



(86) Date de dépôt PCT/PCT Filing Date: 1998/01/23  
(87) Date publication PCT/PCT Publication Date: 1998/07/30  
(45) Date de délivrance/Issue Date: 2007/07/24  
(85) Entrée phase nationale/National Entry: 1999/07/26  
(86) N° demande PCT/PCT Application No.: US 1998/001383  
(87) N° publication PCT/PCT Publication No.: 1998/032700  
(30) Priorité/Priority: 1997/01/27 (US08/790,750)

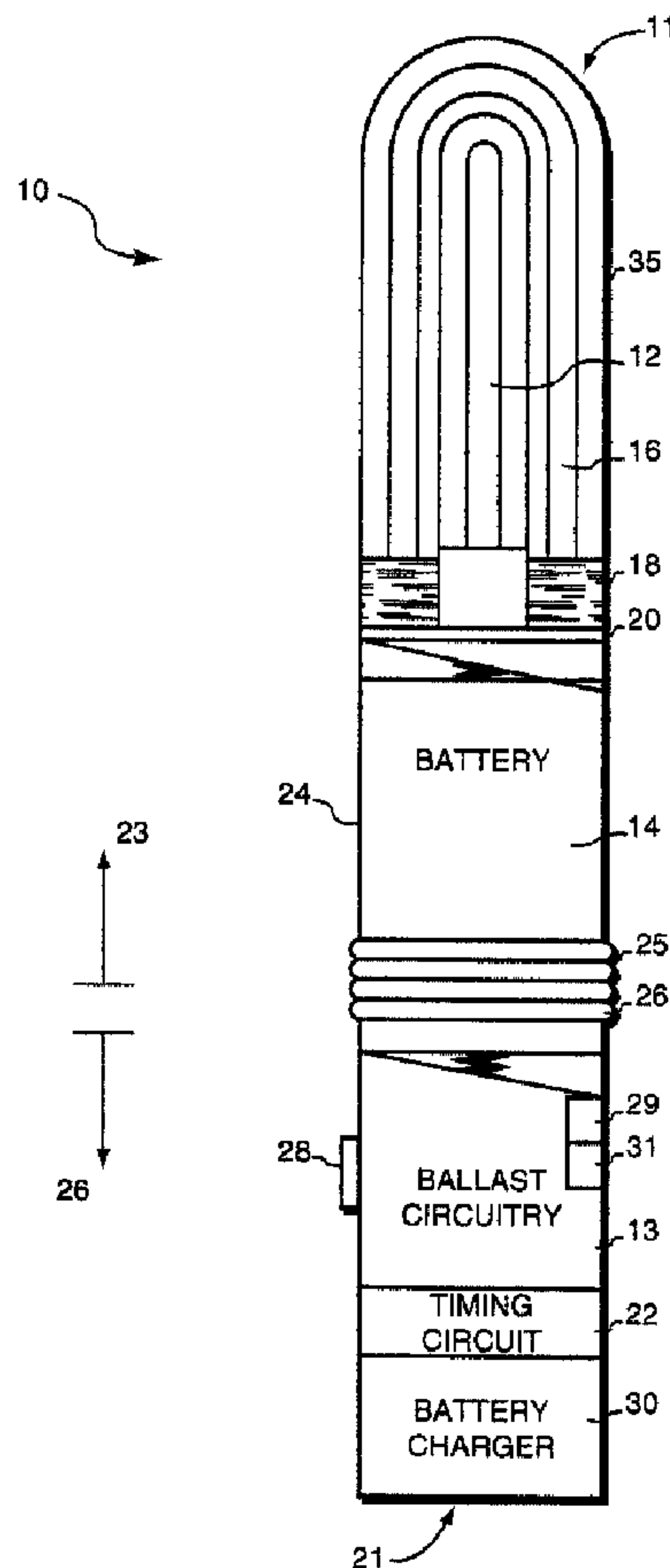
(51) Cl.Int./Int.Cl. *C02F 1/32* (2006.01)

(72) Inventeurs/Inventors:  
MAIDEN, MILES, US;  
WATKINS, ROBERT, US

(73) Propriétaire/Owner:  
HYDRO-PHOTON, INC., US

(74) Agent: SMART & BIGGAR

(54) Titre : DISPOSITIF DE PURIFICATION D'EAU PAR ULTRAVIOLETS, TENANT DANS LA MAIN  
(54) Title: HAND-HELD ULTRAVIOLET WATER PURIFICATION SYSTEM



(57) Abrégé/Abstract:

A hand-held water purification system includes a pen-light sized ultraviolet lamp (12) that is enclosed in a quartz cover and is powered by a battery and associated ballast circuitry. The battery and ballast circuitry are connected to the lamp by switches that



(57) **Abrégé(suite)/Abstract(continued):**

are under the control of a liquid-level sensor. The sensor connects the battery, the ballast circuitry and the lamp once the sensor determines that the ultraviolet lamp is fully immersed in the water. If the container (32) that holds the water is relatively large, the lamp and quartz cover end (16) of the system are used to stir the water, to ensure that all of the water comes sufficiently close to the ultraviolet lamp (12).



PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification<sup>6</sup> :

C02F 1/32

A1

(11) International Publication Number:

WO 98/32700

(43) International Publication Date:

30 July 1998 (30.07.98)

(21) International Application Number: PCT/US98/01383

(22) International Filing Date: 23 January 1998 (23.01.98)

(30) Priority Data:

08/790,750

27 January 1997 (27.01.97)

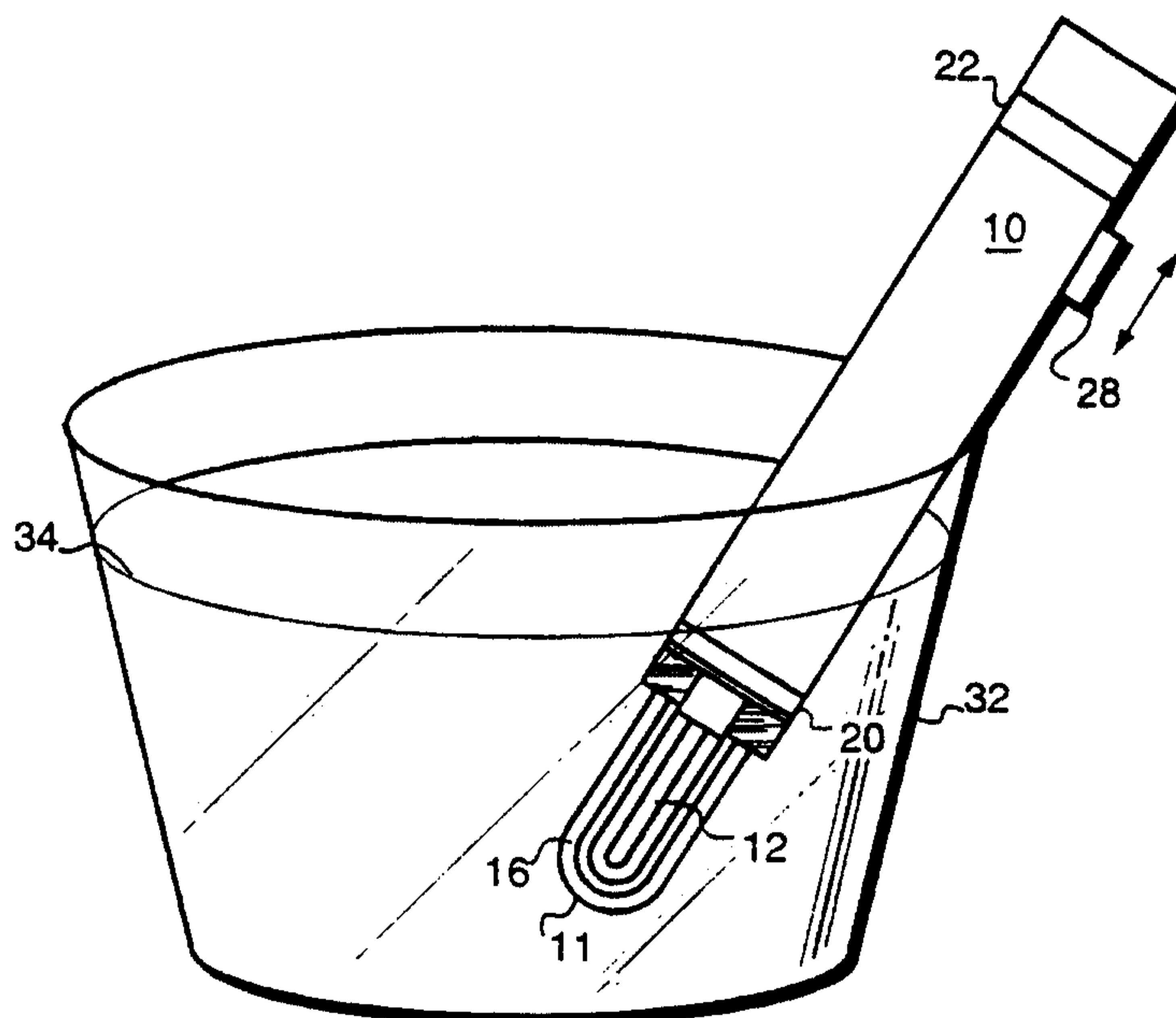
US

(71) Applicant: HYDRO-PHOTON, INC. [US/US]; Route 172,  
P.O. Box 675, Blue Hill, ME 04614 (US).(72) Inventors: MAIDEN, Miles; Parker Point Road, Blue Hill, ME  
04614 (US). WATKINS, Robert; The Grindleville Road,  
Blue Hill, ME 04614 (US).(74) Agents: SHEEHAN, Patricia, A. et al.; Cesari and McKenna,  
LLP, 30 Rowes Wharf, Boston, MA 02110 (US).(81) Designated States: AL, AU, BA, BB, BG, BR, CA, CN, CU,  
CZ, EE, GE, HU, ID, IL, IS, JP, KP, KR, LC, LK, LR, LT,  
LV, MG, MK, MN, MX, NO, NZ, PL, RO, SG, SI, SK,  
SL, TR, TT, UA, UZ, VN, YU, ARIPO patent (GH, GM,  
KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ,  
BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE,  
CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL,  
PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN,  
ML, MR, NE, SN, TD, TG).**Published***With international search report.**Before the expiration of the time limit for amending the  
claims and to be republished in the event of the receipt of  
amendments.*

(54) Title: HAND-HELD ULTRAVIOLET WATER PURIFICATION SYSTEM

## (57) Abstract

A hand-held water purification system includes a pen-light sized ultraviolet lamp (12) that is enclosed in a quartz cover and is powered by a battery and associated ballast circuitry. The battery and ballast circuitry are connected to the lamp by switches that are under the control of a liquid-level sensor. The sensor connects the battery, the ballast circuitry and the lamp once the sensor determines that the ultraviolet lamp is fully immersed in the water. If the container (32) that holds the water is relatively large, the lamp and quartz cover end (16) of the system are used to stir the water, to ensure that all of the water comes sufficiently close to the ultraviolet lamp (12).



WO 98/32700

PCT/US98/01383

**HAND-HELD ULTRAVIOLET WATER PURIFICATION SYSTEM****FIELD OF THE INVENTION**

The invention relates to systems for disinfecting water  
5 using ultraviolet light.

**BACKGROUND OF THE INVENTION**

It is known that ultraviolet ("UV") light in the  
germicidal range, of approximately 254nm, can be used to  
10 disinfect water, that is, to rid water of bacteria, viruses,  
algae and so forth. Known prior water purification systems  
that use UV light are large, installed systems that each  
include a flow-through subsystem, which causes water to travel  
past an elongated UV light source that is suspended therein. A  
15 quartz sleeve surrounds the UV light source, to protect it and  
its electrical connections from the water while allowing the UV  
radiation to pass to the water. Such systems are currently  
used to purify water for use in, for example, hospitals or  
schools.

20 The flow-through subsystems each essentially include a  
flow-through chamber, i.e., a pipe. As water flows through the  
pipe, it travels past the quartz sleeve, and thus, the UV light  
source, and is exposed to UV radiation. The UV radiation kills  
the bacteria, viruses and so forth that are present in the  
25 water. Waste byproducts may build up on the quartz sleeve, and  
accordingly, the systems include wiper mechanisms that  
periodically clean the quartz sleeves. These systems typically  
include a mechanism, such as a viewing port and/or a sensor,  
for determining the output level of the lamp. A user can  
30 visually check the lamp through the view port to ensure both  
that the lamp is turned on and that the quartz sleeve is  
sufficiently clean to pass the level of UV radiation required

-2-

to disinfect the water. The sensor measures the UV radiation for the same purpose.

These flow-through systems work well for disinfecting relatively large quantities of water. They are not, however, suitable for disinfecting small quantities of water.

Today campers, hikers, travelers and the like encounter bacteria and virus infected water in streams, lakes and rivers, and in some countries even in the local plumbing. These hikers, campers and travelers must thus either carry bottled water with them or use portable filtering systems and/or chlorine, hydrogen peroxide or iodine tablets, to disinfect the water. The filtering systems are generally bulky, and thus, inconvenient to carry. Further, while they may remove bacteria and algae from the water, they do not remove viruses, which are typically too small to be caught in the filters. The chemical tablets are certainly portable but they are relatively expensive. Further, the tablets change the taste and smell of the water and add undesirable chemical byproducts to the water. Indeed, the tablet manufacturers generally warn against continuous use of the tablets, for health reasons.

#### SUMMARY OF THE INVENTION

In one embodiment the invention is a portable, hand-held water purifier that uses UV light to disinfect small quantities, or batches, of water. The water purifier, which is approximately the size and shape of a pen light, has extending from one end a small UV lamp with a quartz cover. The cover, and thus, the lamp, are dipped into a container of water and the lamp is then turned on, to rid the water of infectious agents. As necessary, the user may

-3-

use the lamp end of the system to agitate the water, to ensure that all of the water passes sufficiently close to the lamp. The system, which is battery-operated, further includes a liquid-level sensor at the base of the UV lamp.

5 The sensor prevents the lamp from turning on until the lamp is fully immersed in the water. The container and the water act to shield the UV radiation, such that very little is emitted from the container. This prevents potentially harmful UV radiation from reaching the user and, in  
10 particular, the user's eyes.

The invention may be summarized according to one aspect as a hand-held water purification system including:  
A. a case that supports the system, the case having an interior, an exterior, a first end and a second end and  
15 being sized to be held in one hand; B. an ultraviolet light source that extends outwardly from the first end of the case; C. an ultraviolet transmissive cover having a first end and a second end and fitting over the ultraviolet light source, the cover attaching at the first end to the case to  
20 form a water-tight enclosure for the light source and extending outwardly from the case; and D. a battery and associated ballast circuit that fit into the interior of the case and power the light source; wherein the cover is submerged in the water and the light source is turned on to  
25 purify the water.

According to another aspect the invention provides a method of purifying water that is held in a container, the method including the steps of: A. turning a hand-held water purification system on; B. immersing in the water to be  
30 purified an ultraviolet light source and associated water-tight ultraviolet transmissive cover that extend outwardly

-3a-

from other system components and form a first end of the system; C. sensing that the light source is immersed fully in the water; and D. turning the light source on to emit ultraviolet radiation in the container, the radiation  
5 purifying the water.

According to another aspect the invention provides a method of purifying water that is held in a container, the method including the steps of: A. immersing in the water to be purified an outwardly extending ultraviolet light source  
10 and associated water-tight ultraviolet transmissive cover; B. turning the light source on to emit ultraviolet radiation in the water; and C. agitating the water by stirring the water with the light source and cover end of the system, the radiation from the light source purifying the water.

15 According to another aspect the invention provides a method of purifying a batch of unsterilized water that is held in a container, the method including the steps of: A. immersing an ultraviolet light source and associated ultraviolet transmissive cover that extend from a first end  
20 of the system in the batch of unsterilized water; B. sensing that the light source is immersed fully in the unsterilized water; and C. turning the light source on to emit ultraviolet radiation in the batch of unsterilized water in the container, the radiation purifying the water.

25 According to another aspect the invention provides a method of purifying water that is held in a container, the method including the steps of: A. immersing an ultraviolet light source and an associated ultraviolet transmissive cover that form one end of a water purification system in  
30 the water to be purified; B. turning the light source on to emit ultraviolet radiation in the water; and C. agitating the water by stirring the water with the light source and

-3b-

cover end of the system, the radiation from the light source purifying the water.

According to another aspect the invention provides a hand-held system for purifying unsterilized water, the  
5 system including: A. a drinking container having at one end an opening through which water both enters and exits the container and a second closed end for holding the water in the container; B. a case with an outwardly extending ultraviolet light source, the light source for submerging in  
10 the unsterilized water that is held in the drinking container and providing ultraviolet emissions that purify the unsterilized water; and C. switches for turning the light source on and off, the switches being contained in the case.

15 According to another aspect the invention provides a method of purifying water that is held in a container, the method including the steps of: A. immersing an ultraviolet light source and an associated ultraviolet transmissive cover that form one end of a water purification system in  
20 the water to be purified; B. turning the light source on to emit ultraviolet radiation in the water to purify the water; and C. agitating the water to expose all of the water in the container to the ultraviolet radiation.

According to another aspect the invention provides  
25 a hand-held water purification system for purifying unsterilized water in batches, the system including: A. an ultraviolet light source; B. an ultraviolet transmissive cover that fits over the light source; C. power means for supplying power to the light source; and D. a case that  
30 contains the power means and connects to the ultraviolet transmissive cover to form a water-tight enclosure for the ultraviolet light and the power means.

-3c-

According to another aspect the invention provides a hand-held system for purifying unsterilized water, the system including: A. a case with an outwardly extending ultraviolet light source, the light source for submerging in  
5 the unsterilized water and providing ultraviolet emissions that purify the unsterilized water; B. control means for turning the light source on and off, the control means being contained in the case; and C. an ultraviolet transmissive cover that fits over the ultraviolet lamp and connects to  
10 the case in a water-tight manner to protect the lamp and the control means from the water.

According to another aspect the invention provides a method of purifying a batch of unsterilized water that is held in a container, the method including the steps of:  
15 A. immersing an ultraviolet light source and an associated ultraviolet transmissive cover that form one end of a water purification system in the batch of unsterilized water that is held in the container; B. turning the light source on to emit ultraviolet radiation in the batch of unsterilized  
20 water in order to sterilize the water; C. turning the light source off; and D. removing the light source from the batch of water held in the container.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

The above and further advantages of the invention  
25 may be better understood by referring to the following description in conjunction with the accompanying drawings, in which:

Fig. 1 is a cut away side view of a portable water purification system constructed in accordance with the  
30 invention; and

-3d-

Fig. 2 illustrates the portable water purification system of Fig. 1 in use.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Fig. 1 illustrates a portable, hand-held water purification system 10 for disinfecting water in relatively small batches. The system includes, extending from a first end 11, a pen-light sized quartz UV lamp 12 that emits light in the germicidal range. In the exemplary system, the lamp 12 emits light at 254nm. The lamp is powered through ballast circuitry 13 by a battery 14, which in the exemplary system is a size AA, 3.4 volt rechargeable lithium battery. A quartz cover 16 surrounds the UV lamp 12 on three sides. The quartz cover 16 fits into a holder 18 that also acts as a shock absorber for the lamp 12. The holder 18 thus compresses and bends, as appropriate, should the cover 16, and thus, the lamp 12, bump and edge or side of a container 32 (Fig. 2) into which they are placed. In the exemplary system the holder 18 is made of silicon and forms a water-tight seal with the cover 16, to prevent water from reaching the lamp and the associated circuitry. A removable protective cover 35 protects the lamp and quartz cover when the device is not in use.

WO 98/32700

PCT/US98/01383

-4-

A liquid-level sensor 20, which is connected to switches (not shown) between the lamp 12, and the ballast circuitry 13 and battery 14, prevents the UV lamp from turning on until it is fully immersed in water. The UV radiation from the lamp is then absorbed and/or reflected by the water and the container such that very little of the UV radiation escapes from the container. The user, who is holding the other end 21 of the system, is thus protected from harmful levels of the UV radiation, which might otherwise adversely affect his or her eyes.

The sensor 20 may, for example, be a capacitive-type sensor that senses the difference in capacitance of the water and the surrounding air. When the sensor determines that it is in water, which necessarily means that the lamp is immersed in the water, the sensor closes the switches and allows the lamp to be turned on.

The water purifier 10 may also include a timing circuit 22 connected between the sensor and the lamp and associated circuitry. The timing circuit turns the lamp off a predetermined time, for example, 15 seconds, after the sensor 20 turns the lamp on.

The battery 14 and related circuitry are encased in a water-resistant tube 24. In the exemplary embodiment, the tube 24 is constructed of stainless steel. The entire water purifier is approximately six and three-quarters inches long and five-eighths of an inch in diameter, and fits comfortably in one hand. The tube 24 includes two parts, namely, a top 23 and a bottom 26, that screw together at a joint 25, so that the battery 14 can be replaced, as necessary. A silicon O-ring 26 makes the joint 25 water-tight.

The user controls the system with an on-off switch 28. As discussed above, the lighting of the lamp 12 is ultimately controlled by the liquid-level sensor 20, such that the lamp lights only when both the on-off switch 28 is in the on position and the lamp is fully immersed in water.

The water purifier 10 may also include a battery charger 30, which in the exemplary system is a conventional inductive-type charging circuit. Further, the purifier may include a power-on LED 29 and a low-battery LED 31, which indicate to a user, respectively, that the UV lamp is lit and that the battery needs replacing or recharging.

Referring now to Fig. 2, a user places the lamp end 11 of the water purifier 10 in water 34 that is, in the example, contained in a drinking glass 32. The user turns the system 10 on by moving the on-off switch 28 to the appropriate position. When the liquid-level sensor 20 determines that the lamp is fully immersed in the water, the sensor closes the switches (not shown) that separate the ballast circuitry 13 and the battery 14 (Fig. 1) from the lamp 12, and the lamp then turns on. The sensor 20 also starts the timing circuit 22 that keeps the lamp lit for a predetermined time.

The user may use the lamp end 11 of the system 10 to stir the water 34, to ensure that all of the water comes sufficiently close to the source of the UV radiation. If the container is small, however, the user need not stir the water.

After use, the user may wipe or wash the quartz sleeve 16, to clear away any waste byproducts that may have adhered to the sleeve and may adversely affect the output level of the device. Accordingly, the hand held purifier need not include a complex wiping mechanism and associated radiation-level sensor, as is required in the prior flow-through systems.

The hand-held UV water purification system 10 is thus a fully portable system that disinfects relatively small quantities, or batches, of water, such as the water contained in a drinking glass. The water purifier 10 is small and light weight so that it is easily and conveniently used when traveling, hiking, camping and so forth. This is in contrast to known flow-through UV water purification systems that are designed to disinfect large quantities of water for schools,

-6-

hospitals and so forth. Such flow-through systems are installed such that water is piped past an elongated UV light source that is permanently suspended in the piping. These flow-through systems do not work with the small quantities of water with which the hand-held portable system is expected to be used, and are not conveniently portable.

The foregoing description has been limited to a specific embodiment of this invention. It will be apparent, however, that variations and modifications may be made to the invention, with the attainment of some or all of its advantages. Therefore, it is the object of the appended claims to cover all such variations and modifications as come within the true spirit and scope of the invention.

WO 98/32700

PCT/US98/01383

-7-

CLAIMS

1. A hand-held water purification system including:
  - A. a case that supports the system, the case having an interior, an exterior, a first end and a second end and being sized to be held in one hand;
  - B. an ultraviolet light source that extends outwardly from the first end of the case;
  - C. an ultraviolet transmissive cover having a first end and a second end and fitting over the ultraviolet light source, the cover attaching at the first end to the case to form a water-tight enclosure for the light source and extending outwardly from the case; and
  - D. a battery and associated ballast circuit that fit into the interior of the case and power the light source;wherein the cover is submerged in the water and the light source is turned on to purify the water.
2. The system of claim 1 further including a liquid-level sensor that prevents the light source from turning on until the light source is immersed in water.
3. The system of claim 2 further including a timing circuit that turns the light source off a predetermined time after the sensor turns the light source on.
4. The system of claim 2 wherein:
  - a. the battery is rechargeable; and
  - b. the system further includes a battery charger.
5. A method of purifying water that is held in a container, the method including the steps of:
  - A. turning a hand-held water purification system on;
  - B. immersing in the water to be purified an ultraviolet light source and associated water-tight ultraviolet

-8-

transmissive cover that extend outwardly from other system components and form a first end of the system;

C. sensing that the light source is immersed fully in the water; and

D. turning the light source on to emit ultraviolet radiation in the container, the radiation purifying the water.

6. The method of claim 5 further including the step of agitating the water by stirring the water with the first end of the system.

7. The method of claim 5 further including the step of turning the light source off a predetermined time after the light source is turned on.

8. A method of purifying water that is held in a container, the method including the steps of:

A. immersing in the water to be purified an outwardly extending ultraviolet light source and associated water-tight ultraviolet transmissive cover;

B. turning the light source on to emit ultraviolet radiation in the water; and

C. agitating the water by stirring the water with the light source and cover end of the system, the radiation from the light source purifying the water.

9. The method of claim 8 further including the step of sensing that the light source is immersed fully in the water before turning on the light source.

10. The method of claim 5 further including the step of turning the light source off a predetermined time after the light source is turned on.

-9-

11. The method of purifying water of claim 10 further including the step of removing the lamp and quartz cover from the container after the lamp is shut off.

12. A method of purifying a batch of unsterilized  
5 water that is held in a container, the method including the steps of:

A. immersing an ultraviolet light source and associated ultraviolet transmissive cover that extend from a first end of the system in the batch of unsterilized water;

10 B. sensing that the light source is immersed fully in the unsterilized water; and

C. turning the light source on to emit ultraviolet radiation in the batch of unsterilized water in the container, the radiation purifying the water.

15 13. The method of claim 12 further including the step of agitating the water by stirring the water with the first end of the system.

14. The method of claim 12 further including the step of turning the light source off a predetermined time after  
20 the light source is turned on.

15. A method of purifying water that is held in a container, the method including the steps of:

A. immersing an ultraviolet light source and an associated ultraviolet transmissive cover that form one end  
25 of a water purification system in the water to be purified;

B. turning the light source on to emit ultraviolet radiation in the water; and

-10-

C. agitating the water by stirring the water with the light source and cover end of the system, the radiation from the light source purifying the water.

16. The method of claim 15 further including the step  
5 of sensing that the light source is immersed fully in the water before turning on the light source.

17. The method of claim 15 further including the step of turning the light source off a predetermined time after the light source is turned on.

10 18. A hand-held system for purifying unsterilized water, the system including:

A. a drinking container having at one end an opening through which water both enters and exits the container and a second closed end for holding the water in  
15 the container;

B. a case with an outwardly extending ultraviolet light source, the light source for submerging in the unsterilized water that is held in the drinking container and providing ultraviolet emissions that purify the  
20 unsterilized water; and

C. switches for turning the light source on and off, the switches being contained in the case.

19. The system of claim 18 further including a liquid-level sensor that prevents the light source from turning on  
25 until the light source is immersed in water.

20. The system of claim 19 further including a timing circuit that turns the light source off a predetermined time after the sensor allows the light source to turn on.

-11-

21. The system of claim 19 wherein the switches for turning the light source on connect the light source to a battery.

22. The system of claim 21 wherein the battery is  
5 rechargeable and the system further includes a battery charger.

23. A method of purifying water that is held in a container, the method including the steps of:

A. immersing an ultraviolet light source and an  
10 associated ultraviolet transmissive cover that form one end of a water purification system in the water to be purified;

B. turning the light source on to emit ultraviolet radiation in the water to purify the water; and

C. agitating the water to expose all of the water  
15 in the container to the ultraviolet radiation.

24. The method of claim 23 further including the step of sensing that the light source is immersed fully in the water before turning on the light source.

25. The method of claim 23 further including the step  
20 of turning the light source off a predetermined time after the light source is turned on.

26. The method of claim 23 wherein the step of agitating the water includes agitating the water with the immersed ultraviolet light source.

25 27. A hand-held water purification system for purifying unsterilized water in batches, the system including:

A. an ultraviolet light source;

-12-

B. an ultraviolet transmissive cover that fits over the light source;

C. power means for supplying power to the light source; and

5 D. a case that contains the power means and connects to the ultraviolet transmissive cover to form a water-tight enclosure for the ultraviolet light and the power means.

28. The system of claim 27 further including a liquid-  
10 level sensor that prevents the light source from turning on until the light source is immersed in water.

29. The system of claim 28 further including a timing circuit that turns the light source off a predetermined time after the sensor turns the light source on.

15 30. The system of claim 28 wherein:

a. the battery is rechargeable; and

b. the system further includes a battery charger.

31. The system of claim 27 wherein the power means includes a battery and an associated ballast circuit.

20 32. The system of claim 27 wherein the case includes:

a. a first section and a second section that separate to provide access to the power means, and

b. sealing means for making a water-tight seal between the first and second sections.

25 33. The system of claim 32 wherein the sealing means is a gasket.

-13-

34. The system of claim 27 further including in the case a control means for switching the ultraviolet light source on to purify a batch of unsterilized water and thereafter switching the light source off.

5 35. A hand-held system for purifying unsterilized water, the system including:

A. a case with an outwardly extending ultraviolet light source, the light source for submerging in the unsterilized water and providing ultraviolet emissions that  
10 purify the unsterilized water;

B. control means for turning the light source on and off, the control means being contained in the case; and

C. an ultraviolet transmissive cover that fits over the ultraviolet lamp and connects to the case in a  
15 water-tight manner to protect the lamp and the control means from the water.

36. The system of claim 35 wherein the control means includes:

a. a switch; and

20 b. a timer for operating the switch to turn the light source off a predetermined time after the light source turns on.

37. A method of purifying a batch of unsterilized water that is held in a container, the method including the  
25 steps of:

A. immersing an ultraviolet light source and an associated ultraviolet transmissive cover that form one end of a water purification system in the batch of unsterilized water that is held in the container;

-14-

B. turning the light source on to emit ultraviolet radiation in the batch of unsterilized water in order to sterilize the water;

C. turning the light source off; and

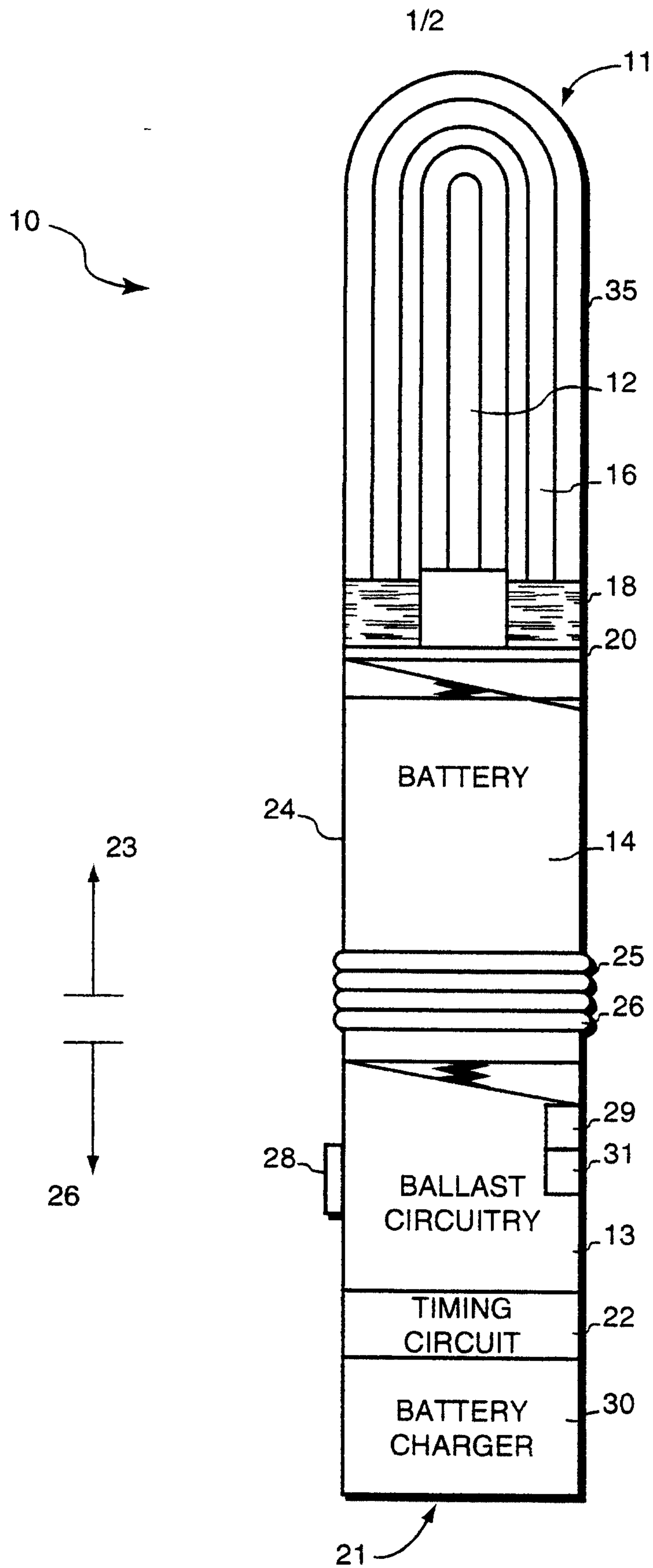
5 D. removing the light source from the batch of water held in the container.

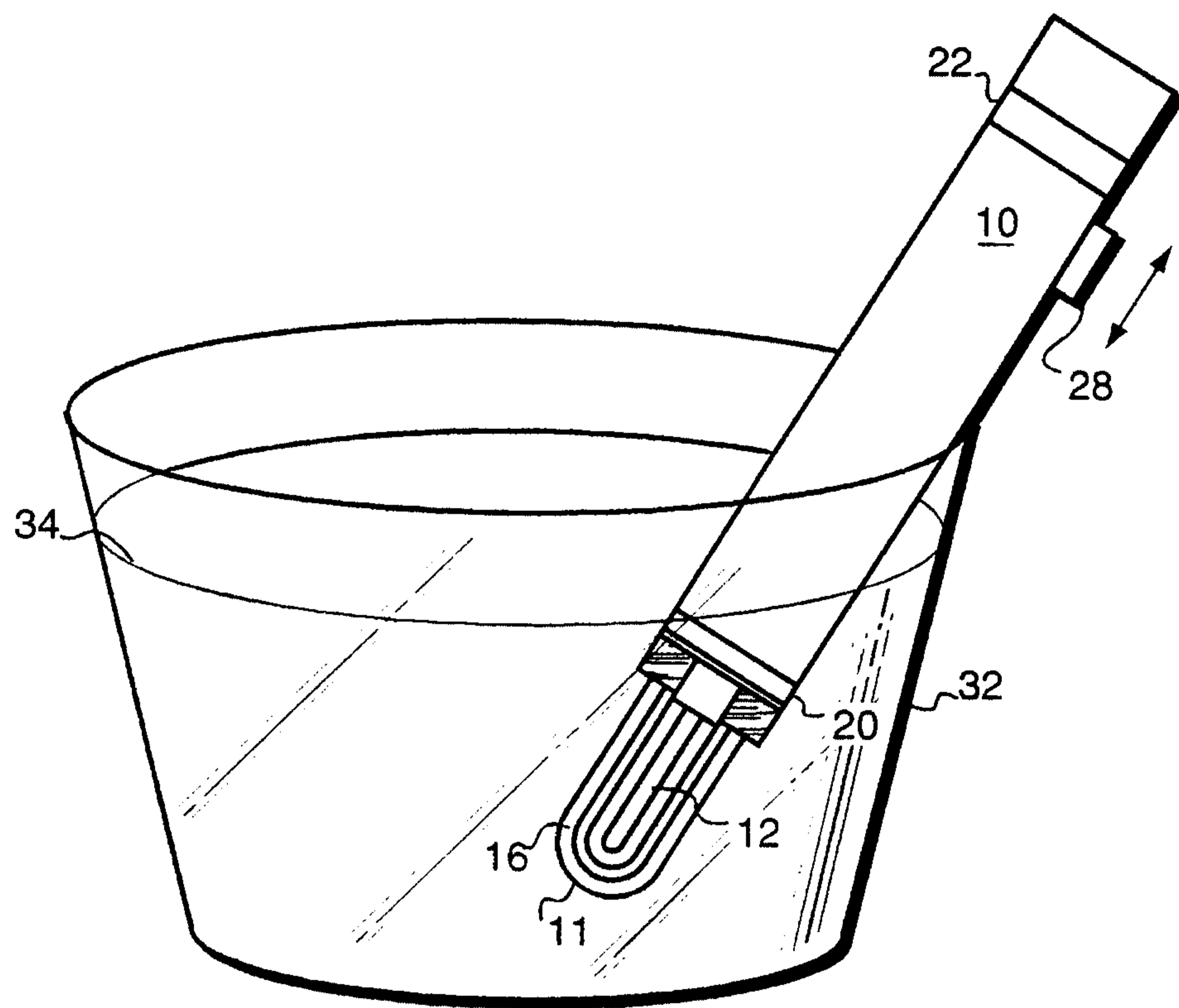
38. The method of claim 37 wherein the step of turning the light source off further includes turning the light source off a predetermined time after turning the light  
10 source on.

SMART & BIGGAR

OTTAWA, CANADA

PATENT AGENTS

**FIG. 1**

**FIG. 2**

