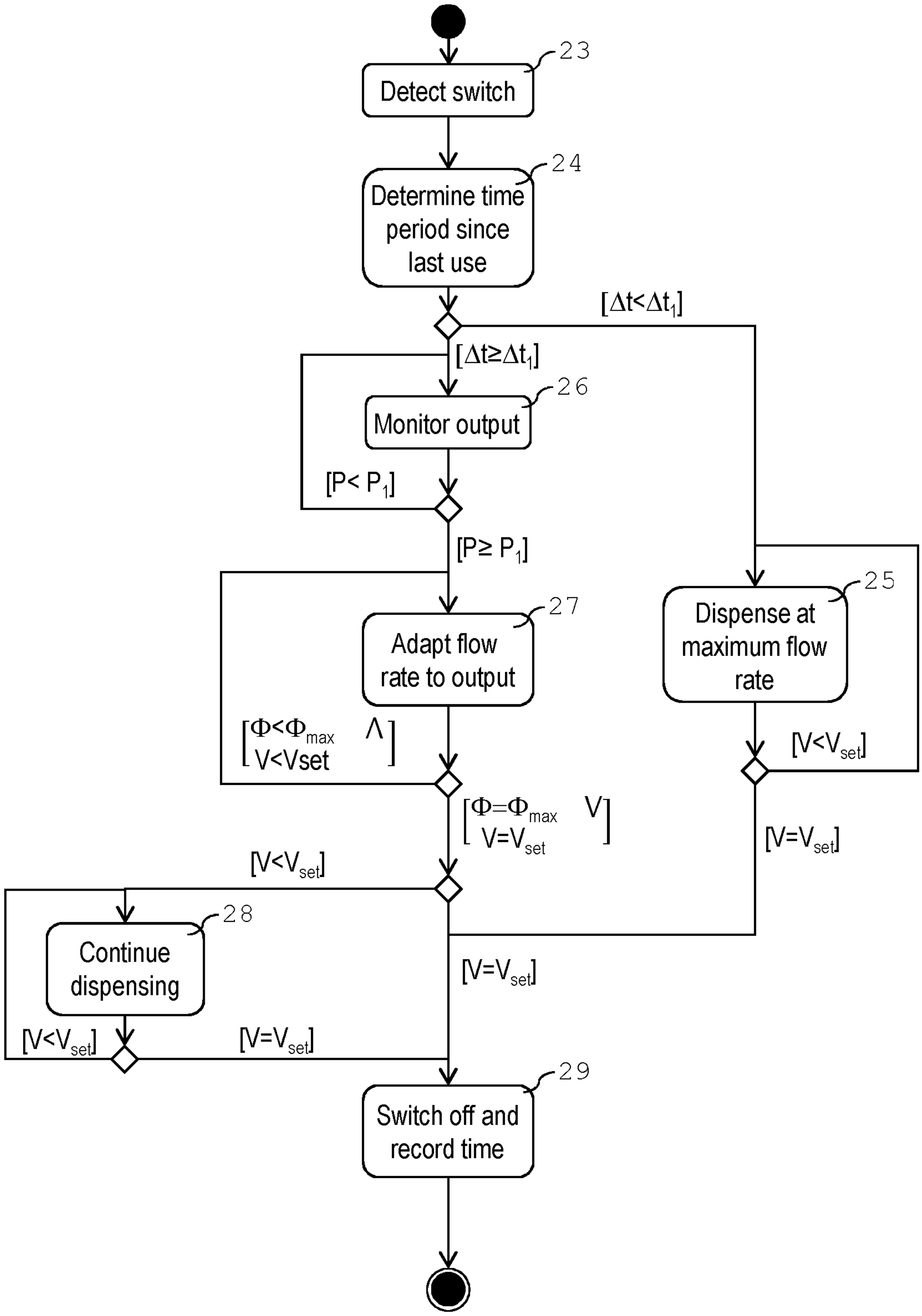
23
Detect switch
24
Determine time period since last use
[Δt<Δt1]
[Δt≥Δt1]
26
Monitor output
[P< P1]
[P≥ P1]
27
Adapt flow rate to output
25
Dispense at maximum flow rate
[Φ<Φmax Λ V<Vset]
[Φ=Φmax V V=Vset]
[V<Vset]
[V=Vset]
[V<Vset]
28
Continue dispensing
[V=Vset]
[V<Vset]
[V=Vset]
29
Switch off and record time

Fig. 4

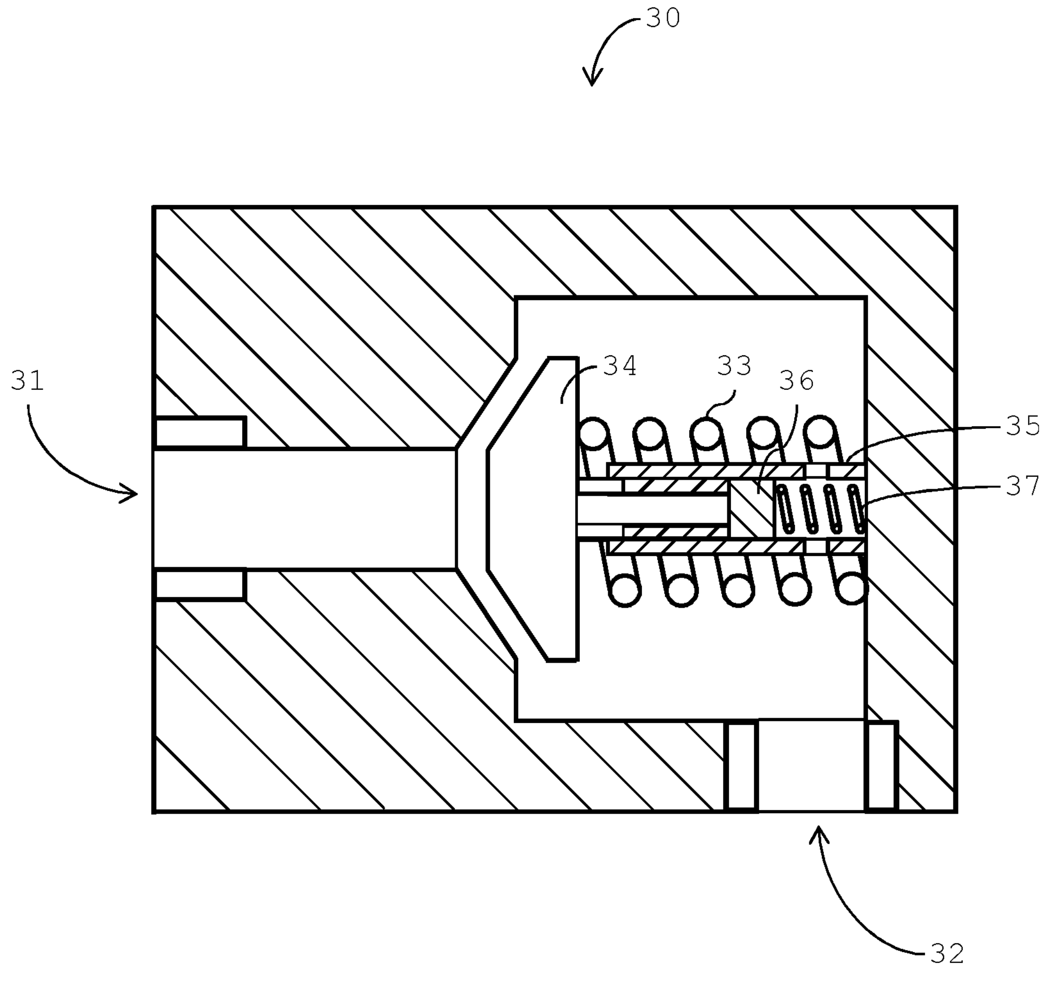

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/057005

A. CLASSIFICATION OF SUBJECT MATTER
INV. C02F1/00 C02F1/32 B01J4/00 B01J19/00
ADD. C02F1/78

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C02F B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

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Y	claims 1-8; figure 1	1-12
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Y	paragraph [0078]; claims 1-21; figures 1-4	1-12
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Y	claims 1,10,11,20,26,27,29,30,32,41,58,64	1-12
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Y	claims 1-3,11,15,19,22	1-12
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 July 2013	18/07/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Van Iddekinge, R

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Y	column 4, line 44 - column 5, line 10 column 6, line 11 - column 6, line 30; claims 1,4; figure 4	1-12
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Y	paragraphs [0023] - [0031], [0046] - [0049]; claims 1-8; figure 1	1-12
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Y	page 3, line 11 - page 4, line 8; claims 1-4; figure 1	1-12
Y	FR 2 414 480 A1 (HYCO & AULAS ETS [FR] HYCO & AULAS ETS) 10 August 1979 (1979-08-10) cited in the application claims 1-10	1-12

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International application No
PCT/EP2013/057005

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