

Description

Field of the Invention

This invention relates to fluid purification systems and more particularly to fluid purification systems incorporating fluid exposure to both ultraviolet radiation and filtration, and also to a liquid sterilization system.

Description of the Prior Art

In an attempt to provide high quality, potable drinking water, various treatment systems have been developed. Many such systems employ activated carbon filters, as a common treatment to remove odor, improve taste, and remove chemicals, such as chlorine and chloroforms. However, carbon is a nutrient source that supports bacteria life and growth. As a result, unless these filters are replaced frequently, the filters themselves provide a breeding ground for bacterial contamination. This bacteria is spread to the consumer as the water flows through the filter, picking up the bacterial contamination and delivering the bacteria to the user.

It has been found that activated charcoal filters are so conducive to bacterial growth that filters not routinely replaced may provide more bacterial contamination to the water than the unfiltered water itself. In addition, the bacteria tend to occupy many of the absorptive sites in the filter, reducing the filter's absorptive capacity and rendering the filter ineffective for its intended purpose of purifying the water.

It is well known that exposure of water to ultraviolet radiation kills microorganisms and bacteria carried by the water. For this reason, many conventional purification systems employ an ultraviolet sterilization unit in series with a filtration unit

For example, US-A- 3 550 782 discloses a liquid purification system having the features set out in the first part of claim 1 and comprising a pair of parallel water carrying tubes and a string of ultraviolet bulbs located between the tubes. A reverse osmosis unit is connected in series between the tubes, so that the liquid flowing through the tubes is exposed to ultraviolet radiation both upstream and downstream of the reverse osmosis unit. US-A- 3 550 782 states that the destruction of bacteria upstream of the reverse osmosis unit is desirable in order to protect the membrane of the unit against the accumulation of live bacteria. After having been exposed to ultraviolet radiation for the second time (i.e. downstream of the reverse osmosis unit) the filtered and sterilized liquid (water) is conducted to a large storage tank, from which

water is drawn on demand.

This known liquid purification system may be suitable for some applications, but is impractical for home, domestic use.

First, the tank used in the known system may act as a further breeding ground for microorganisms and bacteria, especially if the water remains in the tank for any extended period of time. The tank is connected to the faucet or water outlet, and bacteria may enter the tank through the faucet. To counter this and to destroy the bacteria and microorganisms entering the tank, US-A- 3 550 782 describes to produce ozone by means of the ultraviolet source and to introduce the ozone into the storage tank. But the generation of ozone and its use for destroying microorganisms and bacteria is not desirable for domestic use because any leakage of the system might result in escaping of ozone which is dangerous for the health of the user. Furthermore, unless the tank is pre-sterilized prior to its use, or sterilized periodically during use (which would be an almost impossible task for the consumer to undertake), any water fed to the tank from the sterilizer unit would quickly become contaminated with bacteria.

Second, the known system employs straight-line liquid flow tubes adjacent to the string of ultraviolet bulbs. Such a straight-line configuration is impractical for installation in a private residence.

Size constraints of a home installed purification system are of paramount importance. A purification system for use in a private residence should be a compact unit, easily installable by the consumer, within a kitchen sink cabinet or a bathroom vanity, for example.

The storage tank of the system disclosed in US-A- 3 550 782 requires an inordinate amount of space. Furthermore, if the storage tank were omitted from the system and the water was drawn on demand directly from the downstream tube, each tube would necessarily be of such length that it would be impractical to install the system in a private home.

In addition, the system disclosed in US-A- 3 550 782 is not maximally effective in sterilizing the water and maintaining the reverse osmosis filtration unit in a bacteria free state. This is believed to be due to the straight-line path of the water through the flow tubes, which provide no turbulence to the water flow.

US-A-4 151 085 discloses a liquid purification system with a series of germicidal radiation units each of which including an elongated emitting tube member, with fluid-flow controlling conduit means adjacent to the ultraviolet radiation tube member. These fluid-flow controlling conduit means are designed as a channel in form of an annular space surrounding the respective tube member. The fluid

enters said space at one axial end thereof, passes through said space along the entire length of the elongated emitting tube member and leaves the annular space at its opposite axial end.

The system inlet of this known liquid purification system is followed immediately by a filter unit providing an open entry area for microorganisms, bacteria and the like. Furthermore the final stage of this known system includes a mechanical filter from which the clean water output is taken, again providing an entry at the system outlet for bacteria, microorganisms etc. On first hooking up a system of this type the level of bacteria and microorganisms might initially be considered acceptable, but might be excessive after a period of time which would be the result of input and output filters being unprotected and allowing continued and uncontrolled growth of bacteria and microorganisms in them. Moreover, the system according to US-A-4 151 085 is neither compact in design, nor easy in installation and is of relatively expensive construction, therefore this known system would be impractical to be installed in a private home.

US-A-3 894 236 describes a liquid sterilization system comprising a single elongated ultraviolet radiation emitting tube with a pair of tubular liquid conduits being transparent to ultraviolet radiation and being helically coiled in paired manner about the ultraviolet radiation emitting tube for passage of fluid about the periphery of that said tube. But the flow channels are located in the middle portion of the axial extension of the elongated tube only. This known system has relatively large dimensions and is complicated in construction. The inlet of each of both tubular conduits is paired with the inlets for the other conduit and both inlets are located at the same axial side of the tube, which applies also for the arrangement of the conduit outlets. Due to the flattened tubes used therein for the several paths of the liquid flow, this known system is very ineffective in the transmission of liquid for in-house use.

Objects and Summary of the Invention

It is a principal object of the present invention to provide a liquid purification system of improved efficiency, which permits a small and compact design and is inexpensive in construction as well as in operation. Particularly the invention is intended to provide a water purification system which is capable of providing high quality, purified, potable water substantially free of all living microorganisms as well as free of substantially all particulate matter and undesirable chemicals, which is easily installed for domestic use and constructed for maximum water purification in a minimum-sized unit.

The above object can be achieved by a fluid purification system which comprises the features

set out in Claim 1.

The circuitous path of the fluid flowing through the spirally wound conduits creates a turbulent flow, which ensures exposure of all of microorganisms carried by the water to ultraviolet radiation. Furthermore, spirally winding the conduits allows them to be tightly packed, which decreases the overall length of the ultraviolet tube required for sufficient exposure. Thus, the fluid purification system of the present invention assures that the water entering the filter is maximally exposed to ultraviolet radiation prior to filtration, as well as being maximally exposed to ultraviolet radiation a second time, after passage through the filter, immediately prior to delivering the fluid directly to the user. It has been found that the configuration described above provides a water purification system which overcomes many disadvantages inherent in conventional purification systems, and attains a water delivery system capable of producing dependable, continuous, reliable potable water, virtually free of all bacteria, live microorganisms, inorganic particulate matter, organic matter, chemicals, and odor. In addition, the system is equally useful for all fluids in which contaminant purification is sought.

The present invention attains maximum ultraviolet radiation exposure with the equipment being held to the minimum size. As a result, a system capable of providing high quality, potable water, or other fluid, virtually free of bacteria, particulate, and chemicals is attained, with its overall size being sufficiently small to be easily positioned and mounted in any domestic situation in direct association with any desired water faucet or other fluid source.

The fluid purification system of this invention continuously produces potable water for immediate use, both consistently and for longer time intervals than obtained with conventional systems.

By employing this invention, it has been found that the filter is isolated from bacterial contamination since both its inlet and outlet ports are connected directly to the ultraviolet radiation exposure zones and that bacterial growth in the filter medium is virtually eliminated. It is believed that the present invention completely eliminates the food supply for the microorganisms in the filter medium, and a filter previously contaminated by bacteria or other microorganisms will eventually be completely cleaned of all live microorganisms.

In the present invention, the fluid flowing through the system is exposed to ultraviolet radiation prior to entering the filtration zone. This kills most, if not all, live microorganisms in the fluid prior to their reaching the filter.

Furthermore, upon exiting the filter, a second exposure of ultraviolet radiation is provided. In this way, any microorganisms which may have passed

through the first exposure or which have been retained in the filter medium are killed prior to delivery of the fluid for use or consumption.

In addition, passage of airborne microorganisms into the filter medium entering through the fluid delivery port is prevented, since all bacteria or microorganisms would have to pass through the ultraviolet radiation prior to reaching the filtration zone. Consequently, the food supply for any microorganisms retained in the filter zone is cut off, due to the dual exposure of ultraviolet radiation, and the filter medium is maintained substantially bacteria free. As the inventive system requires no storage tank because its outlet is directly connected to an outlet faucet or portal, there is also no need to specifically produce ozone to kill contamination entering such storage tank.

A preferred feature of the invention is the modularization of the purification system of this invention into a sterilization section and a filtration section. In this way, additional sterilization sections and additional filtration sections can be combined in any desired configuration to customize a purification system for various unique situations.

For example, if specific microorganisms, such as giardia lamblia, which are resistant to ultraviolet radiation, were known to be contaminating the water supply, additional sterilization sections would be added to the purification system to provide the necessary ultraviolet exposure to assure that a high quality potable water product is attained. Similarly, if particular toxic chemicals were known to be in the water supply, additional filter sections would be added to the purification system to remove these toxic chemicals and provide the desired high quality potable water.

The invention also relates to a liquid sterilization system the features of which being set out in Claim 19.

This inventive sterilization system has an extremely compact construction which not only reduces the possibility of entry of contamination into the system but furthermore reduces markedly the overall size and cost of the system. This liquid sterilization system can easily be placed underneath the sink of a typical household kitchen and enables the cost of the system to be low enough so that it can be reasonably priced in the consumer market. Only one single ultraviolet bulb needs occasional replacement in the inventive system. The simplicity and elegance of the system according to the invention lends itself to a construction where it is almost impossible to break the integrity of the fluid path of the system in such a way as to result in system contamination and where the overall reliability of the system is substantially enhanced.

The use of one single elongated emitting tube member as ultraviolet radiation source as well as

the provision of first and second flow channels peripherally surrounding substantially the entire length of the elongated emitting tube member assure a very compact construction, simplicity and economy of operation and a very effective purification of the liquid.

Preferred features of the invention are set out in the subclaims.

Preferred forms of the water purification system, as well as other objects, features and advantages of this invention, will become apparent from the following detailed description of illustrative embodiments thereof, which is to be read in connection with the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a perspective view, partially broken away, showing one preferred form of the fluid purification system of this invention.

Fig. 2 is a side elevational view of the sterilizer section of the fluid purification system shown in Fig. 1, with the side cover removed therefrom.

Fig. 3 is a bottom plan view of the sterilizer section of the fluid purification system shown in Fig. 1.

Fig. 4 is a side elevational view, partially broken away, showing the filter section of the fluid purification system shown in Fig. 1.

Figs. 5, 6 and 7 are schematic views showing various structural arrangements in which the modularized fluid purification system of this invention can be employed.

Figs. 8 and 9 are schematic, cross-sectional views showing alternate configurations for the fluid flow-controlling conduit means employed in the fluid purification system of this invention.

Detailed Description of preferred Embodiments

In Fig. 1, one preferred embodiment of fluid purification system 20 of the present invention is shown. In this embodiment, system 20 comprises a sterilization section 21 and a filter section 22.

Sterilization section 21 incorporates a housing 25 in which an elongated, ultraviolet radiation producing tube 26 is securely mounted and connected to electronic control means (not shown) to assure continuous production of ultraviolet radiation. In addition, in this preferred embodiment, fluid flow-controlling conduit means 27 are arcuately coiled about elongated tube 26 in juxtaposed, spaced radiation receiving relationship therewith. As will be described in more detail, conduit means 27 includes first and second ultraviolet radiation transmissible portions, which define first and second flow channels, respectively, for the passage of the fluid in tortuous paths about the periphery of tube

26, and which further define a fluid inlet and a fluid outlet for each of the first and second flow channels. Conduit means 27 controls the fluid flow about tube 26 and assures that the fluid flowing therethrough receives the requisite exposure to ultraviolet radiation.

Preferably, a radiation reflective shield 28 peripherally envelopes conduit means 27, in order to maximize the effectiveness of the ultraviolet radiation as well as prevent or reduce the radiation reaching the outside area. Typically, due to its ease of installation, any reflective material which comprises a cylindrical shape or is easily formed into a cylindrical shape is used for shield 28.

In the embodiment depicted in Figs. 1 and 4, filter section 22 incorporates a housing 30, in which filter means 31 is securely retained and positioned. Furthermore, housing 30 incorporates bracket means 32, to securely affix filter section 22 to sterilizer section 21.

As is more fully detailed below, depending upon the particular contamination contained in the fluid being purified, filter means 31 comprises one or more of the following filter elements -- particulate matter filtration, odor filtration, organic chemical filtration, etc. Typically, filter means 31 comprises an activated charcoal filter to improve water taste by removing undesirable chemicals and suspended particles. However, any other type of filter may be employed, either individually or in combination, in order to satisfy any particular requirement.

As depicted in Figs. 1, 2 and 3, one preferred embodiment of fluid flow controlling conduit means 27 comprises two, transparent substantially equal length tube members 33 and 34, each of which are spirally wound about elongated, ultraviolet radiation producing tube 26 in direct, juxtaposed, spaced facing relationship therewith, extending along substantially the entire length thereof. Preferably, the tube members 33 and 34 are interleaved with each other, with each coil of tube member 33 being adjacent to a coil of tube member 34. Although alternate configurations for the fluid carrying conduit means 27 are shown in Figs. 10 to 15 and will be described in detail, the arcuately coiled embodiment depicted in Figs. 1 and 2 is preferred for maximizing the exposure of the fluid travelling through the conduit means to ultraviolet radiation, using a minimum tube length and a minimum overall system size.

Another principal aspect of the present invention is the construction of fluid purification system 20 with one of the two portions of the fluid flow controlling conduit means 27 being employed to carry the fluid entering the system through a first exposure to ultraviolet radiation, followed immediately by passage of the fluid through filter 31 of

filtration section 22. In addition, once the fluid has passed through filter 31, the fluid enters the other portion of the fluid flow controlling conduit means 27 for a second ultraviolet radiation exposure. Once this second exposure is completed, the purified fluid is delivered directly to the outlet faucet or portal for immediate use.

In Figs. 1, 2, 3 and 4, this preferred construction is shown with tube means 33 receiving the input fluid flow through portal/fitting 35 and controllably carrying the fluid about the arcuately coiled flow path defined thereby, assuring that the fluid flowing therethrough is continuously exposed to the ultraviolet radiation emanating from tube 26. Upon reaching portal/fitting 36, which is the output of tube means 33, the fluid is carried through a connecting tube 46 to filter input portal/fitting 37.

Once the fluid has thoroughly circulated through filter means 31 of filter section 22, the filtered fluid is delivered to portal/fitting 38, and delivered therefrom to portal/fitting 44, which is the input portal to tube means 34. Preferably, exit portal/fitting 38 of filter section 22 and input portal/fitting 44 of tube means 34 are constructed for mating engagement. However, interconnecting tube means may be employed if desired.

Once in tube means 34, the fluid advances through the arcuately coiled flow path defined by tube means 34, wherein the fluid is exposed to the ultraviolet radiation a second time, as the fluid again arcuately flows along the length of elongated ultraviolet radiation tube 26, continuously advancing while simultaneously peripherally circulating thereabout. Once the fluid has passed through tube means 34, the fluid exits through portal/fitting 39 for direct delivery to the user.

Preferably, the purified fluid exiting portal 39 is delivered directly to a faucet or other suitable means for immediate use. By eliminating the need for a storage or holding tank, such as used in the apparatus disclosed in US-A-3 550 782, wherein bacterial contamination would flourish, the purity of the fluid delivered to the user of the present invention is assured.

It has been found that by employing the present invention, purified fluid is obtained which is substantially free of all bacteria, organic contaminants, particulates, odors, and other common, undesirable contaminants. Furthermore, it has been found that by employing the purification system 20 of this invention, filter longevity is attained and contamination and bacterial breeding in the filter is virtually eliminated.

In order to determine the overall size that the fluid purification system of the present invention must be to attain a purified fluid, substantially free of all live microorganisms, several factors must be considered. First of all, the flow rate of the fluid

passing through the system must be established and, secondly, for the given flow rate, the total amount of ultraviolet radiation exposure required must be established.

In determining the ultraviolet radiation exposure required, the type of fluid to be purified and the microorganisms commonly found in that fluid are established. For this analysis, typical drinking water has been selected as the fluid, with the water containing contaminants typically encountered with drinking water. However, the resistance of various microorganisms found in drinking water must be known.

In general, most bacteria are killed by exposures to ultraviolet radiation ranging between about 16,000 and 20,000 microwatt seconds per square centimeter. In addition, viruses commonly found in drinking water supplies are killed by ultraviolet radiation exposures ranging between about 6,000 and 40,000 microwatt seconds per square centimeter. Mold spores require up to 60,000 microwatt seconds per square centimeter in order to be killed, while parasites may require up to 200,000 microwatt seconds per square centimeter or more of ultraviolet radiation before such parasites are killed. In view of these statistical averages, a design objective of 90,000 microwatt seconds per square centimeter was established as the total ultraviolet radiation exposure to which the water passing therethrough should be exposed. However, if desired, a higher exposure can be attained in a variety of ways, such as reducing the flow rate or adding sterilizing sections, as detailed herein.

With this exposure rate established the water flow rate was determined. Since a flow rate of 3.785 litres, (one gallon) per minute is practical for most domestic water sources, this rate was employed to establish the overall size of sterilization section 21 of fluid purification system 20.

Using these criteria, along with the known output of ultraviolet radiation producing tubes, it was found that each tube member 33 and 34 should have a length of at least 1.83 meters (6 feet) with a cross-sectional area of about 1.29cm² (0.2 square inches). With these design goals in mind, it was established that an ultraviolet radiation producing tube having an overall length of 38.1 cm (15 inches), with an illuminated area of about 34.3 cm (13.5 inches), provided the desired axial length for accommodating the preferred lengths of interleaved, spirally wound tube members 33 and 34.

As shown in Figs. 1, 2 and 3, the preferred embodiment of sterilizing section 21 of fluid purifying system 20 also incorporates tube supporting walls 40 and 41, which peripherally surround and supportingly retain a portion of the mounting ends 42 of ultraviolet radiation producing tube 26. As is well known in the art, ends 42 of tube 26 incor-

porate prong contacts extending therefrom, which are interconnected with support plugs 43 mounted to housing 25, providing the required electrical connection.

In addition, in this preferred embodiment, front wall 45 is removably attached to housing 25 by screw means. In this way, wall 45 can be easily removed, whenever necessary in order to change ultraviolet radiation producing tube 26. Once wall 45 has been disconnected from housing 25, one end of tube 26 is automatically disconnected and can be quickly and easily removed from supporting engagement with walls 40 and 41 and then replaced by a new tube. In this way, the efficient operation of sterilization section 21 of this invention can be easily maintained.

If desired, housing 25 may incorporate a removable side wall panel 52. In this way, access to the interior of housing 25 would be easily attained.

In the preferred embodiment, all of the electronics required to operate sterilizing section 21 are mounted directly below housing 25, preferably nested within supporting bracket assembly 47. As shown in Figs. 2 and 3, included within bracket assembly 47 is a transformer 48 which controls the requisite voltage output for properly driving the ultraviolet radiation producing tube 26. In addition, fuse means 49 and an on/off power control switch 50 are included. Any other desired electronics could be incorporated in this zone, including such other optional items as light means (not shown) for providing a positive illumination indication that the system is turned on and properly powered.

Bracket assembly 47 is mounted to the lower wall of housing 25 of sterilizer section 21. In the preferred embodiment, bracket assembly 47 comprises a side wall in which holes are formed in order to facilitate the installation of fluid purifying system 20 of the present invention to an abutting support wall. If desired, mounting holes may be formed in the opposed wall of bracket assembly 47, or bracket assembly 47 may be mounted with the mounting hole containing portion thereof aligned with either the right side or the left side of housing 25 of sterilization section 21. In this way, a universally adaptable mounting system is achieved.

In another preferred embodiment, fluid purifying system 20 of the present invention incorporates ultraviolet radiation level sensing means and cooperating alarm means, in order to inform the user whenever the level of ultraviolet radiation falls below the level required to kill the microorganisms passing therethrough. Preferably, ultraviolet radiation sensing means 53 is mounted directly adjacent on of the fluid flow controlling conduit means 27. This position is preferred since, in this way, sensor 53 senses both the ultraviolet radiation output of tube 26, as well as the amount of ultraviolet

radiation passing through fluid flow-controlling conduit means 27.

In addition, sensor means 53 is connected to an alarm means 54, in order to provide a positive, recognizable indication to the user that a fault condition exists. Alarm means 54 may comprise a sound producing device, such as a horn or bell, in order to audibly warn the user that a fault condition exists. If desired, alarm means 54 may comprise visual indicating means, such as a light, which is illuminated or constructed to flash whenever a fault condition is found. Furthermore, a combination of both alarm types could be employed.

Although ultraviolet radiation sensor 53 may be positioned directly adjacent to ultraviolet radiation producing tube 26, the preferred position is directly adjacent to one of the fluid flow-controlling conduit means 27. This position is preferred since, in this way, sensor 53 will sensor both a reduction in the ultraviolet radiation produced by tube 26, as well as a reduction in the ultraviolet radiation passing through fluid flow-controlling conduit means 27. As a result of this construction, in addition to reduced output from tube 26, a fault condition will be recognized and identified if the fluid passing through fluid flow-controlling conduit means 27 comprises a colloidal suspension or other concentrated particulate matter which prevents the requisite level of ultraviolet radiation from passing through conduit means 27.

This is particularly important when the system is installed to purify drinking water, since heavily soiled, or particle-laden water may not be capable of being completely purified using the sizing of the system constructed for conventional water sources. With this system, the user is provided with a positive indication that the fluid passing through purifying system 20 has an abnormal condition which might be incapable of being fully purified.

In the preferred embodiment, fluid sterilization system 20 of the present invention is constructed with sterilizer section 21 and filter section 22 being completely modularized, in order to allow any desired configuration or component interconnection required for specific application requirements. In Figs. 2 and 3, sterilizer section 21 is depicted in detail, as described above, with the section being constructed for ease of use as a separate, modular element.

In Fig. 4, a detailed view of filter section 22 is shown, with housing 30 peripherally surrounding and containing removable filter element 31 clearly shown therein, with section 22 constructed for ease in use of any particular desired construction or arrangement.

In Figs. 5-7, various alternate configurations of the modularized system of this invention are shown. In Fig. 5, two sterilizer sections 21A and

21B are shown cooperatively interconnected with a single filter section 22. A system of this nature would provide ultraviolet radiation exposure of about 180,000 microwatt seconds per square centimeter, thereby being capable of assuring the elimination of most known bacteria, viruses, spores, and parasites. As a result, in a particular application where high levels of bacteria are present or well known, more resistant microorganisms have been detected, a system as shown in Fig. 5, with two sterilizing sections being employed, would provide the desired fluid purification.

In Fig. 5, the preferred interconnection method for the dual sterilizer sections is shown. As depicted, the fluid entering sterilizer section 21A makes its first pass through section 21A, exits sterilizer section 21A and enters sterilizer section 21B. Once in sterilizer section 21B, the fluid makes its first pass through sterilizer section 21B and passes from sterilizer section 21B into filter 22. After passage through filter 22, the fluid passes for a second time through sterilizer section 21B, followed by a second pass through sterilizer section 21A, where the purified fluid then exits for delivery to the user.

By employing this configuration, the fluid is exposed to a double dose of ultraviolet radiation both before filtration and after filtration. However, if for any particular purpose maximum exposure of the fluid to ultraviolet radiation prior to filtration is considered desirable, this dual sterilizer configuration could be constructed to allow the fluid to pass through sterilizer section 21A in both directions, prior to entering sterilizer section 21B, where a third exposure to ultraviolet radiation would be realized prior to passage of the fluid to filter section 22. Of course, other arrangements can also be employed, as the system may be expanded to include any number of sterilizer sections required to meet particular needs.

In Fig. 6, an alternate arrangement for the modularized fluid purification system 20 of the present invention is shown. In this configuration, a single sterilizing section 21 is employed in combination with two filter sections 22A and 22B. A system construction of this nature is employed in particular installations where a single filter has proven incapable of eliminating the particulate matter, odor, chloroform, or other organic or chemical contents which exists in the fluid supply. In addition, a system of this nature is employed where two different types of filters, such as one activated charcoal and a paper type filter, are required to meet specific needs.

As shown in Fig. 6, the preferred arrangement of this embodiment brings the fluid supply into sterilizer section 21 and then directly from sterilizer section 21 into filter 22B. After passage through

filter 22B, the fluid passes into filter 22A for filtration therethrough. Once through filter 22A, the fluid returns to sterilizer section 21 for its final sterilization exposure before being delivered directly to the user.

If desired, additional filters can be mounted to this system, in a similar fashion, in order to provide further filtration of the fluid for particular needs. However, regardless of the number of filters employed, a final passage of the fluid through sterilizer section 21 prior to delivery to the user is required, in order to attain the beneficial aspects of the present invention.

In Fig. 7, a final example of various alternate installations for fluid purification system 20 of the present invention is shown. In this configuration, two sterilizer sections 21A and 21B are employed along with two filter sections 22A and 22B. Although these sections could be interconnected with each other in a variety of alternate ways, without departing from the scope of the present invention, Fig. 7 depicts the particular configuration considered to be preferred. However, regardless of the particular configuration employed, it is important to note that in accordance with the present invention, the fluid must be exposed to ultraviolet radiation prior to filtration, and must be exposed to ultraviolet radiation again after the final filtration, just prior to passage to the user.

The preferred construction shown in Fig. 7 essentially represents the use of two single filtration systems 20, as detailed above, which are connected in series. As shown in Fig. 7, fluid passes through sterilization section 21A, then through filter section 22A, back through sterilization section 21A, as is done with a single fluid purification system 20. However, in this construction, the fluid exiting sterilization section 21A passes through sterilization section 21B and then through filter 22B. Once through filter 22B, the fluid makes a final pass through sterilization section 21B and is then delivered directly to the user.

As is readily apparent from the alternate structural arrangements detailed above for constructing a fluid purification system in accordance with the present invention, these particular constructions are merely examples of numerous alternate construction arrangements that can be employed for the present invention. Consequently, the constructions detailed above have been presented merely for exemplary purposes, and are not in any way intended to limit the scope of the present invention.

In Figs. 8 and 9, two alternate configurations for the fluid flow-controlling conduit means are shown. In Fig. 8, conduit means 27A is depicted as a corrugated elongated, continuous tube, with the side walls thereof comprising a corrugated, varying diameter configuration along the entire length

thereof. It is believed that this corrugated conduit configuration acts optically to enhance the transfer of ultraviolet radiation to the fluid passing therethrough by dispersing the ultraviolet rays, due to the irregular shape of the sidewalls of the corrugated tube.

In Fig. 9, another alternate construction for conduit means 27 is shown. In this configuration, the conduit means comprises an elongated, extruded construction in which two conduits are extruded in a side-by-side configuration, in order to further enhance the construction of sterilizer section 21. Furthermore, in this configuration, the extruded conduit means 27B comprises a convex outer surface matingly interconnected with a concave outer surface. With this configuration, the concave surface is positioned about elongated, ultraviolet radiation producing tube 26 in juxtaposed, spaced facing relationship therewith. In this way, the concave surface functions as a lens, and optically acts to deliver improved ultraviolet radiation transfer to the fluid passing therethrough.

In addition to these two alternate conduit means, a variety of other conduit means constructions can be employed without departing from the scope of this invention. However, regardless of the tube configuration, the tube or conduit means must be formed from a material or a combination of materials which allows ultraviolet radiation to pass through at least the radiation receiving walls thereof and into the fluid stream. Presently, ultraviolet permeable tubes formed from teflon are preferred. However, any other material having similar or better ultraviolet radiation transmission properties may be employed.

Although illustrative embodiments of the present invention have been described herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various other changes and modifications may be effected therein by one skilled in the art within the scope of the invention.

Claims

1. A fluid purification system which comprises ultraviolet radiation producing means (26), an outlet faucet or portal for delivering purified fluid to a user, filter means (22) for filtering fluid, the filter means (22) having an inlet port (37) to receive fluid to be filtered, and an outlet port (38) to allow fluid filtered thereby to pass therefrom, and fluid flow-controlling conduit means (27) positioned adjacent to the ultraviolet radiation producing means (26), the fluid flow controlling



filter 22B, the fluid passes into filter 22A for filtration therethrough. Once through filter 22A, the fluid returns to sterilizer section 21 for its final sterilization exposure before being delivered directly to the user.

If desired, additional filters can be mounted to this system, in a similar fashion, in order to provide further filtration of the fluid for particular needs. However, regardless of the number of filters employed, a final passage of the fluid through sterilizer section 21 prior to delivery to the user is required, in order to attain the beneficial aspects of the present invention.

In Fig. 7, a final example of various alternate installations for fluid purification system 20 of the present invention is shown. In this configuration, two sterilizer sections 21A and 21B are employed along with two filter sections 22A and 22B. Although these sections could be interconnected with each other in a variety of alternate ways, without departing from the scope of the present invention, Fig. 7 depicts the particular configuration considered to be preferred. However, regardless of the particular configuration employed, it is important to note that in accordance with the present invention, the fluid must be exposed to ultraviolet radiation prior to filtration, and must be exposed to ultraviolet radiation again after the final filtration, just prior to passage to the user.

The preferred construction shown in Fig. 7 essentially represents the use of two single filtration systems 20, as detailed above, which are connected in series. As shown in Fig. 7, fluid passes through sterilization section 21A, then through filter section 22A, back through sterilization section 21A, as is done with a single fluid purification system 20. However, in this construction, the fluid exiting sterilization section 21A passes through sterilization section 21B and then through filter 22B. Once through filter 22B, the fluid makes a final pass through sterilization section 21B and is then delivered directly to the user.

As is readily apparent from the alternate structural arrangements detailed above for constructing a fluid purification system in accordance with the present invention, these particular constructions are merely examples of numerous alternate construction arrangements that can be employed for the present invention. Consequently, the constructions detailed above have been presented merely for exemplary purposes, and are not in any way intended to limit the scope of the present invention.

In Figs. 8 and 9, two alternate configurations for the fluid flow-controlling conduit means are shown. In Fig. 8, conduit means 27A is depicted as a corrugated elongated, continuous tube, with the side walls thereof comprising a corrugated, varying diameter configuration along the entire length

thereof. It is believed that this corrugated conduit configuration acts optically to enhance the transfer of ultraviolet radiation to the fluid passing therethrough by dispersing the ultraviolet rays, due to the irregular shape of the sidewalls of the corrugated tube.

In Fig. 9, another alternate construction for conduit means 27 is shown. In this configuration, the conduit means comprises an elongated, extruded construction in which two conduits are extruded in a side-by-side configuration, in order to further enhance the construction of sterilizer section 21. Furthermore, in this configuration, the extruded conduit means 27B comprises a convex outer surface matingly interconnected with a concave outer surface. With this configuration, the concave surface is positioned about elongated, ultraviolet radiation producing tube 26 in juxtaposed, spaced facing relationship therewith. In this way, the concave surface functions as a lens, and optically acts to deliver improved ultraviolet radiation transfer to the fluid passing therethrough.

In addition to these two alternate conduit means, a variety of other conduit means constructions can be employed without departing from the scope of this invention. However, regardless of the tube configuration, the tube or conduit means must be formed from a material or a combination of materials which allows ultraviolet radiation to pass through at least the radiation receiving walls thereof and into the fluid stream. Presently, ultraviolet permeable tubes formed from teflon are preferred. However, any other material having similar or better ultraviolet radiation transmission properties may be employed.

Although illustrative embodiments of the present invention have been described herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various other changes and modifications may be effected therein by one skilled in the art within the scope of the invention.

Claims

1. A fluid purification system which comprises ultraviolet radiation producing means (26), an outlet faucet or portal for delivering purified fluid to a user, filter means (22) for filtering fluid, the filter means (22) having an inlet port (37) to receive fluid to be filtered, and an outlet port (38) to allow fluid filtered thereby to pass therefrom, and fluid flow-controlling conduit means (27) positioned adjacent to the ultraviolet radiation producing means (26), the fluid flow controlling



conduit means (27) including elongated hollow tubing having first and second ultraviolet radiation transmissible portions defining first (33) and second (34) flow channels respectively for the passage of fluid and for exposing fluid flowing therethrough to ultraviolet radiation emitted from the ultraviolet radiation producing means (26), and defining a fluid inlet and a fluid outlet for each of the first and second flow channels, the outlet of said first flow channel (33) being in communication with the inlet port (37) of the filter means (22), and the inlet of said second flow channel (34) being in communication with the outlet port (38) of said filter means,

characterized by

the ultraviolet radiation producing means being defined as comprising one single elongated emitting tube member (26), both said first and second flow channels providing for a passage of fluid in tortuous paths about the periphery of the single elongated emitting tube member (26) and being spirally wound about it so as to peripherally surrounding substantially the entire length of said one single elongated tube member (26), and the outlet of said second flow channel (34; 61) being directly connected to said outlet faucet or portal.

2. A fluid purification system according to claim 1, characterized by radiation reflecting means (28) being mounted about the fluid flow-controlling conduit means (27) in peripherally surrounding and enveloping relationship therewith, for receiving ultraviolet radiation passing through such fluid flow-controlling conduit means (27) and reflecting said radiation back to said conduit means (27).
3. A fluid purification system according to claim 2 characterized in that said ultraviolet radiation reflecting means is further defined as comprising a sheet of metalized foil material (28) wrapped about the outer periphery of said fluid flow-controlling conduit means (27).
4. A fluid purification system according to any one of claims 1 to 3 further characterized by ultraviolet radiation level sensing means (53) positioned for receiving and monitoring the ultraviolet radiation produced by said ultraviolet radiation producing tube means (26), said sensing means (53) being adapted to provide an output signal whenever said ultraviolet radiation falls below a predetermined level.

5. A fluid purification system according to claim 4 further characterized by means (54) connected to said ultraviolet radiation sensing means (53) and being adapted to provide a warning to the user when receiving said output signal.
6. A fluid purification system according to claim 4 or 5 characterized in that said ultraviolet radiation level sensing means (53) is further defined as being positioned in juxtaposed relationship with said first and second portions of said fluid flow-controlling conduit means (27) for sensing the radiation level produced by the ultraviolet radiation producing tube means (26) and passing through said fluid flow-controlling conduit means (27).
7. A fluid purification system according to any one of claims 1 to 6 characterized by the system being constructed in modular form to provide a plurality of alternate arrangements for the system interconnection.
8. A fluid purification system according to any one of claims 1 to 7 characterized in that said filter means is further defined as being housed in an independent filter section (22) incorporating easily accessible inlet (37) and outlet (38) ports, and said ultraviolet radiation producing tube means (26) and said fluid flow-controlling conduit means (27) are further defined as being housed in an independent sterilizer section (21; 50), wherein said inlets (35, 44) and outlets (36, 39) of the first and second portions of the conduit means (27) are readily accessible to allow any number of sterilizer sections (21; 50) and any number of filter sections (22; 22A; 22B) to be interconnected in any desired arrangement for attaining fluid purification of any particular fluid source.
9. A fluid purification system according to any one of claims 1 to 8 characterized in that the elongated tubing (33) defining the first portion of the fluid flow-controlling conduit means (27) comprises an overall length substantially equal to the elongated tubing (34) defining the second portion of the fluid flow-controlling conduit means (27).
10. A fluid purification system according to claim 9 wherein the first tubing portion and the second tubing portion of the fluid flow-controlling conduit means (27) are coiled or spirally wound about said single elongated ultraviolet radiation producing tube members (26) in interleaved relationship with each other.



11. A fluid purification system according to claim 10 characterized in that said elongated tubing (33, 34; 60, 61) is further defined as comprising a corrugated-shaped outer surface.
12. A fluid purification system according to claim 10 or 11 characterized in that said first and second tubing portions are further defined as being formed from extruded radiation transmissible material (27B) in an interconnected, side-by-side relationship, one surface thereof comprising a substantially concave shape, with said concave shape being positioned in juxtaposed, spaced relationship with the single elongated ultraviolet radiation producing tube member (26).
13. A fluid purification system according to any one of claims 1 to 12 characterized in that the fluid to be purified is a liquid.
14. A fluid purification system according to any one of claims 1 to 13 characterized in that said first and second flow channels include first and second conduits (33, 34) helically coiled in paired manner about said single elongated emitting tube member (26) from one end to the other end thereof which each coil laterally abutting adjacent coils.
15. Fluid purification system according to claim 14 characterized in that said first and second conduits (33, 34) have a corrugated-shaped outer surface.
16. A liquid purification system according to claim 14 or 15 characterized in that said first and second conduits (27B) are formed from extruded material so as to be laterally interconnected, a surface thereof being of substantially concave shape for receiving the radiation and enhancing the transmission of radiation to the fluid passing therethrough.
17. A fluid purification system according to claim 7 and 13 characterized by a number of modular liquid sterilisation systems (21A, 21B) each having an elongated emitting tube member (26) coupled to a source of electrical energy for emitting ultraviolet radiation, and a pair of tubular liquid conduits (33, 34), said conduits (33, 34) helically coiled in paired manner about said elongated emitting tube member (26) from one end to the other end thereof with each coil laterally abutting adjacent coils to peripherally surround substantially the entire length of said elongated emitting tube member (26), each conduit (33, 34) having an inlet Port (35; 44) at one end and an outlet port (36; 39) at the other end, said conduits (33, 34) being transparent to ultraviolet radiation to allow exposure of liquid flowing through said conduits (33; 34) to ultraviolet radiation and wherein the inlet port (35; 44) of one conduit (33; 34) is paired with and immediately adjacent the outlet port (39; 44) of the other conduit (33; 34) to allow for opposing flow of liquid through said conduits (33; 34), a number of modular filter systems (22A; 22B) for filtering incoming fluid, each filter system (22A; 22B) having a filter input and filter output, means for interconnecting a liquid purification system having a particular desired arrangement, said arrangement including a system inlet, a system outlet, a first liquid sterilization system (21A) selected from said number of modular liquid sterilization systems (21A; 21B), said first liquid sterilization system (21A) having an inlet port of one conduit being connected to said system inlet and the paired outlet port of the other conduit being connected to said system outlet, and selected one of said number of modular liquid sterilization systems (21A; 21B) and said number of filter systems (22A; 22B) being coupled to the inlet port of said other conduit and the outlet port of said one conduit of said first liquid sterilization system (21A) to achieve a closed liquid purification system.
18. A liquid purification system according to claim 17, characterized in that said means for interconnecting a liquid purification system is readily disconnectable and reconnectable.
19. A liquid sterilization system comprising a single elongated ultraviolet radiation emitting tube (26) coupled to a source of electrical energy for emitting ultraviolet radiation, and a pair of tubular liquid conduits (33, 34), said conduits being helically coiled in paired manner about said single ultraviolet radiation emitting tube (26) with each coil laterally abutting adjacent coils, each conduit (33; 34) having an inlet port (35; 44) at one end and an outlet port (36; 39) at the outer end, said conduits (33; 34) being transparent to ultraviolet radiation to allow exposure of liquid flowing through said conduits (33; 34) to ultraviolet radiation emitted by said tube (26), characterized in that said conduits (33; 34) peripherally surround substantially the entire length of said single ultraviolet radiation emitting tube (26) and that the inlet port (35; 44) of



one conduit (33; 34) is paired with and immediately adjacent to the outlet port (36; 39) of the other conduit (34; 33) to allow for opposing flow of liquid through said conduits (33; 34).

20. A system according to claim 19 characterized in that the outlet (36) of one conduit (33) is coupled to the inlet (44) of the other conduit (34).
21. A system according to claim 19 or 20 characterized in that the outlet (36) of said one conduit (33) is coupled to the inlet (44) of the other conduit (34) through a further liquid filtering means (22).
22. A system according to any one of claims 19 to 21 characterized in that said conduits (33, 34) are composed of plastic and are cylindrical in cross section and the liquid to be radiated is water.

Patentansprüche

1. Fluidreinigungssystem mit Mitteln (26) zur Erzeugung von Ultraviolettstrahlung, einem Auslaßhahn oder einer Auslaßöffnung zum Zuführen von gereinigtem Fluid zu einem Benutzer, Filtermitteln (22) zum Filtern von Fluid, die (22) eine Einlaßöffnung (37) zur Aufnahme von zu filterndem Fluid sowie eine Auslaßöffnung (38) aufweisen, um durch diese ein Abziehen von durch die Filtermittel gefiltertem Fluid zu gestatten, und mit Leitungseinrichtungen (27) zur Führung des Fluidstromes, die in der Nähe der Mittel (26) zur Erzeugung von Ultraviolettstrahlung angeordnet sind und ein längliches Hohlrohr mit ersten und zweiten Abschnitten enthalten, die für Ultraviolettstrahlung durchlässig sind und einen ersten (33) bzw. einen zweiten (34) Strömungskanal für den Durchfluß von Fluid sowie für eine von den Mitteln (26) zur Erzeugung von Ultraviolettstrahlung ausgestrahlte ultraviolette Bestrahlung von dort durchströmendem Fluid festlegen und für den ersten und den zweiten Strömungskanal jeweils einen Fluideinlaß sowie einen Fluidauslaß ausbilden, wobei der Auslaß des ersten Strömungskanals (33) in Verbindung mit der Einlaßöffnung (37) der Filtermittel (22) und der Einlaß des zweiten Strömungskanals (34) in Verbindung mit der Auslaßöffnung (38) besagter Filtermittel steht, **dadurch gekennzeichnet**, daß die Mittel zur Erzeugung von Ultraviolettstrahlung so ausgebildet sind, daß sie ein ein-

zelnes längliches Strahlungsröhrenteil (26) aufweisen, wobei der erste und der zweite Strömungskanal einen Durchfluß von Fluid auf gewundenen Wegen um den Umfang des einzelnen länglichen Strahlungsröhrenteiles (26) herum vorsehen und um dieses spiralförmig derart herumgewunden sind, daß sie im wesentlichen auf der gesamten Länge des einen einzelnen länglichen Röhrenteiles (26) dessen Umfang umschließen, und daß der Auslaß des zweiten Strömungskanals (34; 61) direkt an dem Auslaßhahn oder die Auslaßöffnung angeschlossen ist.

2. Fluidreinigungssystem nach Anspruch 1, gekennzeichnet durch strahlungsreflektierende Mittel (28), die um die Leitungseinrichtungen (27) zur Führung des Fluidstromes herum in einer deren Umfang umgebenden und umhüllenden Weise angebracht sind, zum Empfang von Ultraviolettstrahlung, die durch solche Leitungseinrichtungen (27) zur Führung des Fluidstromes hindurchläuft, und zum Zurückstrahlen besagter Strahlung zu den Leitungseinrichtungen (27).
3. Fluidreinigungssystem nach Anspruch 2, dadurch gekennzeichnet, daß die besagten Mittel zum Reflektieren von Ultraviolettstrahlung ferner so ausgebildet sind, daß sie eine Fläche aus metallisiertem Folienmaterial (28) aufweisen, das um den Außenumfang der Leitungseinrichtungen (27) zur Führung des Fluidstromes herumgewickelt ist.
4. Fluidreinigungssystem nach einem der Ansprüche 1 bis 3, ferner gekennzeichnet durch Mittel (53) zum Erfassen der Intensität der Ultraviolettstrahlung, die zum Empfang und zur Überwachung der von den Röhrenmitteln (26) zur Erzeugung von Ultraviolettstrahlung stammenden Ultraviolettstrahlung angeordnet sind, wobei die Erfassungsmittel (53) dazu eingerichtet sind, ein Ausgangssignal immer dann abzugeben, wenn die Ultraviolettstrahlung unter eine vorbestimmte Intensität abfällt.
5. Fluidreinigungssystem nach Anspruch 4, ferner gekennzeichnet durch Mittel (54), die mit den Mitteln (53) zum Erfassen von Ultraviolettstrahlung verbunden und dazu eingerichtet sind, bei Empfang des Ausgangssignals den Benutzer zu warnen.
6. Fluidreinigungssystem nach Anspruch 4 oder 5, dadurch gekennzeichnet, daß die Mittel (53) zum Erfassen der Intensität von Ultraviolett-



strahlung noch so ausgebildet sind, daß sie neben den ersten und zweiten Abschnitten der Leitungseinrichtungen (27) zur Führung des Fluidstromes angeordnet sind, um die durch die Leitungseinrichtungen (27) zur Führung des Fluidstromes laufende Strahlungsintensität aus den Röhrenmitteln (26) zur Erzeugung von Ultraviolettstrahlung zu erfassen.

7. Fluidreinigungssystem nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß das System in modularer Form ausgeführt ist, um eine Mehrzahl abwechselnder Anordnungen für ein Zusammenschalten des Systems zu schaffen.

8. Fluidreinigungssystem nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß die Filtermittel ferner so ausgebildet sind, daß sie in einem unabhängigen Filterabschnitt (22) aufgenommen sind, in den leicht zugängliche Einlaß- (37) und Auslaßöffnungen (38) eingebaut sind, und dadurch, daß die Röhrenmittel (26) zur Erzeugung von Ultraviolettstrahlung und die Leitungseinrichtungen (27) zur Führung des Fluidstromes ferner in einem unabhängigen Sterilisierabschnitt (21; 50) aufgenommen sind, wobei die Einlässe (35, 44) und Auslässe (36, 39) der ersten und zweiten Abschnitte der Leitungseinrichtungen (27) ohne weiteres zugänglich sind, um ein Zusammenschalten jeder Anzahl von Sterilisierabschnitten (21; 50) und jeder Anzahl von Filterabschnitten (22; 22A; 22B) in jeder gewünschten Anordnung zur Erzielung einer Fluidreinigung irgendeiner bestimmten Fluidquelle zu ermöglichen.

9. Fluidreinigungssystem nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß das längliche Rohr (33), das den ersten Abschnitt der Leitungseinrichtungen (27) zur Führung des Fluidstromes ausbildet, eine Gesamtlänge aufweist, die im wesentlichen gleich dem länglichen Rohr (34) ist, das den zweiten Abschnitt der Leitungseinrichtungen (27) zur Führung des Fluidstromes ausbildet.

10. Fluidreinigungssystem nach Anspruch 9, wobei der erste Rohrabschnitt und der zweite Rohrabschnitt der Leitungseinrichtungen (27) zur Führung des Fluidstromes um das einzelne längliche Röhrenteil (26) zur Erzeugung von Ultraviolettstrahlung um eine Windung zueinander versetzt gewickelt oder spiralförmig herumgewunden sind.

11. Fluidreinigungssystem nach Anspruch 10, dadurch gekennzeichnet, daß das längliche Rohr

(33, 34; 60, 61) ferner so ausgebildet ist, daß es eine gewellte Außenfläche aufweist.

12. Fluidreinigungssystem nach Anspruch 10 oder 11, dadurch gekennzeichnet, daß der erste und der zweite Rohrabschnitt ferner so ausgebildet sind, daß sie aus extrudiertem, strahlungsdurchlässigem Material (27B) geformt und gegenseitig verbunden Seite an Seite angeordnet sind, wobei eine ihrer Flächen eine im wesentlichen konkave Form aufweist und diese konkave Form in einem Abstand neben dem einzelnen länglichen Röhrenteil (26) zur Erzeugung von Ultraviolettstrahlung angeordnet ist.

13. Fluidreinigungssystem nach einem der Ansprüche 1 bis 12, dadurch gekennzeichnet, daß das zu reinigende Fluid eine Flüssigkeit ist.

14. Fluidreinigungssystem nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß der erste und der zweite Strömungskanal erste und zweite Leitungen (33, 34) enthält, die schraubenförmig paarweise um das einzelne längliche Strahlungsröhrenteil (26) von dessen einem Ende zum anderen Ende gewickelt sind, wobei jede Windung seitlich an benachbarten Windungen anliegt.

15. Fluidreinigungssystem nach Anspruch 14, dadurch gekennzeichnet, daß die ersten und die zweiten Leitungen (33, 34) eine wellenförmige Außenfläche aufweisen.

16. Flüssigkeitsreinigungssystem nach Anspruch 14 oder 15, dadurch gekennzeichnet, daß die ersten und zweiten Leitungen (27B) aus extrudiertem Material so geformt sind, daß sie seitlich miteinander verbunden sind, wobei eine ihrer Flächen eine im wesentlichen konkave Form aufweist, um die Strahlung aufzunehmen und die Übertragung von Strahlung auf das dort hindurchlaufende Fluid zu verbessern.

17. Fluidreinigungssystem nach Anspruch 7 und 13, gekennzeichnet durch eine Anzahl modularer Flüssigkeitssterilisationssysteme (21A, 21B), deren jedes ein längliches Strahlungsröhrenteil (26), das an eine elektrische Energiequelle zum Ausstrahlen von Ultraviolettstrahlung gekoppelt ist, und ein Paar von Rohrleitungen (33, 34) für eine Flüssigkeit aufweist, die (33) schraubenförmig paarweise um das längliche Strahlungsröhrenteil (26) von dessen einem Ende zum anderen Ende gewickelt sind, wobei jede Windung seitlich an benachbarten Windungen anliegt, um im wesentlichen über der gesamten



Länge des länglichen Strahlungsrohrenteils (26) dessen Umfang zu umschließen, und wobei jede Leitung (33, 34) eine Einlaßöffnung (35; 44) an einem Ende sowie eine Auslaßöffnung (36; 39) am anderen Ende aufweist und die Leitungen (33, 34) für Ultraviolettstrahlung durchlässig sind, damit die durch die Leitungen (33; 34) strömende Flüssigkeit Ultraviolettstrahlung ausgesetzt ist, und wobei die Einlaßöffnung (35; 34) einer Leitung (33; 34) als Paar mit und unmittelbar in der Nähe der Auslaßöffnung (39; 34) der anderen Leitung (33; 34) angeordnet ist, um ein gegenläufiges Strömen von Flüssigkeit durch die Leitungen (33; 34) zu gestatten,

ferner durch eine Anzahl modularer Filtersysteme (22A; 22B) zum Filtern von ankommendem Fluid, wobei jedes Filtersystem (22A; 22B) einen Filtereingang und einen Filterauslaß aufweist,

durch Mittel zum Zusammenschalten eines Flüssigkeitsreinigungssystems, das eine bestimmte gewünschte Anordnung aufweist, die einen Systemeinlaß, einen Systemauslaß und

ein erstes Flüssigkeitssterilisationssystem (21A) enthält, das aus besagter Anzahl modularer Flüssigkeitssterilisationssysteme (21A 21B) ausgewählt wurde und bei dem die Einlaßöffnung einer Leitung am Systemeinlaß und die paarweise zugeordnete Auslaßöffnung der anderen Leitung am Systemauslaß angeschlossen sind,

wobei das aus der Anzahl modularer Flüssigkeitssterilisationssysteme (21A; 21B) und der Anzahl von Filtersystemen (22A; 22B) ausgewählte System an die Einlaßöffnung besagter anderer Leitung und an die Auslaßöffnung besagter einer Leitung des ersten Flüssigkeitssterilisationssystems (21A) angeschlossen ist, um ein geschlossenes Flüssigkeitsreinigungssystem auszubilden.

18. Flüssigkeitsreinigungssystem nach Anspruch 17, dadurch gekennzeichnet, daß die Mittel zum Zusammenschalten eines Flüssigkeitsreinigungssystems ohne weiteres lösbar und wieder miteinander verbindbar sind.

19. Flüssigkeitssterilisationssystem mit einer einzelnen länglichen Röhre (26) zum Ausstrahlen von Ultraviolettstrahlung, wobei die Röhre an eine elektrische Energiequelle zum Ausstrahlen von Ultraviolettstrahlung angekoppelt ist, und mit einem Paar von Rohrleitungen (33, 34) für Flüssigkeit, die paarweise schraubenförmig um diese einzelne Röhre (26) zum Ausstrahlen

von Ultraviolettstrahlung herumgewickelt sind, wobei jede Windung seitlich an benachbarten Windungen anliegt und jede Leitung (33; 34) eine Einlaßöffnung (35; 44) an einem Ende und eine Auslaßöffnung (36; 39) am Außenende aufweist und wobei die Leitungen (33; 34) für Ultraviolettstrahlung durchlässig sind, um durch die Leitungen (33; 34) strömende Flüssigkeit der durch die Röhre (26) ausgestrahlten Ultraviolettstrahlung auszusetzen, dadurch gekennzeichnet, daß die Leitungen (33; 34) im wesentlichen über die gesamte Länge den Umfang der einzelnen, Ultraviolettstrahlung aussendenden Röhre (26) umgeben und dadurch, daß die Einlaßöffnung (35; 44) einer Leitung (33; 34) als Paar mit und unmittelbar in der Nähe der Auslaßöffnung (36; 39) der anderen Leitung (34; 33) angeordnet ist, um ein gegenläufiges Strömen von Flüssigkeit durch die Leitungen (33; 34) zu gestatten.

20. System nach Anspruch 19, dadurch gekennzeichnet, daß der Auslaß (36) einer Leitung (33) an den Einlaß (44) der anderen Leitung (34) angekoppelt ist.

21. System nach Anspruch 19 oder 20, dadurch gekennzeichnet, daß der Auslaß (36) der einen Leitung (33) an den Einlaß (44) der anderen Leitung (34) über weitere, eine Flüssigkeit filternde Mittel (22) angekoppelt ist.

22. System nach einem der Ansprüche 19 bis 21, dadurch gekennzeichnet, daß besagte Leitungen (33, 34) aus Kunststoff bestehen und einen zylindrischen Querschnitt aufweisen, und daß die zu bestrahlende Flüssigkeit Wasser ist.

Revendications

1. Système de purification de fluide, comprenant, un moyen de production de rayonnement ultraviolet (26), une robinetterie ou une distributeur extérieur pour fournir du fluide purifié à un utilisateur, un moyen de filtrage (22) pour filtrer le fluide, le moyen de filtrage (22) ayant un orifice d'entrée (37) pour recevoir du fluide à filtrer et un orifice de sortie (38) pour permettre au fluide ayant été filtré de sortir, et un moyen de conduite de commande de débit de fluide (27), placé adjacent au moyen de production de rayonnement ultraviolet (26), le moyen de conduite de commande de débit de fluide (27) comprenant un tubage creux allongé ayant des première et deuxième parties perméables au rayonnement ultraviolet, définissant respectivement des premier (33) et



deuxième (34) canaux d'écoulement pour le passage de fluide et pour l'exposition du fluide s'y écoulant au rayonnement ultraviolet émis par le moyen de production de rayonnement ultraviolet (26) et définissant une entrée de fluide et une sortie de fluide pour chacun des premier et deuxième canaux d'écoulement la sortie dudit premier canal d'écoulement (33) étant en communication avec l'orifice d'entrée (37) du moyen de filtrage (22) et l'entrée dudit deuxième canal d'écoulement (34) étant en communication avec l'orifice de sortie (38) dudit moyen de filtrage, caractérisé par le fait que le moyen de production de rayonnement ultraviolet est défini comme comprenant un organe tubulaire émetteur (26) allongé, unique, lesdits deux premier et deuxième canaux d'écoulement constituant un passage de fluide, avec des trajectoires tortueuses, sur la périphérie dudit organe tubulaire émetteur (26) allongé unique et enroulé en spirale autour de lui, de façon à entourer en périphérie pratiquement toute la longueur dudit organe tubulaire (26) allongé unique, et la sortie dudit deuxième canal d'écoulement (34; 61) étant directement reliée à ladite robinetterie ou distributeur de sortie.

2. Système de purification de fluide selon la revendication 1, caractérisé par un moyen réflecteur de rayonnement (28), monté autour dudit moyen formant conduit de commande d'écoulement (27) en l'entourant en périphérie et en relation d'enveloppement vis-à-vis de lui, pour recevoir le rayonnement ultraviolet passant à travers ce moyen formant conduite de commande d'écoulement (27) et réfléchir ledit rayonnement pour le faire revenir audit moyen formant conduit (27).

3. Système de purification de fluide selon la revendication 2, caractérisé en ce que ledit moyen de réflexion de rayonnement ultraviolet est en outre défini par le fait de comprendre une feuille de matériaux en film métallisé (28) enroulée autour de la périphérie extérieure dudit moyen formant conduite de commande d'écoulement de fluide (27).

4. Système de purification de fluide selon l'une quelconque des revendications 1 à 3, caractérisé en outre par un moyen de détection de niveau de rayonnement ultraviolet (53), positionné de façon à recevoir et surveiller le rayonnement ultraviolet produit par ledit moyen de tubulaire de production de rayonnement ultraviolet (26), ledit moyen capteur (53) étant

adapté pour fournir un signal de sortie dans le cas où le rayonnement ultraviolet descend au dessous d'un niveau prédéterminé.

5. Système de purification de fluide selon la revendication 4, caractérisé en outre par un moyen (54) relié audit moyen capteur de rayonnement ultraviolet (53) et adapté pour donner à l'utilisateur une alarme en cas de réception dudit signal de sortie.

6. Système de purification de fluide selon la revendication 4 ou 5, caractérisé en ce que ledit moyen de détection de niveau de rayonnement ultraviolet (53) est en outre défini comme étant placé en relation de juxtaposition avec lesdites première et deuxième parties dudit moyen formant conduit de commande d'écoulement de fluide (27), pour appréhender le niveau de rayonnement produit par le moyen tubulaire de production de rayonnement ultraviolet (26) et passer à travers ledit moyen formant conduit de commande d'écoulement de fluide (27).

7. Système de purification de fluide selon l'une quelconque des revendications 1 à 6, caractérisé par le fait que le système est construit sous forme modulaire pour former une pluralité d'agencements alternés placés en interconnexion pour constituer le système.

8. Système de purification de fluide selon l'une quelconque des revendications 1 à 7, caractérisé en ce que ledit moyen de filtrage est en outre défini comme étant logé dans une section de filtrage (22) indépendante, comprenant des orifices d'entrée (37), à accessibilité aisée, et des orifices de sortie (38), et ledit moyen tubulaire de production de rayonnement ultraviolet (26) et ledit moyen formant conduit de commande d'écoulement de fluide (27) étant en outre définis comme étant logés dans une section de stérilisateur (21; 50) indépendante, lesdites entrées (35, 44) et sortie (36, 39) desdites première et deuxième parties dudit moyen formant conduites (27) étant facilement accessible pour permettre à un nombre quelconque de sections de stérilisateur (21; 50) et à un nombre quelconque de sections de filtrage (22; 22A; 22B) d'être interconnectés en un agencement souhaité quelconque, pour effectuer la purification du fluide venant d'une source de fluide particulière quelconque.

9. Système de purification de fluide selon l'une quelconque des revendications 1 à 8, caractérisé en ce que le tubage allongé (33) définis-



- sant la première partie du moyen formant conduit de commande d'écoulement de fluide (27) comprend une longueur générale sensiblement égale à celle du tubage allongé (34) définissant la deuxième partie du moyen formant conduite de commande d'écoulement de fluide (27). 5
10. Système de purification de fluide selon la revendication 9, dans lequel la première partie de tubage et la deuxième partie de tubage du moyen formant conduit de commande d'écoulement de fluide (27) sont bobinés ou enroulés en spirale autour des organes tubulaires de production de rayonnement ultraviolet (26) allongés uniques, placés en relation imbriquée les uns avec les autres. 10 15
11. Système de purification de fluide selon la revendication 10, caractérisé en ce que ledit tubage allongé (33, 34; 60, 61) est en outre défini comme comprenant une surface extérieure à forme ondulée. 20
12. Système de purification de fluide selon la revendication 12, ou 11, caractérisé en ce que lesdites première et deuxième parties de tubage sont en outre définies comme étant formées à partir d'un matériau extrudé (27b) perméable au rayonnement, en une relation d'interconnexion cote-à-cote une surface ayant une forme sensiblement concave, ladite forme concave étant placée en relation de juxtaposition, espacée, par rapport audit organe tubulaire de production de rayonnement ultraviolet (26) allongé unique. 25 30 35
13. Système de purification de fluide selon l'une quelconque des revendications 1 à 12, caractérisé en ce que le fluide à purifier est un liquide. 40
14. Système de purification de fluide selon l'une quelconque des revendications 1 à 13, caractérisée en ce que lesdits premier et deuxième canaux comprennent des premier et deuxième conduits (33, 34), bobinés en hélice par paires autour dudit organe tubulaire émetteur (26) allongé unique, d'une extrémité à l'autre de cet organe, chaque bobinage venant latéralement en butée contre des bobinages adjacents. 45 50
15. Système de purification de fluide selon la revendication 14, caractérisé en ce que lesdits premier et deuxième conduits (33, 34) ont une surface extérieure ondulée. 55
16. Système de purification de liquide selon la revendication 14 ou 15, caractérisé en ce que lesdits premier et deuxième conduits (27B) sont formés à partir de matériaux extrudés, de façon à être interconnectés latéralement, une surface de ceux-ci étant de forme sensiblement concave, de façon à recevoir le rayonnement et à améliorer la transmission du rayonnement au fluide passant à travers lui.
17. Système de purification de fluide selon la revendication 7 ou 13, caractérisé par un nombre déterminé de systèmes de stérilisation de liquide (27A, 27B) modulaires ayant chacun un organe tubulaire émetteur allongé (26) couplé à une source d'énergie électrique, pour émettre un rayonnement ultraviolet, et une paire de conduits de liquide tubulaire (33, 34), lesdits conduits (33, 34) étant bobinés hélicoïdalement par paires autour dudit organe tubulaire émetteur allongé (26) d'une extrémité à l'autre, chaque bobine étant latéralement en butée contre des bobines adjacentes, afin d'envelopper la périphérie sur pratiquement toute la longueur dudit organe tubulaire émetteur allongé (26), chaque conduit (33, 34) ayant un orifice d'entrée (35; 44) à une extrémité et un orifice de sortie (36; 39) à l'autre extrémité, lesdits conduits (33, 34) étant transparents au rayonnement ultra-violet, de façon à permettre l'exposition au ultraviolet du liquide s'écoulant à travers lesdits conduits (33; 34) au rayonnement au ultraviolet, et dans lequel l'orifice d'entrée (35; 44) d'un conduit (33; 34) est couplé, par paires, et immédiatement adjacent à l'orifice de sortie (39; 44) de l'autre conduit (33; 34), de façon à permettre un écoulement en opposition de liquide à travers lesdits conduits (33, 34).
un nombre déterminé de systèmes de filtrage modulaires (22A; 22B), destinés à filtrer le fluide arrivant, chaque système de filtrage (22A; 22B) ayant une entrée de filtre et une sortie de filtre, des moyens pour assurer une interconnexion pour constituer un système de purification de liquide ayant un agencement particulier souhaité, ledit agencement comprenant
une entrée de système,
une sortie de système,
un premier système de stérilisation de liquide (21A), sélectionné dans ledit nombre de système de stérilisation de liquide (21A; 21B), ledit premier système de stérilisation de liquide (21A) ayant un orifice d'entrée d'un conduit relié à ladite entrée de système et l'orifice de sortie, couplé par paire, de l'autre conduit étant relié à ladite sortie de système,



et l'un, sélectionné parmi ledit nombre de systèmes de stérilisation de liquide modulaire (21A; 21B) et ledit nombre de systèmes de filtrage (22A; 22B), étant couplé à l'orifice d'entrée dudit autre conduit et à l'orifice de sortie dudit premier conduit dudit premier système de stérilisation de liquide (21A), pour constituer un système de purification de liquide fermé.

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conduits (33, 34) sont réalisés en matière plastique et ont une section transversale leur donnant une forme cylindrique et le liquide à irradier étant de l'eau.

18. Système de purification de liquide selon la revendication 17, caractérisé en ce que ledit moyen d'interconnexion pour constituer un système de purification de liquide est facilement démontable et remontable.

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19. Système de stérilisation de liquide comprenant :

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un tube émetteur de rayonnement ultraviolet (26) allongé unique couplé à une source d'énergie électrique pour émettre un rayonnement ultraviolet,

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et une paire de conduits liquide tubulaire (33, 34) lesdits conduits étant bobinés hélicoïdalement, par paires, autour dudit tube émetteur de rayonnement ultraviolet (26) unique, chaque bobine étant latéralement en butée avec des bobines adjacentes, ledit conduit (33; 34) ayant son orifice d'entrée (35; 44) à une extrémité et son orifice de sortie (36; 39) à l'autre extrémité, lesdits conduits (33; 34) étant transparent au rayonnement ultraviolet, de façon à permettre d'exposition du liquide passant à travers lesdits conduits (33; 34) au rayonnement ultraviolet émis par ledit tube (26),

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caractérisé en ce que lesdits conduits (33; 34) s'enroulent en périphérie pratiquement sur toute la longueur dudit tube émetteur de rayonnement ultraviolet unique (26) et en ce que l'orifice d'entrée (35; 44) du premier conduit (33; 34) est couplé par paire et immédiatement adjacent à l'orifice de sortie (36; 39) de l'autre conduit (34; 33) pour permettre d'établir un écoulement de liquide en opposition à travers lesdits conduits (33; 34).

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20. Système selon la revendication 18, caractérisé en ce que la sortie (36) du premier conduit (33) est couplée à l'entrée (44) de l'autre conduit (34).

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21. Système selon la revendication 19 ou 20, caractérisé en ce que la sortie (36) dudit premier conduit (33) est couplée à l'entrée (44) dudit deuxième conduit (34) par un autre moyen de filtrage de liquide (22).

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22. Système selon l'une quel conque des revendications 19 à 21, caractérisé en ce que lesdits