

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
21 December 2007 (21.12.2007)

PCT

(10) International Publication Number
WO 2007/143785 A1

(51) International Patent Classification:
D06F 39/02 (2006.01) *D06F 17/00* (2006.01)
C01B 13/10 (2006.01)

(74) Agent: ALLENS ARTHUR ROBINSON PATENT &
TRADE MARK ATTORNEYS; Cnr Hunter and Philip
Streets, Sydney, NSW 2000 (AU).

(21) International Application Number:
PCT/AU2007/000829

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date: 14 June 2007 (14.06.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2006202541 15 June 2006 (15.06.2006) AU

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (*for all designated States except US*): OZONE
TECHNOLOGIES PTY LIMITED [AU/AU]; Unit 35,
34-36 Ralph Street, Alexandria, NSW 2015 (AU).

(72) Inventors; and

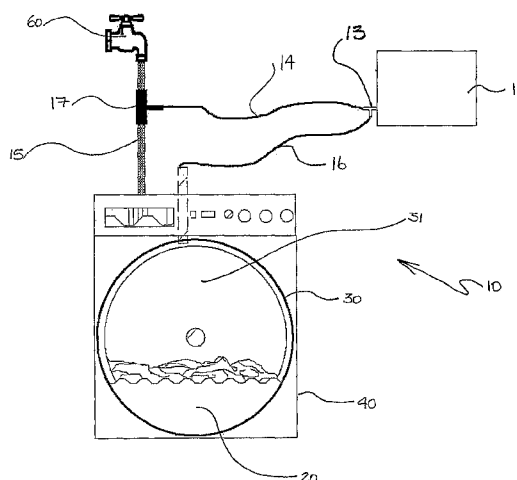
(75) Inventors/Applicants (*for US only*): NAGLE, Kevin
[AU/AU]; 21 Greenbank Street, Marrickville, NSW 2204
(AU). VON KONIGSMARK, Peter [AU/AU]; 4/33
Stokes Street, Lane Cove, NSW 2066 (AU). MOUT-
ZOURIS, Paul [AU/AU]; 30 Anderson Avenue, Ryde,
NSW 2112 (AU).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SYSTEM AND DEVICE FOR INTRODUCING OZONE INTO A WASHING APPARATUS



(57) Abstract: The present invention is directed to a system for introducing ozone into a washing apparatus, the system comprising ozone supply means; and ozone delivery means including a first fluid conduit adapted to transfer ozone from the ozone supply means to a wash liquid inlet means, said wash liquid inlet means adapted to deliver wash liquid to a wash chamber of the washing apparatus, and a second fluid conduit adapted to deliver ozone to an above-liquid region of the wash chamber; wherein said system is adapted so that, during a wash cycle, ozone is introduced: into the wash chamber via the wash liquid inlet means, mixed in the wash liquid, and into the above-liquid region of the wash chamber via the second fluid conduit. The invention is also directed to a device adapted for use in the system, to an arrangement, and to related methods.

SYSTEM AND DEVICE FOR INTRODUCING OZONE INTO A WASHING APPARATUS

Technical Field

The present invention relates generally to systems and devices for using ozone in washing applications. More specifically, the present invention relates to a system for introducing ozone into a washing apparatus, a device adapted for use in the system, and a method of washing items using said device or system.

Background

10 **Ozone in washing applications**

Ozone (O_3) is comprised of three oxygen atoms, generally formed when a single oxygen atom collides with O_2 .

Once exposed to both organic and inorganic material either in the air or in wash liquid, the extra oxygen atom of the ozone molecule breaks off and combines with other matter to alter its chemical structure. Hydroxyls and hydroxyl radicals are formed when the ozone strips hydrogen atoms from wash liquid molecules (H_2O), forming hydroxyl (OH). The hydroxyl consists of a hydrogen atom and an oxygen atom with a shared electron. A little hydrogen peroxide (H_2O_2) is also typically formed, which helps with bleaching and disinfection.

20 A radical (also called a "free radical") is a cluster of atoms, one of which contains an unpaired electron in its outermost shell of electrons. This is an extremely unstable configuration and therefore radicals react readily with other molecules or radicals to achieve a more stable configuration. This reaction is very quick which largely explains why ozone is known to be about 3000 times faster than chlorine at destroying bacteria.

25 In the cleaning context, these ozone reactions are more powerful than chemical or thermal disinfection and are faster and more effective at removing re-deposition and brightening and deodorising linen. The reason for this is that ozone reacts directly with organics by attacking unsaturated carbon to carbon double bonds. Some reaction products of ozonation typically include organic peroxides, hydrogen peroxide, and super oxide anions.

30 These organic peroxides can react non-selectively with other saturated or unsaturated compounds in the recycled cleaner (through the free radical reaction mechanism), thus forming new compounds through a coupling process that is similar to polymerization.

This results in the creation of a wide variety of surface active compounds in a wash process that also utilises a detergent. After repeated exposure of detergent solutions to limited amounts of ozone, new surfactants begin forming that are amphoteric (soluble in acids and bases) with alcohol, glycol, and carboxylic acid functional groups (all on the backbone of a hydrocarbon). These surfactants variably exhibit high solubility in wash liquid and the ability to chelate and sequester metal ions. They can also increase the detergent's capacity to emulsify and solubilize hydrophobic contaminants such as grease and oil.

The complex, fast and poly-facetic reactions caused by ozone within the laundry context make it a particularly beneficial additive to a wash liquid for a laundry process.

Conventional methods of generating ozone

There are at least two methods commonly used for generating ozone. Each such method uses a different mechanism: one uses an ultra-violet (UV) lamp and the other relies on corona discharge, also known as, cold plasma. A brief description of both methods is as follows:

(i) Corona discharge ozone generator

Using a Corona Discharge (CD) system, ozone is produced by passing air through a high voltage electrical discharge, or corona. A minimum of 5,000 volts of electricity is generally necessary to create the corona (14,000V is a practical design maximum voltage). Air (containing 21% O₂) or concentrated oxygen (95% pure oxygen) dried to a minimum of -60°C dew point passes through the corona. This causes the O₂ bond to break, freeing single oxygen atoms which then collide and temporarily bond with other O₂ molecules to create O₃.

Ozone production can be regulated by adjusting either the applied voltage or feed-gas flow. By reducing the feed-gas flow, ozone concentration is increased, but the overall production rate decreases. Reducing the applied voltage decreases concentration. The ozone/gas mixture discharged from the CD ozone generator normally contains from 1% to 3% (by weight) ozone when using dry air, and 3% to 6% (by weight) ozone when using high purity oxygen as the feed-gas.

The feed-gas for the generator should have particulate material and moisture removed as a minimum. Any contaminants present in the gas stream build up quickly and affect the electrical discharge. Moisture in the feed-gas causes two serious problems. First, moisture will cause a significant drop in ozone production. Second, a small amount of nitrogen in the air converts to oxides, which dissolve in moisture to form nitric acid. Feed-gas must be

dried to below -63°C dew point to ensure that this does not occur. Moisture can be removed by passing the air through molecular sieves, activated alumina, silica gel, or by a combination of refrigeration and desiccation.

One of the major drawbacks with CD systems is the amount of equipment required to generate the ozone and the number of protective devices that must be used to protect the operator from accidental inhalation of potentially toxic levels of ozone. Furthermore, the size and expense of conventional CD systems renders them mechanically and economically unfeasible to install in laundries having low wash loads, typically less than about 1200 kg per week.

10 **(ii) Ultra-violet lamp ozone generator**

When an oxygen molecule (O_2) absorbs a photon of light with a wavelength shorter than 200 nanometers the energy splits the molecule into two oxygen atoms ($2 \times O$).

Therefore, in ultra violet (UV) lamp ozone generators, the UV lamp is preferably designed to generate light at a wavelength of about 185nm. This wavelength breaks apart the oxygen molecule and generates free oxygen atoms, and ozone is produced as described above. Dry, clean air is not necessary for use with UV lamps which makes such lamps more suitable for use in the laundry. UV lamps will produce ozone with little reduction in ozone concentration in most ambient air conditions. Over a period of time (generally 8000 hours of use), the lamps solarise and ozone output may reduce to 20% of the original.

20 To direct the ozone from such generators into a wash liquid for a washing machine, the UV lamps are typically encased in a stainless steel, aluminium or PVC housing (approximately 50mm in diameter), and ambient air is fed through the housing via an air pump. As the air flows over the enclosed UV lamps, ozone is produced from the oxygen in the air and transferred to the wash liquid. Ozone production can be regulated by adding or removing UV lamps or adjusting the air flow.

Although, as explained above, ozone is considered to be an excellent additive to washing liquids, it has been found that detergent in wash liquid consumes ozone very quickly, if not immediately. This has led skilled artisans to believe that, to be effective, a high concentration of ozone in the wash liquid is required. Consequently, in recent years, UV lamps have rarely been used to generate ozone as UV light systems only produce a fraction of the amount of ozone that corona discharge systems produce. Therefore, despite their size and expense, corona discharge systems have generally become the product of choice for use with laundry machines.

Conventional washing systems that utilise ozone

Conventional laundry systems can be broken down into at least two broad categories.

Some systems, referred to as "closed-loop laundry systems", recycle the wash liquid used during each cycle of the wash load. Others apply an "open-loop laundry system", in which the laundry waste wash liquid is drained after each wash cycle and after each rinse cycle of the laundry wash process.

Typically, conventional washing systems that use ozone introduce the ozone into the wash liquid before the wash liquid comes into contact with the items to be washed. In some prior art systems, this is achieved by having ozone introduced or injected into the wash liquid via an open ended pipe. As ozone is typically more quickly absorbed by wash liquid when the bubble size is minimised, preferably in the form of micro-bubbles, the drawback of this system is that absorption of ozone is slow. In other systems, ozone is introduced into the washing machine with the assistance of a venturi injector in the wash liquid line.

Other conventional systems for introducing ozone into washing machines include a diffuser at the base of the wash cavity, which injects ozone bubbles up through the wash liquid which disperse or dissolve in the wash liquid. A problem with such systems is that the diffuser may become blocked with lint and scale, severely reducing the integration of ozone into the liquid.

There are also several other systems for introducing ozone into the wash liquid, for which quite complex engineering is required.

In addition to relying on physical alterations to the washing machines, conventional systems have also sought to introduce ozone at one of a number of different stages during the wash cycle. For example, in some conventional systems, ozone is introduced into the wash liquid during the washing step only, so as to reduce the consumption of ozone gas. However, introducing ozone for such a short period in the entire wash cycle may prevent the limited amount of ozone used from working to its potential or achieving the desired result.

In order to address the fact that the size of the washing load may vary from wash to wash, some conventional systems have also sought to introduce a mechanism whereby the operator can vary the concentration of ozone being introduced into the wash liquid.

On the whole, however, as mentioned above, most conventional systems introduce a high concentration of ozone into the wash liquid in order to maintain a sufficient concentration of ozone during the various wash cycles. The risks associated with using high

concentrations of ozone include health risks to persons in the laundry, and rapid degradation of the mechanical components used in the system.

Although the use of ozone in laundry applications and other washing applications is quite well known and used with considerable success, conventional systems suffer a number of drawbacks. Addressing some of these drawbacks often causes other different problems to arise. This makes it difficult to overcome several of these drawbacks in one system. For example, on the one hand, it is believed that high concentrations of ozone are necessary to avoid the rapid consumption of ozone by detergents in the wash liquid. On the other hand, high concentrations of ozone are hazardous to the health of operators and others in the laundry and may cause rapid degradation of physical components of the various parts of the machines.

There is, therefore, a need for improved systems for the introduction of ozone into washing applications, and for devices for use in those systems.

In this specification, where a document, act or item of knowledge is referred to or discussed, this reference or discussion is not an admission that the document, act or item of knowledge or any combination thereof was at the priority date:

- (i) part of common general knowledge; or
- (ii) known to be relevant to an attempt to solve any problem with which this specification is concerned.

Summary of Invention

In this specification, the following definitions apply:

"mix" (and other grammatical variations of mix), when used in the context of the invention, includes combine, blend, disperse, dissolve, or any combination of these.

"conduit", when used in the context of this invention, means a tube, hose, pipe, channel, duct, or other similar means for transmitting fluid, or a combination of any of these. "Fluid", when used in the context of this invention, may mean a gas or liquid (depending on the context) and, in particularly preferred embodiments, means gas. Accordingly, "fluid conduit" preferably means a tube, hose, pipe, channel or duct capable of transmitting a liquid or gas.

"venturi" is a means, device or altered physical configuration of a portion of a conduit, tube, channel, duct, or like fluid transmission means, adapted to effect a reduction in pressure in the vicinity of the means, device or altered physical configuration which is

capable of drawing a fluid (ie liquid or gas) in the direction of the means, device or altered physical configuration.

"wash cycle", in conventional systems, typically includes several phases or steps including, pre-wash, main wash, and one or more rinse phases or steps. In the context of this invention, the term "wash cycle" is not intended to limit the number or order of phases or steps which the wash cycle may include. The wash cycle of preferred embodiments typically commences when a user initiates the washing process, by for example, pressing the "start" button of the washing apparatus, and ends on completion of the last phase or step, for example, the last rinse phase.

- 10 According to a first aspect, the present invention provides a system for introducing ozone into a washing apparatus, the system comprising:

ozone supply means; and

ozone delivery means including:

- 15 a first fluid conduit adapted to transfer ozone from the ozone supply means to a wash liquid inlet means, said wash liquid inlet means adapted to deliver wash liquid to a wash chamber of the washing apparatus, and

a second fluid conduit adapted to deliver ozone to an above-liquid region of the wash chamber;

- 20 wherein said system is adapted so that, during a wash cycle, ozone is introduced: into the wash chamber via the wash liquid inlet means, mixed in the wash liquid, and into the above-liquid region of the wash chamber via the second fluid conduit.

- In some preferred embodiments, a first end of the second fluid conduit is connected to the first fluid conduit so that the second fluid conduit is in fluid communication with the first fluid conduit. This connection between the first end of said second fluid conduit and the first fluid conduit may be a substantially T-shaped connection located intermediate two ends of the first fluid conduit.

- Some preferred embodiments of the system further include gas redirection means adapted to substantially inhibit ozone from being introduced into the wash chamber via the second fluid conduit while wash liquid is being introduced into the wash chamber via the wash liquid inlet means. The gas redirection means of preferred embodiments is a venturi adapted to draw ozone into the wash liquid inlet means.

- 30 In preferred embodiments of the invention that utilise a venturi as a gas redirection means, the venturi (aided by forces created by wash liquid running past) effects a

reduction in pressure in the vicinity of a junction between the first fluid conduit and the wash liquid inlet means, drawing ozone from the first fluid conduit into the wash liquid inlet means, mixing the ozone with the wash liquid.

5 The wash liquid inlet means typically communicates with an outlet from a water supply, such as the main water supply to a laundry. Alternatively, the wash liquid inlet means may communicate with a separate reservoir containing wash liquid (eg water and detergent).

10 In a particularly preferred embodiment of this invention, the system is further adapted so that, during the wash cycle, after the wash liquid has been introduced into the wash chamber, the ozone is introduced into the wash chamber via the second fluid conduit.

In the above system, the ozone may be delivered into the ozone delivery means via a single outlet.

15 Preferably, the system of the present invention further includes a pump adapted to deliver ozone into the ozone delivery means. The pump may be interposed between the ozone supply means and the ozone delivery means. In embodiments that include a pump, positive pressure created by the pump enhances mixing of ozone into the wash liquid.

In a further preferred embodiment, the ozone delivered via the second fluid conduit is provided to the wash chamber through a vent in the washing apparatus.

20 The ozone supply means may be adapted to supply ozone in response to a signal that the washing apparatus has been activated. Typically, the activation signal is an electrical signal.

25 The ozone supply means is preferably an ozone generator. Preferably, the ozone generator generates ozone by exposing air to ultraviolet light and, in particularly preferred embodiments, to ultraviolet light of a wavelength sufficient to generate from the air oxygen atoms capable of colliding with oxygen molecules to form ozone. Preferably, the wavelength of the ultraviolet light ranges from about 150nm to about 280nm and, in particularly preferred embodiments, the wavelength is about 185nm.

30 Typically, the washing apparatus is a laundry washing machine. The system of the present invention could also be adapted for use with multiple washing machines, wherein there is at least one ozone delivery means for each washing machine. However, as would be appreciated by persons skilled in the art, the system of the present invention is not limited to use with laundry washing machines and it could also be applied to other washing applications.

According to a second aspect of this invention, there is provided an ozone delivery arrangement, for delivering ozone from an ozone supply means to a washing apparatus connected to wash liquid inlet means; said ozone delivery arrangement comprising:

5 a first fluid conduit, for transferring ozone from the ozone supply means to the wash liquid inlet means;

a mixer connection, connecting the first fluid conduit to the wash liquid inlet means, said mixer connection adapted to enable ozone to flow into the wash liquid inlet means and mix with wash liquid flowing through the wash liquid inlet means; and

10 a second fluid conduit adapted to transfer ozone to a wash chamber of the washing apparatus when wash liquid ceases flowing through the wash liquid inlet means.

The second fluid conduit is preferably adapted to transfer the ozone to an above-liquid region of the wash chamber.

15 Preferably, a first end of the second fluid conduit is connected to the first fluid conduit so that the second fluid conduit is in fluid communication with the first fluid conduit. The connection between the first end of said second fluid conduit and the first fluid conduit may be a substantially T-shaped connection located intermediate two ends of the first fluid conduit.

Preferably, the mixer connection is a venturi connection.

20 Preferably, either or both of the first and second fluid conduit(s) comprise(s) a hose, a tube, a pipe or a combination of these.

According to a third aspect of this invention, there is provided a method of installing an ozone delivery arrangement of the second aspect of this invention, said method comprising:

25 connecting a first end of the first fluid conduit to an outlet of the ozone supply means;

connecting a second end of the first fluid conduit to the wash liquid inlet means with a mixer connection adapted to enable ozone to flow into the wash liquid inlet means and mix with wash liquid flowing through the wash liquid inlet means;

30 positioning a first end of the second fluid conduit so as to enable it to receive ozone from the ozone supply means; and

connecting a second end of the second fluid conduit to the washing apparatus;

wherein the installed ozone delivery arrangement is adapted to transfer ozone from the ozone supply means to the wash liquid inlet means, via the first fluid conduit, when

wash liquid flows through the wash liquid inlet means, and to transfer ozone to the wash chamber, via the second fluid conduit, when wash liquid ceases flowing through the wash liquid inlet means.

5 Preferably, the ozone transferred to the wash chamber is transferred to an above-liquid region of the wash chamber.

Preferably, the first end of the second fluid conduit is connected to the first fluid conduit so that said second fluid conduit is in fluid communication with the first fluid conduit. The first end of the second fluid conduit may be connected to the first fluid conduit by means of a substantially T-shaped connection located intermediate two ends of the first fluid conduit.

10 According to a fourth aspect, the present invention provides an ozone generator adapted for use in the system of the first aspect of this invention, the ozone generator comprising:

air inlet means adapted to receive air,

15 a controller adapted to cause at least one ultraviolet light source to expose received air to ultraviolet light in response to an activation signal corresponding to activation of the washing apparatus, and

ozone outlet means adapted to deliver generated ozone to the ozone delivery means.

Preferably, the activation signal is an electrical signal.

20 The abovementioned controller is preferably further adapted to monitor, and indicate any deficiency or malfunction of, the function of each ultraviolet light source. Preferably, an indication of deficiency or malfunction of an ultraviolet light source is provided by illuminating a first indicator light associated with the generator.

25 The air inlet means may further include a pump adapted to deliver air into the generator under the control of the controller. Preferably, the controller is further adapted to monitor, and indicate any deficiency or malfunction of, the function of the pump. Preferably, an indication of deficiency or malfunction of the pump is provided by illuminating a second indicator light associated with the generator.

30 It is preferred that the controller is further adapted to monitor and measure the concentration of ozone in ambient air outside the system, the measurements being provided by an ozone sensor. In some such embodiments, the controller is adapted to indicate if the ozone concentration measured by the ozone sensor exceeds a predetermined level, typically about 0.10ppm ozone gas. An indication that the predetermined level has been exceeded is preferably provided by illuminating a third indicator light associated with the generator.

The above generator may further include an audible alarm which, under the control of the controller, is adapted to sound when the controller detects a deficiency or malfunction in one or more components of the generator. Preferably, the audible alarm is adapted to be sounded when the controller detects:

- 5 any deficiency or malfunction of the function of an ultraviolet light source,
- any deficiency or malfunction of the function of the pump; and/or
- that the concentration measured by the ozone sensor has exceeded the predetermined level.

10 The generator may further include reset means adapted to turn-off the alarm when activated by a user.

In a further preferred embodiment, the generator may include data logging means adapted to log generator activities selected from the group consisting of generator on, generator off, generator power-up, pump OK, pump deficiency or malfunction, ultraviolet light source OK, ultraviolet light source deficiency or malfunction, reset means activated.

15 According to a fifth aspect of this invention, there is provided a method of washing material in a washing apparatus connected to wash liquid inlet means, said method comprising:

- 20 providing wash liquid to a washing chamber of the washing apparatus via the wash liquid inlet means, said wash liquid including a material cleaning-effective amount of ozone; and
- after the wash liquid has been provided to the washing apparatus, and whilst the washing apparatus is in a wash cycle, providing ozone to an above-liquid region of the washing chamber.

25 Throughout this specification, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters
30 form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed in Australia before the priority date of each claim of this specification.

In order that the present invention may be more clearly understood, preferred embodiments will be described with reference to the following drawings and examples.

Brief Description of the Drawings

5 The invention will now be further explained and illustrated by reference to the accompanying drawings in which:

Figure 1 is a schematic representation of the system of a preferred embodiment of the invention.

10 Figures 2A, 2B and 2C are simplified representations of part of the system of a preferred embodiment of the invention, illustrating how ozone from the second fluid conduit may be mixed into the wash liquid with the aid of kinetic forces from wash activity in the wash chamber.

15 Figure 3 is a graphical representation showing comparisons of O_3 concentration versus time (in the wash cycle) for a typical corona discharge system and for a UV light source of a system of a preferred embodiment of the present invention.

Figure 4 is a graphical representation showing comparisons of O_3 concentration versus time (in the wash cycle) in the wash liquid as delivered by the first fluid conduit (via the wash liquid inlet means) and the second fluid conduit respectively in the system of a preferred embodiment of the invention.

20 Figures 5A and 5B are schematic representations of various views of an ozone generator of one preferred embodiment of the invention.

Figure 5C is a schematic representation of the ozone generator of Figure 5A and 5B showing a preferred wiring arrangement.

25 Figure 6 is a schematic representation of one preferred configuration of the system incorporating a power control means.

Figure 7 is a schematic representation of a power control means of a preferred embodiment.

Figure 8 is a preferred circuit layout for one embodiment of the power control means of the present invention.

Mode(s) for Carrying Out the Invention**System**

The system of a preferred embodiment of the first aspect of the invention is best illustrated in Figure 1 and identified by reference numeral 10. Ambient air is received by the ozone
5 generator 11 and exposed to ultraviolet light by UV light source 12 to generate ozone.

Generated ozone is then delivered to or pumped into first fluid conduit 14, where it is free to travel between the ozone generator 11 and wash liquid inlet means 15 (adapted to deliver wash liquid 20 to the wash cavity 30 of a washing apparatus 40); and/or along a second fluid conduit 16 between the ozone generator 11 and an above-liquid section 31 of
10 the wash cavity 30.

In one preferred embodiment, a first end of the second fluid conduit 16 is connected to the first fluid conduit 14 so that the second fluid conduit 16 is in fluid communication with the first fluid conduit 14. This connection may be a substantially T-shaped connection 13.

The ozone generator 11 operates under control of a control means 71. The control
15 means 71 is discussed in more detail below. In particularly preferred embodiments, the control means 71 is adapted to cause the ozone generator 11 to turn on in response to an activation signal corresponding to activation of the washing apparatus 40. Once activated, the wash cavity 30 begins to fill with wash liquid from wash liquid outlet 60. As the control means 71 has now activated the ozone generator 11, and generated ozone is
20 being pumped or delivered into the first fluid conduit 14, generated ozone is available for being mixed in wash liquid being delivered to wash cavity 30.

In a particularly preferred embodiment, a venturi injector 17 is operably coupled to the wash liquid inlet means 15 so as to draw generated ozone into the wash liquid as the wash liquid is delivered into the wash cavity 30. Consequently, in this preferred
25 embodiment, generated ozone is typically inhibited from entering the second fluid conduit 16 while the wash cavity 30 is being filled with wash liquid from the wash liquid outlet 60.

Once the desirable amount of wash liquid has been delivered to the wash cavity 30, generated ozone is then free to be delivered via the second fluid conduit 16 to the above-liquid section 31 of the wash cavity 30.

30 As is best illustrated in Figures 2A, 2B and 2C, generated ozone that has been introduced into the above-liquid section 31 is available to be mixed into the wash liquid 20, aided by kinetic forces from wash activity in the wash cavity 30. The system 10 of preferred embodiments is, therefore, only required to generate small amounts of ozone in order to maintain a relatively consistent concentration of ozone sufficient to contribute to the

washing process. Preferably, only 0.5-2.0 grams per hour of ozone need to be generated during the course of the wash cycle. Also, generated ozone is preferably mixed in the wash liquid 20 by the first fluid conduit 14 at a rate of about 0.05 to 0.2 ppm dissolved ozone.

- 5 The system 10 may further include a pump 18 adapted to pump generated ozone into the first fluid conduit 14. Preferably, the pump 18 is operably connected to the ozone generator 11 such that it is adapted also to deliver ambient air into the ozone generator 11 for conversion to ozone. In another preferred embodiment, the pump 18 is interposed between the ozone generator 11 and first fluid conduit 14. Generated ozone is then
10 drawn into the wash liquid inlet means 15 via negative pressure in the venturi injector 17, and is also pressurised into the venturi injector 17 via the air pump 18. This increases the absorption of ozone by the wash liquid as per Henry's law in some such preferred embodiments.

According to Henry's law, gases dissolve in liquids to form solutions. This dissolution is
15 an equilibrium process for which an equilibrium constant can be written. For example, the equilibrium between oxygen gas and dissolved oxygen in wash liquid is $O_2(aq) \rightleftharpoons O_2(g)$. The equilibrium constant for this equilibrium is $K = p(O_2)/c(O_2)$. The form of the equilibrium constant shows that the concentration of a solute gas in a solution is directly proportional to the partial pressure of that gas above the solution. (This statement, known
20 as Henry's law, was first proposed in 1800 by J.W. Henry as an empirical law well before the development of our modern ideas of chemical equilibrium (Source - <http://www.psigate.ac.uk/>)).

Typically, the system 10 uses an ozone generator 11 reliant on a UV light source 12 to generate ozone. As explained above, many of the conventional systems tend to use
25 corona discharge in preference to UV light sources. Figure 3 provides a graphical illustration of a comparison in concentration of ozone generated by corona discharge versus UV light source. Table 1 (below) provides a tabulated form of the data illustrated in the graphical representation, with reference to the various activities comprising the wash cycle.

Table 1:

A comparison of ozone concentrations between a corona discharge system and a UV light system (Based on field testing with a ozone detection kit, for example, one such as that manufactured by the HACH Company)

Wash Cycle	Time (Mins)	Ozone Levels (mg/l) using	
		Corona Discharge System at 8 gph*	UV Light System at 1.5 gph*
	0	0.00	-
Pre Wash	1	1.34	-
	2	1.09	-
Main Wash	3	1.97	0.15
	4	1.02	0.12
	5	0.66	0.06
	6	0.45	0.03
	7	0.29	0.03
	8	0.16	0.02
	9	0.08	0.02
	10	0.01	0.02
	11	0.01	0.02
	12	0.00	0.02
Rinse 1	13	2.06	0.17
	14	1.61	0.14
Rinse 2	15	1.89	0.19
	16	1.48	0.16
Rinse 3	17	2.22	-
	18	1.30	-
	19	1.28	-
	20	1.00	-

5 *Note: gph = grams per hour ozone output, a method used to size ozone generators.

CT values

The concentration (C in mg/l) of dissolved ozone multiplied by the time (T in minutes) of contact between the dissolved ozone and the contaminants in the wash liquid provides a 'CT value'. CT value is the disinfectant concentration required to inactivate a certain microbiological population percentage under specific conditions (i.e., pH, temperature) according to, for example, the Chick-Watson model of disinfection kinetics. This value is used as an index to the effectiveness of the disinfection process. Scientific guidelines such as CT Values are used as a standard of measurement for applications such as treatment of drinking water, and are generally accepted in a range of jurisdictions by, for example, the US Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), Centres for Disease Control (CDC) and equivalent bodies in Australia and around the world. Ozone disinfection systems achieve adequate disinfection with a CT of 1.6 or greater. Eg. A dissolved ozone value of 0.4 mg/l in contact with the wash liquid for 4 minutes provides a CT value of $0.4 \times 4 = 1.6$.

Adequate disinfection may not occur when:

- The quantity of ozone introduced into the wash liquid is too low to reach the proper CT value.
- The concentration of applied ozone is too low to achieve the proper CT value.
- The wash liquid temperature is too high (above 50°C) causing rapid decomposition of ozone.
- The microbiological and/or organic content of the wash liquid is too high for the available ozone.

When using the above system, it is preferred that there is a minimum contact time of 25 mins at an average of 0.08 mg/l. This gives a CT value of 2.0, which exceeds the microbiocidal criteria while delivering ozone at minimal levels.

As explained above, the system preferably introduces ozone into the wash liquid by the first fluid conduit 14 (delivering ozone to wash liquid via wash liquid inlet means 15) and by the second fluid conduit 16 (delivering ozone into the above-liquid section 31 of the wash cavity 30). Figure 4 provides a graphical illustration of the differences in the concentration of ozone over time (during the wash cycle) in the wash liquid as delivered by the first fluid conduit 14 (via the wash liquid inlet means 15) and the second fluid conduit 16, respectively.

Table 2 (below) provides a tabulated form of the data illustrated in the graph in Figure 4.

Table 2

	Time (Mins)	Ozone Levels (mg/l) in washing apparatus	
Wash Cycle		via wash liquid inlet means	via second fluid conduit
Main Wash	1	0.08	0.02
	2	0.08	0.02
	3	0.08	0.03
	4	0.06	0.04
	5	0.03	0.04
	6	0.00	0.05
	7	0.00	0.07
	8	0.00	0.09
	9	0.00	0.10
	10	0.00	0.12
Rinse 1	11	0.08	0.08
	12	0.05	0.10
Rinse 2	13	0.08	0.09
	14	0.02	0.11

As a corollary to only requiring smaller concentrations of ozone, the system 10 also improves on conventional systems by enhancing the safety of personnel and equipment.

- 5 Table 3 (below) provides an analysis of a test for free ozone in the work environment which was conducted using the system 10 of preferred embodiments. As can be seen, the table illustrates various locations in the vicinity of the washing apparatus 40.

Table 3

	Location of sample	Ozone meter reading [ppm]	Comments
1	Near ironing board	0.000	-
2	Rear of Washer 2 at 1.5 m	0.000 – 0.050	Depended on wash cycle & ozone injection
3	Rear of 2 & 3 Washers	0.000	-
4	Front of washers (closed)	0.000	-
5	At door of Washer 1 (closed)	0.000	-
6	At 5m from inlet tube	0.000	-
7	Rear of Washer 1	0.000	-
8	Rear of Washer 2	0.000	-
9	200 mm above ozone generator	0.000	-
10	At 100. cm from inlet tube	0.000	-
11	Inside Washer 2	0.000	-
	Occupational Standard	0.1 ppm	Ceiling level

The very small concentration of ozone in the washing apparatus 40 will minimise damage to the laundry equipment as the corrosive effect of the ozone is less than that of the laundry chemicals.

The system 10 of the present invention can be installed on any size of laundry machine from domestic top-loading 5kg machines to 1000kg per hour batch washers.

Additionally, the installation of equipment to the system 10 is relatively straightforward.

Preferably, the laundry can continue to operate while the installation takes place.

Downtime of the laundry is thereby minimised.

The system 10 may also be adapted to operate in a range of different water and/or wash liquid conditions, air temperatures and humidity.

Ozone generator

Preferred embodiments of the present invention also include an ozone generator 11 adapted for use in the system 10. Figure 5A and B are schematic representations of various views of an ozone generator 11 of a preferred embodiment of the present invention. Figure 5C is a schematic representation of the ozone generator 11 of Figure 5A and B showing a preferred wiring arrangement.

The ozone generator 11 comprises an air inlet means 70 adapted to receive air (including ambient air), a control means 71 adapted to cause at least one ultraviolet light source 12 to expose received air to ultraviolet light in response to an activation signal corresponding to activation of the washing apparatus 40, and an ozone outlet means 72 adapted to deliver generated ozone to the first fluid conduit 14.

Typically, the air inlet means 70 and ozone outlet means 72 are respectively connected to opposing sides of a tube 73. Depending on the size of the generator 11, there may be two or four tubes 73 incorporated into the generator 11. However, the present invention contemplates there being different numbers of tubes 73 in varying sized generators 11.

10 The tubes 73 may be formed of any suitable material, including metals or plastics or combinations of these. In one preferred embodiment, the tubes 73 are formed of aluminium. One end of one of the tubes 73 has an aperture 74, for receiving a UV lamp 75. The UV lamp 75 may be held in place via an ozone resistant "O" – ring (not shown) and if desired a plastic collar (not shown) may be engaged in the body of the tube 73.

15 Each tube 73 itself may further include two end caps 78 and 79 respectively. One end cap 78 incorporates the aperture 74 for receiving the UV lamp 75. The other end cap 79 has a shape, such as an indentation, which corresponds to the shape of an end of the UV lamp 75. An example of a suitable UV lamp 75 is one produced by Heraeus, a German company, and is identified by product number UVV480HO.

20 The ozone generator 11 may further include a ballast means 80 for providing energy to the UV lamp 75. Typically, there is one ballast means 80 for each UV lamp 75 in the ozone generator 11. The ballast means 80 is preferably a digital ballast. An example of an appropriate digital ballast is that produced by Tridonic with product No. PC1/26/32/42 TCT PRO.

25 In one embodiment, the UV light source 12 is comprised of the UV lamp 75 and the ballast means 80.

The components of the ozone generator 11 are preferably housed in a housing 81. Preferably, the housing 81 includes at least one aperture 82 for ventilation. However, the housing may include multiple apertures 82 for ventilation.

30 As mentioned above in the context of the system 10 of the present invention, a pump 18 may be incorporated into the ozone generator 11, or it may be adapted to operably communicate with the ozone generator 11. The pump 18 may serve the dual purpose of causing ambient air to be delivered into the ozone generator 11 and increasing the pressure with which generated ozone is delivered into the first fluid conduit 14. An

example of a suitable pump 18 for use with the present invention is that produced by Hailea, known as the Oil-Less 40LPM Diaphragm Air Pump. The pump 18 may further include an electrical connection 86 adapted to draw power to operate the pump 18.

5 Some preferred embodiments of the ozone generator 11 and/or system 10 further include an ozone concentration sensor (the connection for which is identified with reference numeral 87) adapted to measure the concentration of ozone in ambient air surrounding the washing apparatus 40. An example of an appropriate ozone concentration sensor is that produced by Aeroqual, identified as the series-100 ozone sensor.

10 The control means 71 is adapted to cause at least one ultra violet light source 12 to expose received ambient air to ultra violet light in response to an activation signal corresponding to activation of the washing apparatus 40. The control means 71 may also be responsible for the control and monitoring of other functions of the ozone generator 11. Specifically, the control means 71 controls power to, and monitors function of, the UV light source 12, and controls, and monitors the function of, the pump 18. When the ozone
15 generator 11 includes an ozone concentration sensor (the connection for which is identified with reference numeral 87), the control means 71 may further monitor and control the ozone concentration sensor.

The ozone generator 11 is typically connected to a power control means 90. The power control means 90 generally supplies power to the ozone generator 11 and its operation is
20 discussed in more detail below. Here, reference is made to the relationship between the control means 71 of the ozone generator 11 and the power control means 90.

When the power control means 90 senses that the washing apparatus 40 is operating, it sends an activation signal to the control means 71, which in turn switches on the pump 18 and UV light source 12. The power control means 90 releases the activation signal when
25 the washing apparatus 40 has stopped.

The ozone generator 11 is typically fed mains power by the power control means 90. However, the ozone generator 11 is only considered to be "running" whilst the activation signal is received by the power control means 90.

Upon receiving the activation signal from the power control means 90, the control means
30 71 supplies power to each of the UV lamps 75 in the generator 11.

Preferably, the ozone generator 11 includes at least one indicator light 83 adapted to illuminate to warn a user of a particular condition of one of the components of the ozone generator 11. (When this activation signal is received, the control means 71 lights a fourth indicator light 83D).

There are typically two or four indicators (each referred to as 83A) on the generator 11 to display the status of each UV lamp 75. As explained, different size ozone generators may have different numbers of UV lamps. The number of indicators 83A will correspond to the number of UV lamps 75 in a particular embodiment. Each indicator 83A will remain on while its UV lamp 75 is operating correctly. The control means 71 detects failure of the lamp 75 and, for example, disconnection of the connection between the ballast means 80 and the corresponding UV lamp 75. If a UV lamp 75 is not operating, the control means 71 causes the audible alarm speaker 84 to sound an alarm and flashes the relevant indicator 83 for that UV lamp 75. The indicator 83A continues to flash until the lamp 75 is operational or the reset switch 85 has been activated. In some preferred embodiments, the indicator 83A shall continue to flash even after the power control means 90 has released the activation signal.

Upon receiving the activation signal from the power control means 90, the control means 71 supplies power to the pump 18. The pump 18 remains on until the power control means 90 releases the activation signal. There is an indicator 83B that is lit whilst the pump 18 is operating. The pump 18 is typically externally mounted and plugs into the generator 11. The control means 71 monitors the current fed to the pump 18 and detects when the pump is not operating (eg due to disconnection). If this occurs, the control means 71 causes the audible alarm speaker 84 to sound an alarm and flashes the pump indicator 83B. The indicator 83B will continue to flash until the pump 18 is operational. The alarm will sound until the pump 18 is operational or the reset switch 85 is activated.

The audible alarm speaker 84 sounds an alarm whenever an error connection is triggered and shall continue to sound until the user activates the reset switch 85 or until the error is corrected. In some preferred embodiments, the indicator relating to that error condition shall continue to flash until the error is corrected, or until power to the generator 11 is removed. If a new alarm condition is triggered after a previous alarm condition has been silenced, the audible alarm speaker 84 shall sound again, until the new alarm condition is reset.

When the ozone concentration sensor (the connection for which is identified with reference numeral 87) is incorporated, this sensor is preferably powered and controlled by the control means 71. An alarm is sounded and the third indicator light 83C flashes if ozone levels in the ambient air around the washing apparatus 40 exceed a predetermined level of ozone. In Australia, the predetermined level would typically be the Australian standard of 0.10 ppm ozone gas in ambient air.

As will be appreciated by persons skilled in the art, the factors indicated by the first, second, third and fourth indicator lights 83A, 83B, 83C and 83D are examples of the types of factors which would desirably be monitored by the ozone generator 11. The present invention contemplates further indicator lights associated with monitoring and indicating the status of other components of, or factors associated with, the ozone generator 11 or system 10.

The ozone generator 11 may further include a cooling fan adapted to inhibit the ozone generator 11 and/or control means 71 from exceeding a predetermined temperature.

The ozone generator 11 may also include data logging means adapted to log ozone generator 11 activities. Preferably, the data logging means comprises a quantity of non-volatile memory for data logging. A plurality of events within the generator 11 are logged to the non-volatile memory with a time and date stamp in preferred embodiments. The memory is, preferably, erasable under firmware control. Preferably, the non-volatile memory is sufficiently large to store at least 20 events per day for a period of at least 3 years. Examples of generator 11 activities that may be logged by the data logging means include generator on, generator off, generator power-up, pump ok, pump deficiency or malfunction, ultraviolet light source ok, ultraviolet light source deficiency or malfunction, and reset switch activated.

In a preferred embodiment, the control means 71 provides an RS-232 port 200 for connection to a PC for transmission of logged data. Preferably, this communication port operates at 115-200 bps and provides hardware handshaking via RPS/CPS RS 232 control lines. The connector is preferably a female DB 9, mounted on the generator housing 81, and wired into the control means 71.

The generator 11 may further include a real time clock means for time keeping. The real time clock means keeps track of time and assists in the time and date stamp function of the data logging means.

Power control means

Throughout this specification the description often refers to voltage and current values suitable for the Australian environment. The present invention can be adapted for use in other jurisdictions also and appropriate changes to the voltage and current values could be made by a person skilled in the art.

In a preferred embodiment, the system 10 or the ozone generator 11 further includes power control means 90. The power control means 90 is adapted to monitor the power

supply supplying the washing apparatus 40 and to convey the activation signal (corresponding to activation of the washing apparatus 40) to the control means 71.

In a particularly preferred embodiment, the power control means 90 monitors the power fed to the washing apparatus 40 using a contactless current sensor. A schematic representation of a preferred configuration of the power control means 90 incorporated into the system 10 is provided in Figure 6, a schematic representation of the preferred power control means 90 is shown in Figure 7, and a preferred circuit layout for one embodiment of a power control means 90 is shown in Figure 8.

The power control means 90 is preferably adapted to connect with, and form part of, the electrical circuit from the junction box 94 to the washing apparatus 40.

During installation, the installer connects the Earth 97, Neutral (not shown) and the 3 phases 98 coming from the junction box 94 each to a terminal block mounted on the DIN rail 96A. The installer also connects the cables coming from the washing apparatus 40 to the other side of each respective DIN rail mounted terminal block 96B. One of the phases 98 is threaded through a current sensing transformer 91.

The DIN rail mounted terminal blocks 96 preferably serve several purposes. They allow termination of the cable runs to the junction box 94 and the washing apparatus 40, whilst allowing access to a single phase of the washing apparatus' 40 power supply. In addition, they provide access to the 3 phase 98 supply for the power transformer 91.

The power transformer 91 taps off the 415V supply connected to the DIN rail terminal blocks 96. This transformer 91 generates the local low voltage supply for the power control means' 90 electronics, also 240V (when used in Australia at least) for the ozone generator 11.

The power transformer 91 is protected by a DIN rail mounted fuse 100, whilst the 240V secondary of the transformer 91 is protected by a panel mount fuse 101.

The power control means 90 contains a power control board 92 (a preferred circuit layout of which is shown in Figure 8) which contains electronics used for sensing washing apparatus 40 current, and hence making the decision as to whether the washing apparatus 40 is operating or not.

Two 240V mains power signals are made available at power connector 102. One mains power signal is connected irrespective of washing apparatus 40 operation. This is used for keeping the ozone generator 11 in standby mode, during which times no ozone will be produced.

The other mains power signal at the power connector 102 is preferably connected when the washing apparatus 40 is operating. This is used as the activation signal for turning the ozone generator 11 ON so it will start producing ozone.

5 The power switch 103 enables and disables both 240V mains power signals presented at the power connector 102. Power is preferably not available at the power connector 102 if this switch 103 is set to OFF. When the power switch 103 is set to ON, the power indicator 95 is illuminated to show that power is available at the connector. This function is generally not influenced by washing apparatus 40 operation.

10 The power control means 90 preferably, therefore, adaptively senses the current drawn through a single phase by the washing apparatus 40 using a current transformer 91. When the current transformer 91 senses current draw by the washing apparatus 40, a sensing circuit, generally housed by a power control board 92 generates an activation signal which is then forwarded to the control means 71 of the ozone generator 11. Substantially simultaneously, the power control means 90 provides power to a power
15 outlet (not shown) which is adapted to supply the power to the ozone generator 11.

The sensing circuit generally has a sufficiently large time constant so that the ozone generator 11 remains switched on during a standard wash cycle of the washing apparatus 40, and is not switched off during momentary drops in power usage of the washing apparatus 40. For example, when the washing apparatus' 40 motors change direction,
20 there is a momentary drop in current as the motors stop and restart. The large time constant means that the ozone generator 11 will not switch off until several seconds after the washing apparatus 40 has switched off. As the ozone generator 11 of preferred embodiments uses UV lamps, it may be undesirable to have them switching on and off too frequently. Preferably, this time constant is approximately 5 seconds.

25 The power control means 90 may further include a control knob (not shown) to enable a user to set the sensitivity of the power control means 90 to the washing apparatus' 40 operation. The control knob may take the form of a small potentiometer which is accessed by inserting a screw-driver into a small aperture (not shown) on the side of the housing 81. This feature may be particularly desirable in circumstances where the
30 amount of current draw from a power source is particularly low or inconsistent.

The power control means 90 may additionally include an override switch (not shown) which can be used for, for example, the purpose of testing the operation of the ozone generator 11. The override switch is operably connected to the power control board 92 and is adapted to override the current sensor and supply power to the power outlet (not

shown) when the washing apparatus 40 is not operating. This particular optional feature provides yet another mechanism to enable a user to exercise control over the operation of the power control means 90.

Preferably, the power control means 90 also includes at least one indicator 95, generally housed in the power control board 92. The indicators 95 are adapted to indicate under a number of different circumstances including those selected from the group consisting of power being present from the junction box 94, detection by the power control means 90 that the washing apparatus 40 is operating, and power being available at the power outlet (not shown).

- 10 The power control means 90 may accept a nominal power input of 3 phase 415 VAC. The power control means 90 preferably provides a suitable low voltage (for example, 15V) for powering the internal circuitry of the power control means 90, such as the current transformer 91, the power control board 92, the power outlet switch and the sensing circuit. The power outlet (not shown) supplies an appropriate voltage to the ozone
- 15 generator 11 for operation. For example, when the system 10 and/or ozone generator 11 is adapted to be used in Australia, the power supply provided via the power outlet (not shown) shall be 240VAC, and be rated 150W. This output is preferably further protected from excessive current draw.

Power Control Means - Electronics Operation

- 20 The electronics on the power control board 92 is typically powered by an onboard voltage regulator which is powered by the 15V secondary 104 of the power transformer 91. This secondary 104 is protected by a fuse (not shown) mounted on the power control board 92.

The power control means 90 may use a current transformer 91 mounted on the power control board 92 to sense the current drawn by the washing apparatus 40. One of the 3 phase 98 cables to the washing apparatus 40 is passed through the centre of the current transformer 91 during installation of the power control means 90. This cable forms the primary side of the current transformer 91.

25

- A proportion of the current transformer's 91 primary current is presented at the secondary side of the current transformer 91. This signal is then amplified and filtered through several stages, where the gain of the amplifier is adjustable to cater for various models of washing apparatus 40, which might exhibit very different current consumption profiles.
- 30 The final amplified signal is compared to a stable reference, where the decision is made as to whether the washing apparatus 40 is operating or not.

The power control means may include a housing which is adapted to be wall mounted, typically on the wall behind the washing apparatus 40.

The power control means 90 is preferably adapted to operate in an ambient air temperature in the range of -10°C to +60°C. The power control means 90 also may
5 include appropriate and adequate heat sinking provisions to maintain component temperature appropriately.

Persons skilled in the art would appreciate that a number of other adaptations can be made to the power control means 90 to assist its operation in varying environmental conditions. For example, appropriate adaptations can be made to assist the power control
10 means 90 to accommodate the relative humidity conditions, to prevent the power control means 90 from being subjected to appreciable vibration, to prevent the power control means 90 from being subjected to repeated shock, to protect the power control means 90 against dripping wash liquid and/or water by applying appropriate wash liquid proofing, to inhibiting the power control means 90, and in particular its componentry, from being
15 exposed to corrosive substances (if the environment in which the washing apparatus 40 is being used would be likely to expose the power control means 90 to such substances.)

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present
20 embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

Claims:

1. A system for introducing ozone into a washing apparatus, the system comprising:
ozone supply means; and
ozone delivery means, including:
 - 5 a first fluid conduit adapted to transfer ozone from the ozone supply means to a wash liquid inlet means, said wash liquid inlet means adapted to deliver wash liquid to a wash chamber of the washing apparatus, and
a second fluid conduit adapted to deliver ozone to an above-liquid region of the wash chamber;
 - 10 wherein said system is adapted so that, during a wash cycle, ozone is introduced:
into the wash chamber via the wash liquid inlet means, mixed in the wash liquid, and
into the above-liquid region of the wash chamber via the second fluid conduit.
- 15 2. The system of claim 1, wherein a first end of the second fluid conduit is connected to the first fluid conduit so that the second fluid conduit is in fluid communication with the first fluid conduit.
3. The system of claim 2, wherein the connection between the first end of said second fluid conduit and the first fluid conduit is a substantially T-shaped
20 connection located intermediate two ends of the first fluid conduit.
4. The system of any one of the preceding claims, further including gas redirection means adapted to substantially inhibit ozone from being introduced into the wash chamber via the second fluid conduit while wash liquid is being introduced into the wash chamber via the wash liquid inlet means.
- 25 5. The system of claim 4, wherein the gas redirection means includes a venturi adapted to draw ozone into the wash liquid inlet means.
6. The system of claim 4 or 5, further adapted so that, during the wash cycle, after the wash liquid has been introduced into the wash chamber, the ozone is introduced into the wash chamber via the second fluid conduit.
- 30 7. The system of any one of the preceding claims, further adapted so that ozone is delivered into the ozone delivery means via a single outlet.

8. The system of any one of the preceding claims, further including a pump adapted to deliver ozone into the ozone delivery means.
9. The system of claim 8, wherein the pump is interposed between the ozone supply means and the ozone delivery means.
- 5 10. The system of claim 8 or 9, wherein positive pressure created by the pump enhances mixing of ozone into the wash liquid.
11. The system of any one of the preceding claims, wherein the ozone delivered via the second fluid conduit is provided to the wash chamber through a vent in the washing apparatus.
- 10 12. The system of any one of the preceding claims, wherein the ozone supply means is adapted to supply ozone in response to a signal that the washing apparatus has been activated.
13. The system of any one of the preceding claims, wherein the ozone supply means is an ozone generator.
- 15 14. The system of claim 13, wherein the ozone generator generates ozone by exposing air to ultraviolet light.
15. The system of claim 14, wherein the ultraviolet light is of a wavelength sufficient to generate from the air oxygen atoms capable of colliding with oxygen molecules to form ozone.
- 20 16. The system of claim 15, wherein the wavelength ranges from 150 nm to 280 nm.
17. The system of claim 16, wherein the wavelength is about 185 nm.
18. The system of any one of the preceding claims, wherein the washing apparatus is a laundry washing machine.
19. The system of any one of the preceding claims, adapted for use with multiple
25 washing apparatuses, wherein there is at least one ozone delivery means for each washing apparatus.
20. An ozone delivery arrangement, for delivering ozone from an ozone supply means to a washing apparatus connected to wash liquid inlet means, said ozone delivery arrangement comprising:
30 a first fluid conduit, for transferring ozone from the ozone supply means to the wash liquid inlet means;

a mixer connection, connecting the first fluid conduit to the wash liquid inlet means, said mixer connection adapted to enable ozone to flow into the wash liquid inlet means and mix with wash liquid flowing through the wash liquid inlet means; and

5 a second fluid conduit adapted to transfer ozone to a wash chamber of the washing apparatus when wash liquid ceases flowing through the wash liquid inlet means.

21. The ozone delivery arrangement according to claim 20, wherein the second fluid conduit is adapted to transfer the ozone to an above-liquid region of the wash
10 chamber.

22. The ozone delivery arrangement according to claim 20 or 21, wherein a first end of the second fluid conduit is connected to the first fluid conduit so that the second fluid conduit is in fluid communication with the first fluid conduit.

15 23. The ozone delivery arrangement according to claim 22, wherein the connection between the first end of said second fluid conduit and the first fluid conduit is a substantially T-shaped connection located intermediate two ends of the first fluid conduit.

24. The ozone delivery arrangement according to any one of claims 20 to 23, wherein the mixer connection is a venturi connection.

20 25. The ozone delivery arrangement according to any one of claims 20 to 24, wherein either or both of the first and second fluid conduit(s) comprise(s) a hose, a tube, a pipe or a combination of these.

26. A method of installing an ozone delivery arrangement of any one of claims 20 to 25, said method comprising:

25 connecting a first end of the first fluid conduit to an outlet of the ozone supply means;

connecting a second end of the first fluid conduit to the wash liquid inlet means with a mixer connection adapted to enable ozone to flow into the wash liquid inlet means and mix with wash liquid flowing through the wash liquid inlet means;

30 positioning a first end of the second fluid conduit so as to enable it to receive ozone from the ozone supply means; and

connecting a second end of the second fluid conduit to the washing apparatus;

wherein the installed ozone delivery arrangement is adapted to transfer ozone from the ozone supply means to the wash liquid inlet means, via the first fluid conduit, when wash liquid flows through the wash liquid inlet means, and to transfer ozone to the wash chamber, via the second fluid conduit, when wash liquid ceases flowing through the wash liquid inlet means.

27. The method of installing an ozone delivery arrangement according to claim 26, wherein the first end of the second fluid conduit is connected to the first fluid conduit so that said second fluid conduit is in fluid communication with the first fluid conduit.

28. The method of installing an ozone delivery arrangement according to claim 27, wherein the first end of the second fluid conduit is connected to the first fluid conduit by means of a substantially T-shaped connection located intermediate two ends of the first fluid conduit.

29. An ozone generator adapted for use in the system of any one of the preceding claims, the ozone generator comprising:

air inlet means adapted to receive air,

a controller adapted to cause at least one ultraviolet light source to expose received air to ultraviolet light in response to an activation signal corresponding to activation of the washing apparatus, and

ozone outlet means adapted to deliver generated ozone to the ozone delivery means.

30. The generator of claim 29, wherein the activation signal is an electrical signal.

31. The generator of claim 29 or 30, wherein the controller is further adapted to monitor, and indicate any deficiency or malfunction of, the function of each ultraviolet light source.

32. The generator of claim 31, wherein an indication of deficiency or malfunction of an ultraviolet light source is provided by illuminating a first indicator light associated with the generator.

33. The generator of any one of claims 29 to 32, wherein the air inlet means includes a pump adapted to deliver air into the generator under the control of the controller.

34. The generator of claim 33, wherein the controller is further adapted to monitor, and indicate any deficiency or malfunction of, the function of the pump.

35. The generator of claim 34, wherein an indication of deficiency or malfunction of the pump is provided by illuminating a second indicator light associated with the generator.
- 5 36. The generator of any one of claims 29 to 35, wherein the controller is further adapted to monitor measurements of the concentration of ozone in ambient air outside the system, the measurements being provided by an ozone sensor.
37. The generator of claim 36, wherein the controller is adapted to indicate if the ozone concentration measured by the ozone sensor exceeds a predetermined level.
- 10 38. The generator of claim 37, wherein the predetermined level is 0.10ppm ozone gas in ambient air.
39. The generator of claim 37 or 38, wherein an indication that the predetermined level has been exceeded is provided by illuminating a third indicator light associated with the generator.
- 15 40. The generator of any one of claims 31 to 39, further including an audible alarm which, under the controller of the controller, is adapted to sound when the controller detects a deficiency or malfunction in one or more components of the generator.
41. The generator of claim 40, wherein the audible alarm is adapted to be sounded when the controller detects:
- 20 any deficiency or malfunction of the function of an ultraviolet light source,
any deficiency or malfunction of the function of the pump; and/or
that the concentration measured by the ozone sensor has exceeded the predetermined level.
42. The generator of claim 40 or 41, further including reset means adapted to turn-off the alarm when activated by a user.
- 25 43. The generator of any one of claims 29 to 42, further including data logging means adapted to log generator activities selected from the group consisting of generator on, generator off, generator power-up, pump OK, pump deficiency or malfunction, ultraviolet light source OK, ultraviolet light source deficiency or malfunction, reset means activated.
- 30 44. A method of washing material in a washing apparatus connected to wash liquid inlet means, said method comprising:

providing wash liquid to the washing apparatus via the wash liquid inlet means, said wash liquid including a material cleaning-effective amount of ozone; and

after the wash liquid has been provided to the washing apparatus, and whilst the washing apparatus is in a wash cycle, providing ozone to an above-liquid region of the washing chamber.

FIGURE 1

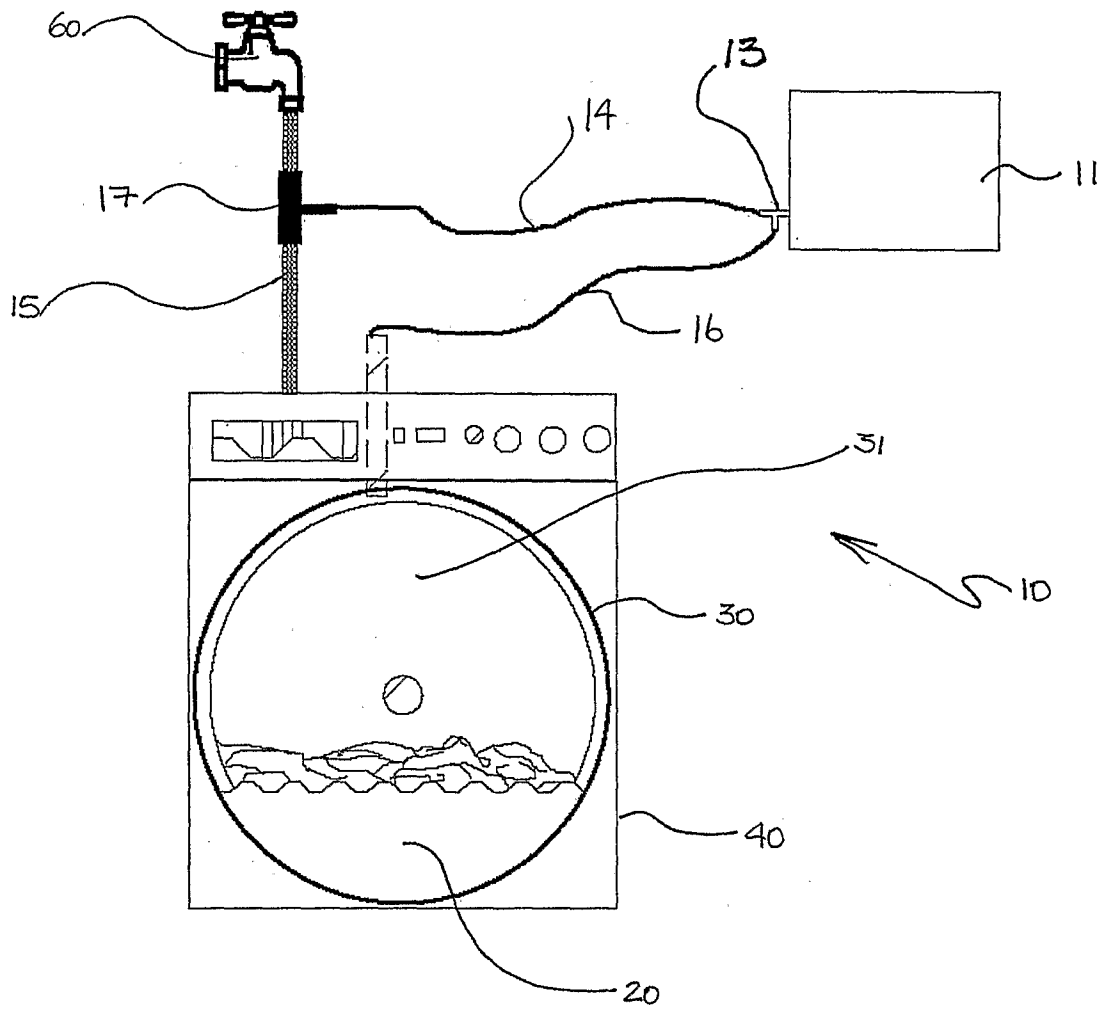


FIGURE 2A

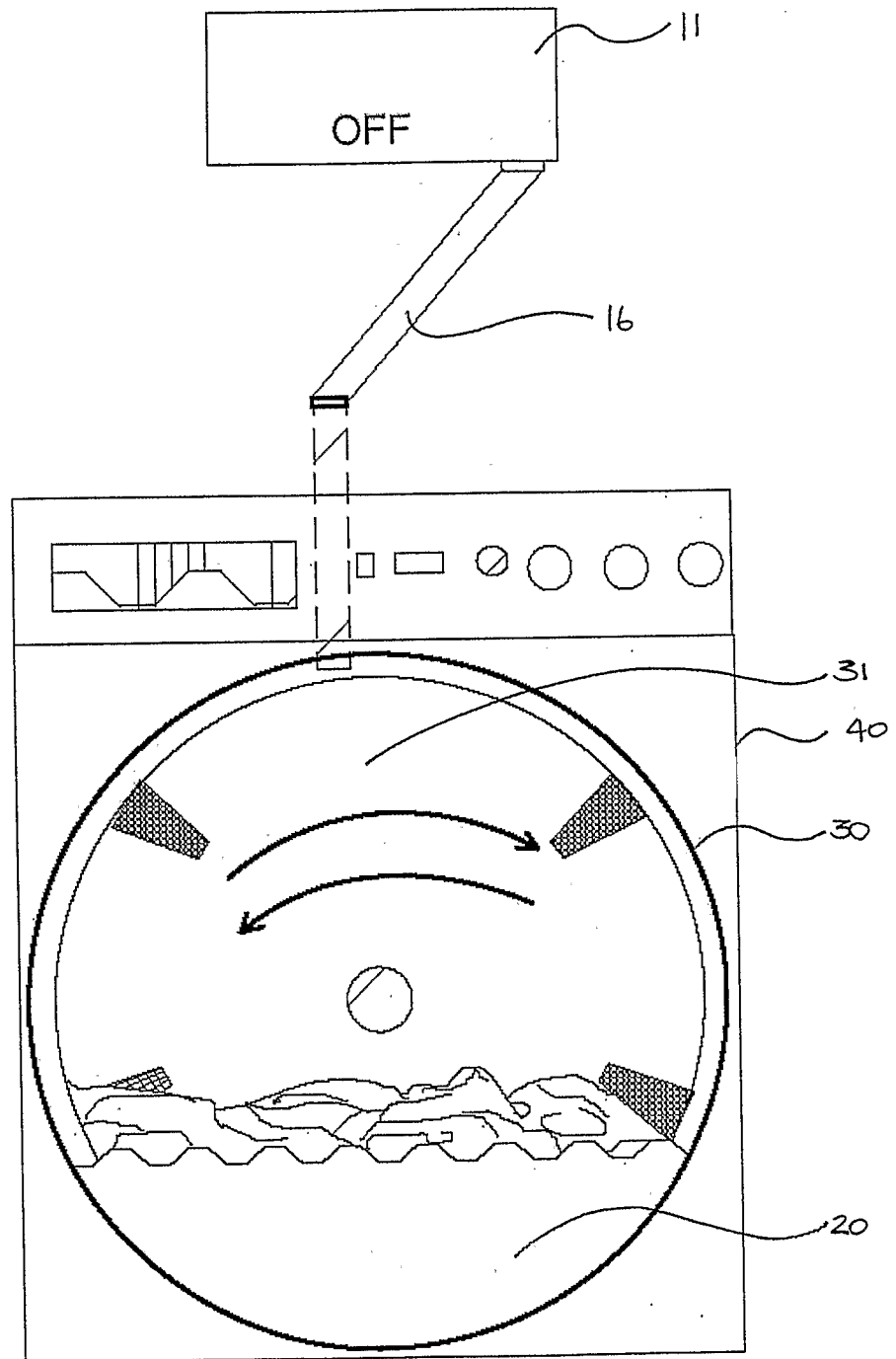


FIGURE 2B

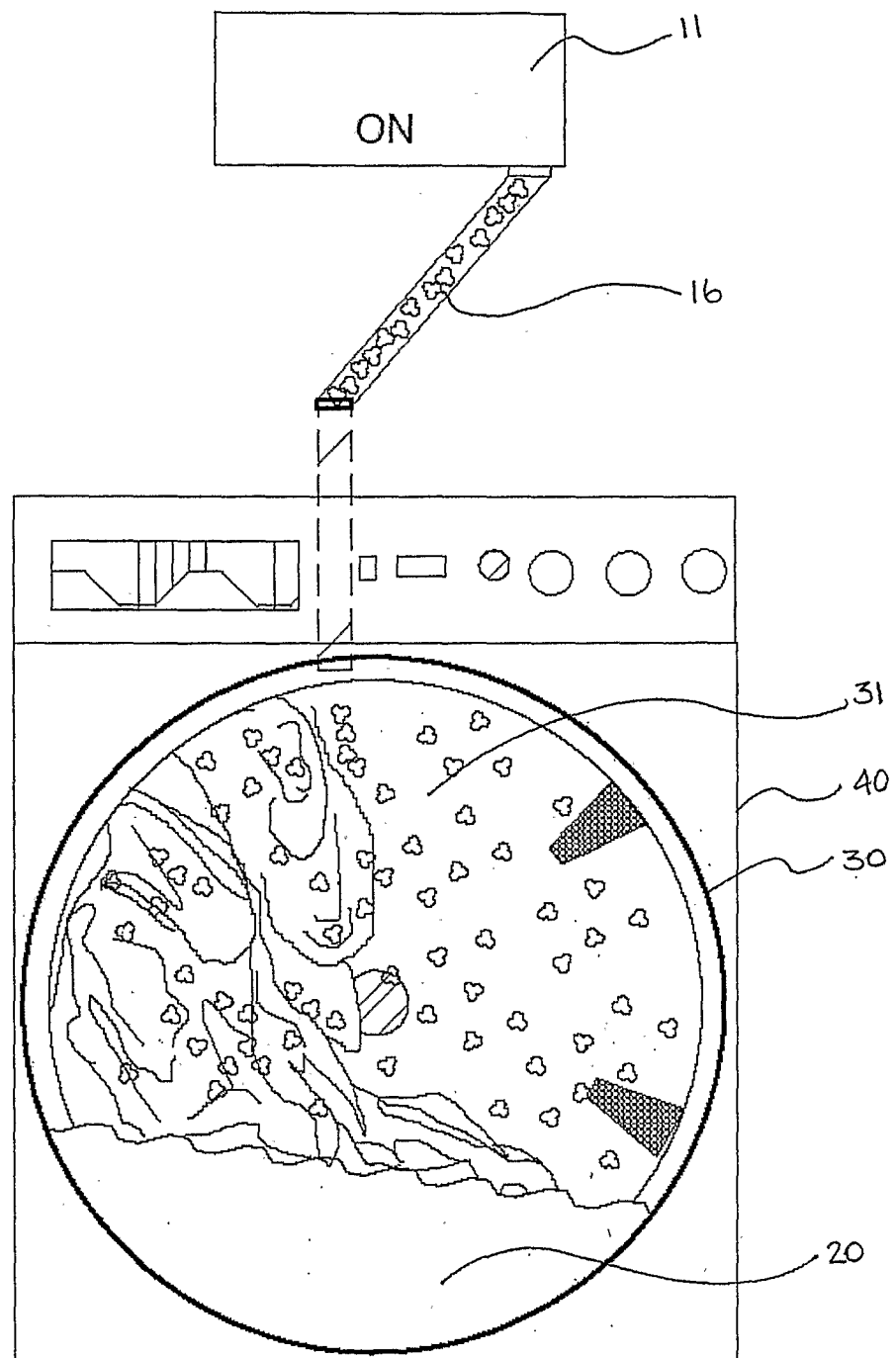


FIGURE 2C

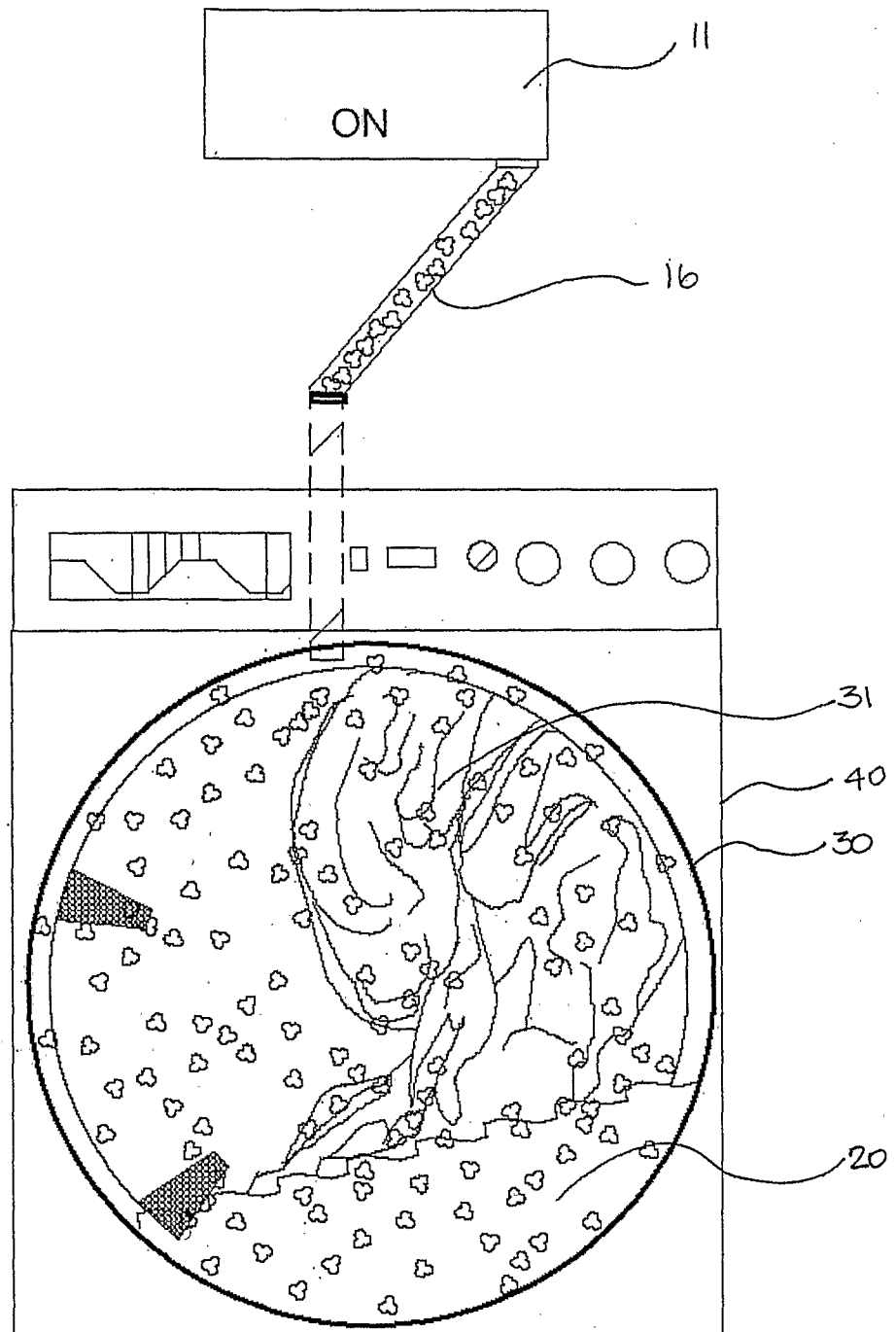


FIGURE 3

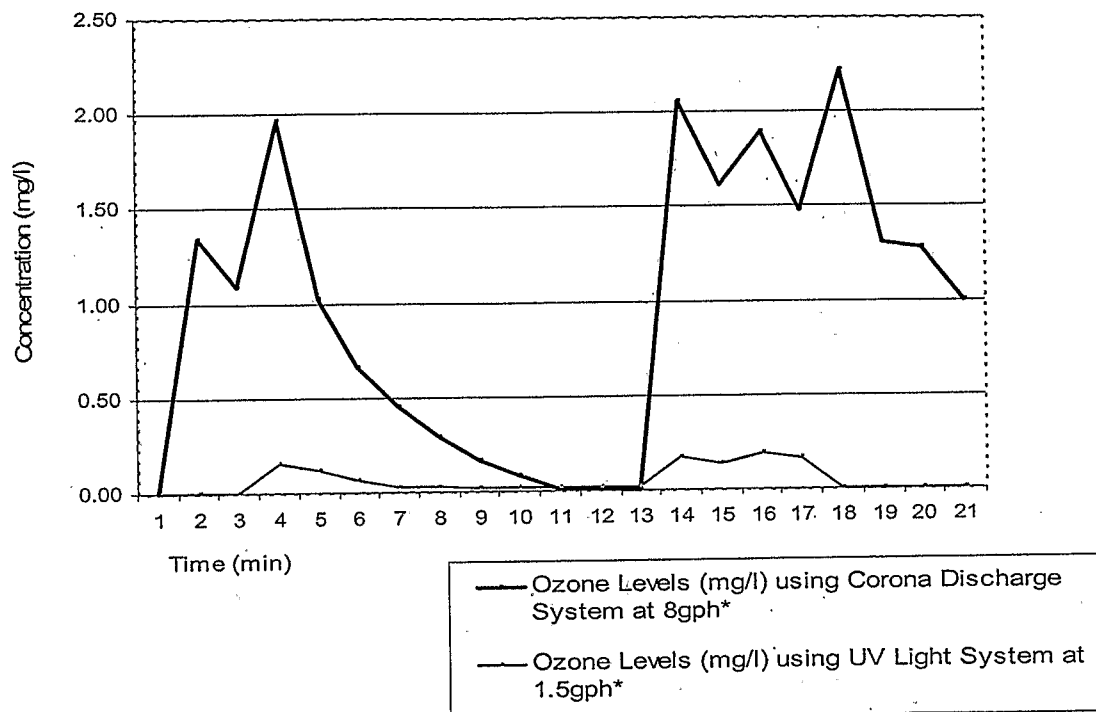
Comparison of Ozone Concentration over Wash Time

FIGURE 4

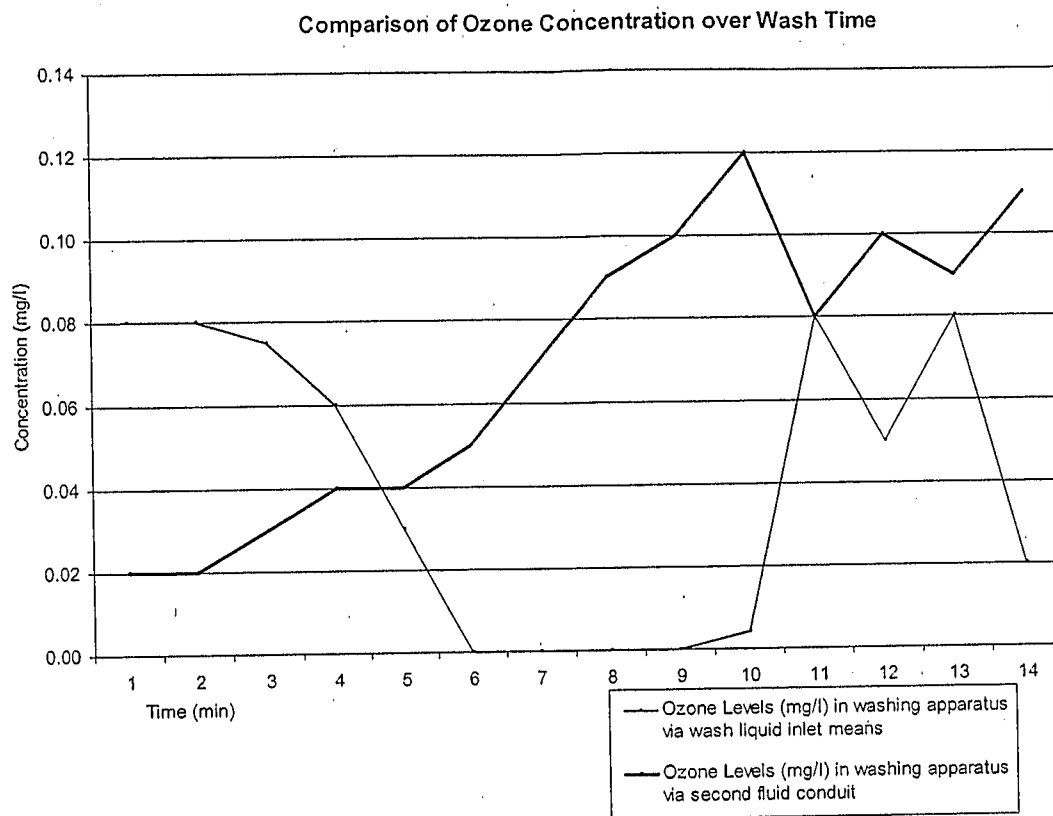


FIGURE 5A

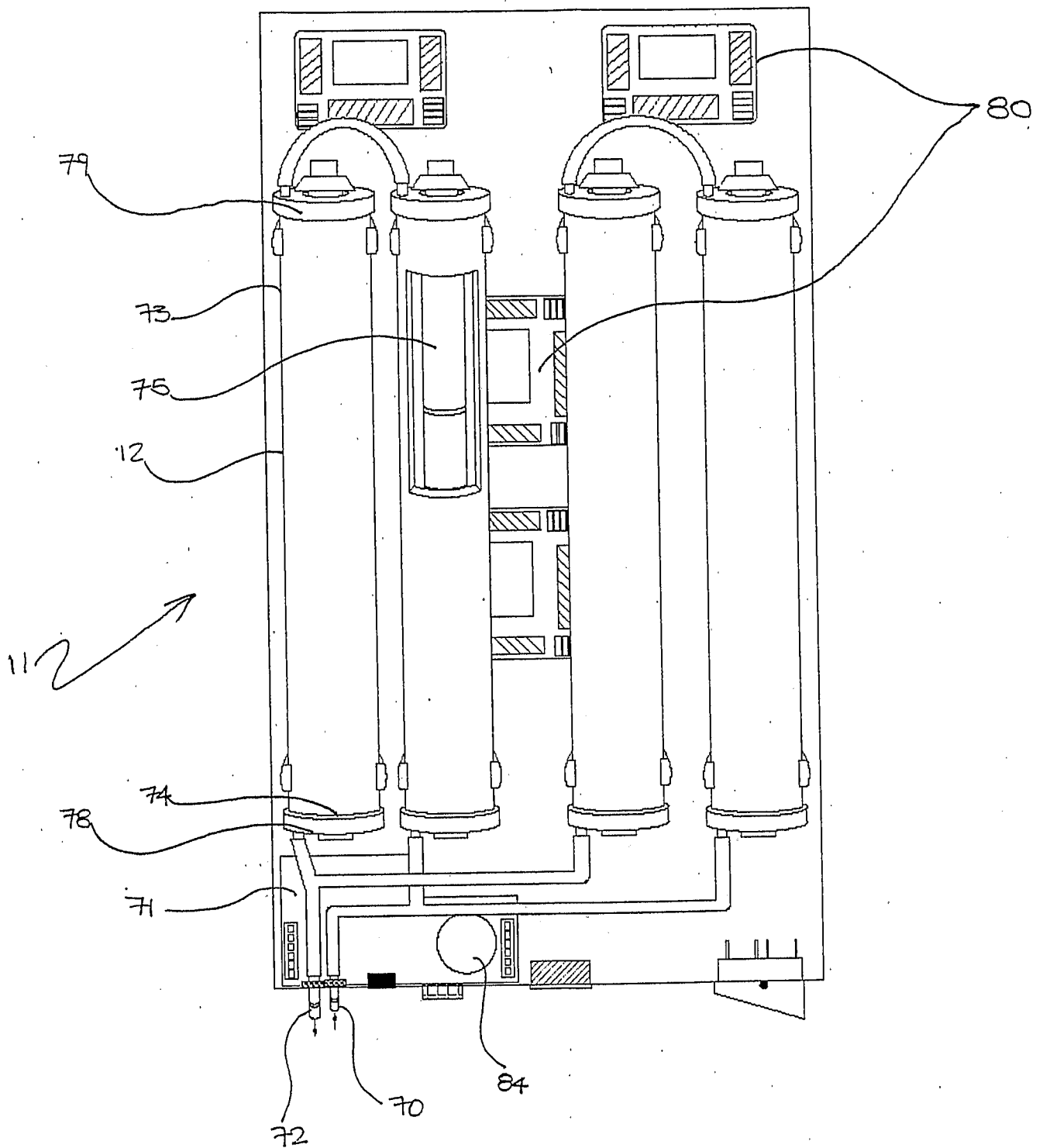


FIGURE 5B

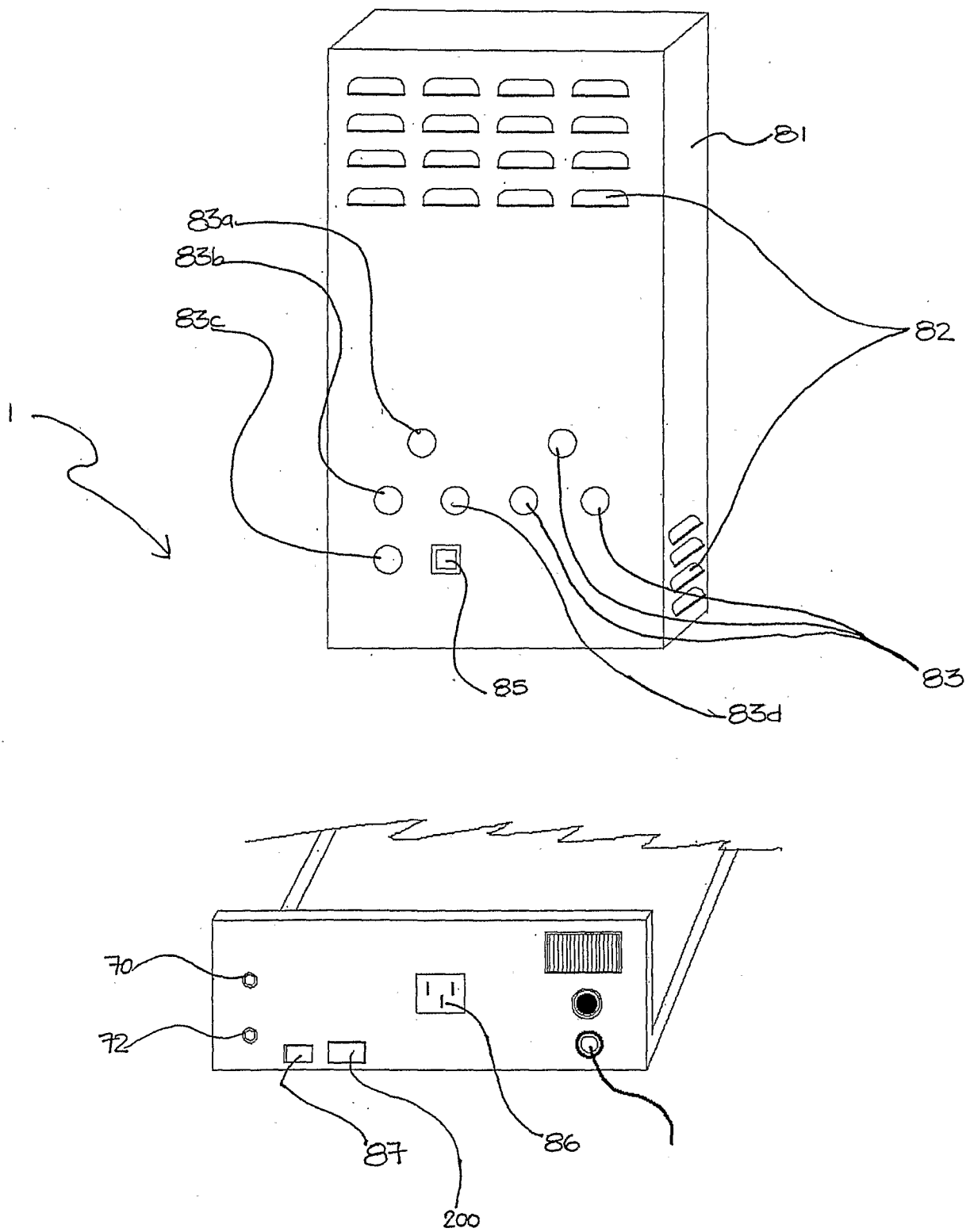


FIGURE 5C

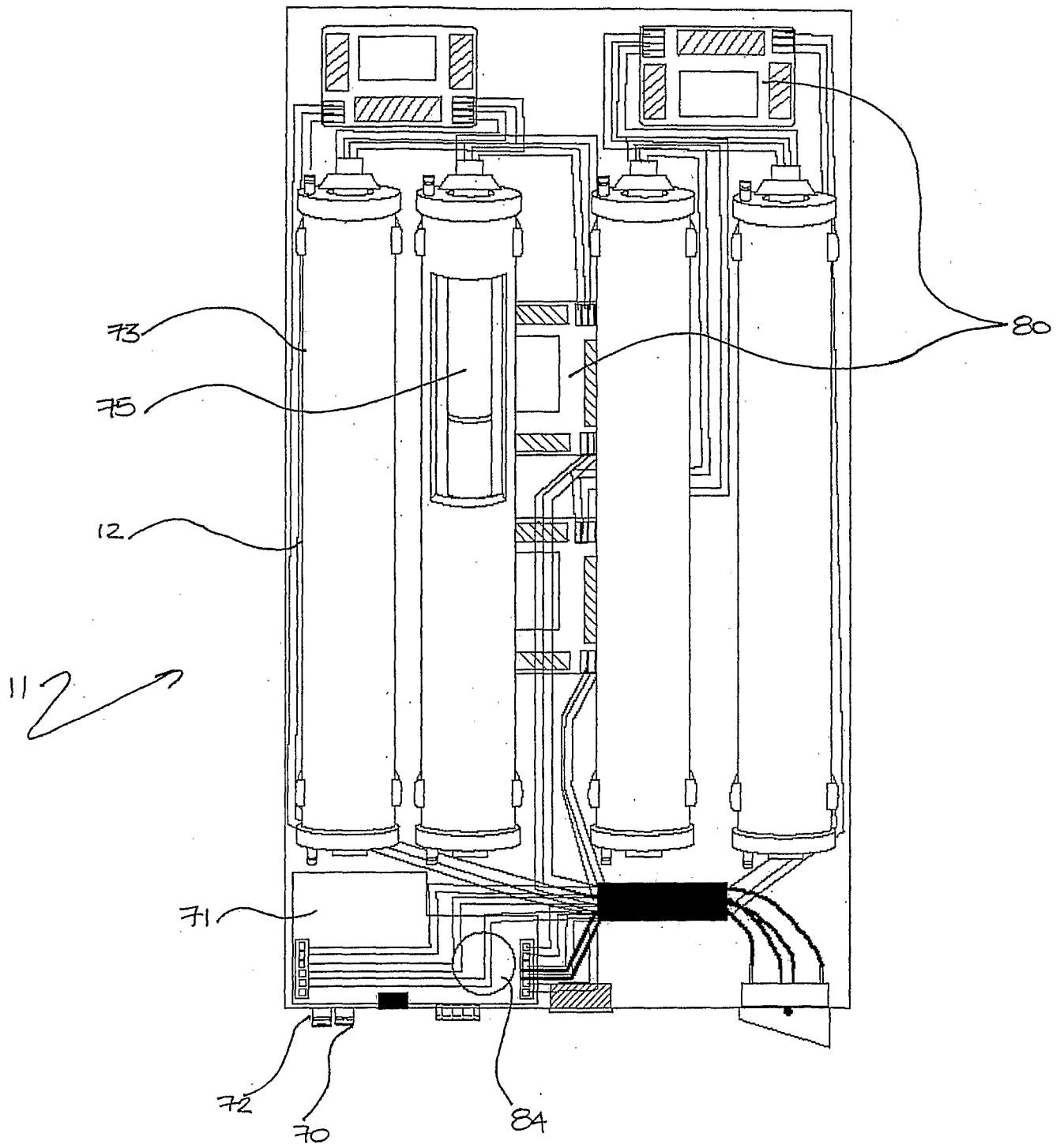


FIGURE 6

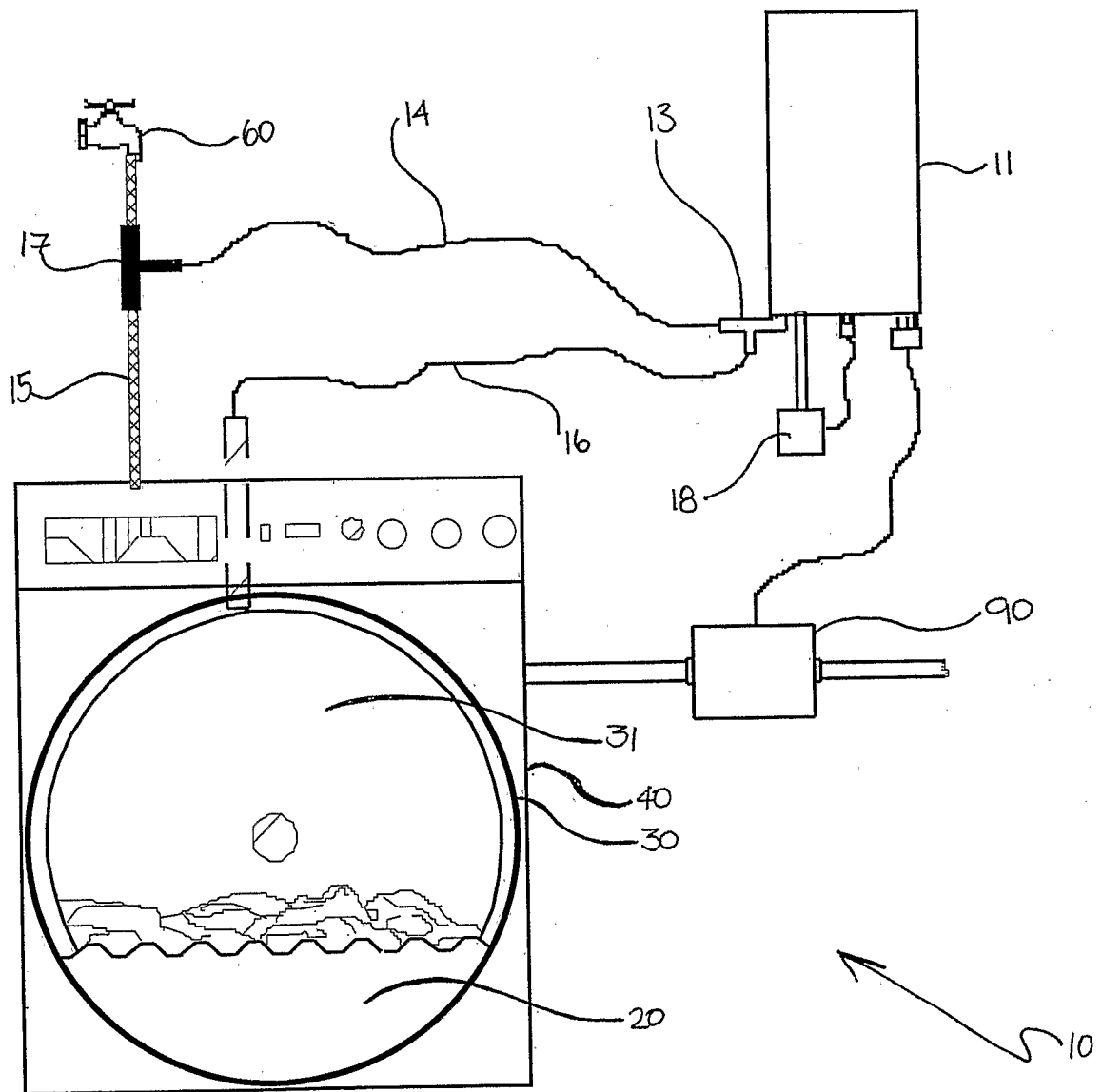


FIGURE 7

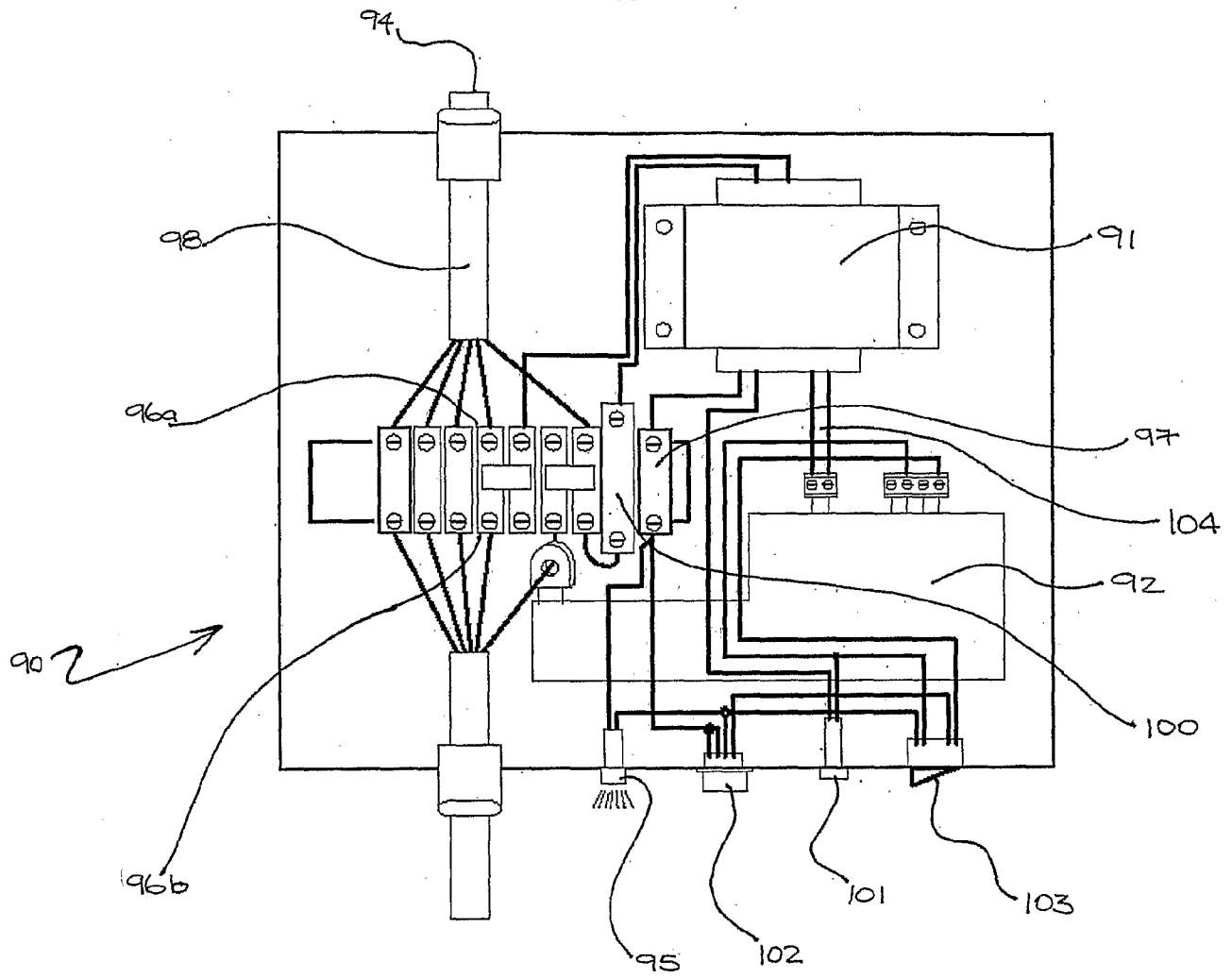
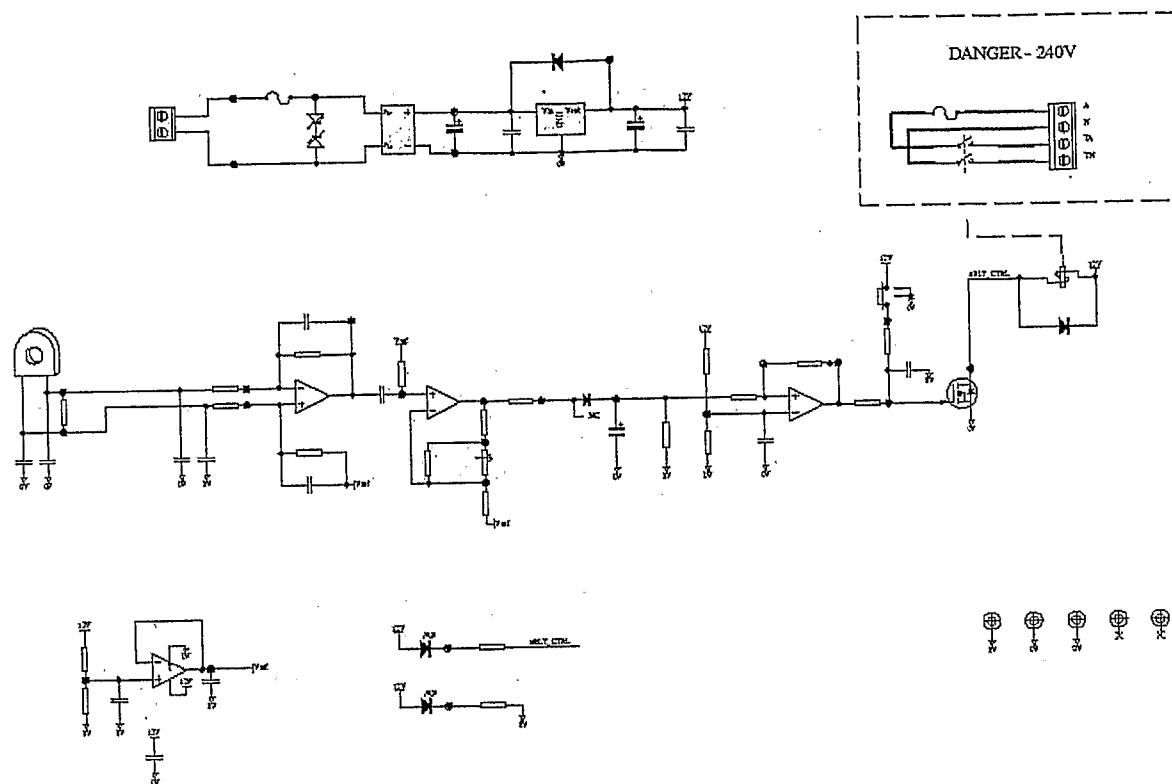


FIGURE 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/000829

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

D06F 39/02 (2006.01) **C01B 13/10** (2006.01) **D06F 17/00** (2006.01)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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

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

DWPI -IPC D06F/- & keywords: laundry, washing, ozone, O3, supply, feed, chamber, tub, conduit, inlet, path, second, dual, separate and like terms.

D06F/-, C01B/-, C02F 1/-, C02F 103/-, A61L 2/- & keywords: generate, produce, prepare, ozone, O3, ultraviolet, UV, air, washing, cleaning, sterilise and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2000/015893 A1 (ENVIROCLEANSE SYSTEMS, INC.) 23 March 2000 Whole document, in particular figures 2-4 and accompanying description	1-44
X	JP 08141270 A (FUJI SHARYO KK) 4 June 1996 Column 2 lines 44-50, column 3 lines 16-26	1-44
X	US 6881331 B1 (BARNES) 19 April 2005 Whole document	29-43



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
28 August 2007

Date of mailing of the international search report **05 SEP 2007**

Name and mailing address of the ISA/AU
AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
E-mail address: pct@ipaustalia.gov.au
Facsimile No. (02) 6285 3929

Authorized officer
Zbigniew Bielawski
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No : (02) 6283 2218

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2007/000829

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1362828 A1 (LIGHT SOURCES, INC.) 19 November 2003 Whole document	29-43
X	US 5806120 A (MCEACHERN) 15 September 1998 Whole document	29-43
A	US 5313811 A (WASINGER et al.) 24 May 1994 Whole document	
A	US 5625915 A (RADLER et al.) 6 May 1997 Whole document	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2007/000829

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

(See Supplemental sheet)

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☒ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/000829

Supplemental Box

(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: III (lack of unity)

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are different inventions as follows:

- Claims 1-20, 21-28 and 44 are directed to a system, an arrangement or a method of introducing ozone into a washing apparatus (IPC: D06F 39/02). It is considered that the system, arrangement or the method of introducing ozone into a washing apparatus with the washing liquid and also providing ozone to the wash chamber comprises a first distinguishing feature.
- Claims 29-43 are directed to an ozone generator (IPC: C01B 13/10) comprising air inlet means, a controller adapted to cause at least one ultraviolet light source to expose received air to ultraviolet light in response to an activation signal corresponding to activation of the washing apparatus and ozone outlet means. It is considered that the ozone generator with these features comprises a second distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

The only feature common to all of the claims is providing ozone to a washing apparatus. However this concept is not novel in the light of:

WO 2000/015893 A1

This means that the common feature can not constitute a special technical feature within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over the prior art.

Because the common feature does not satisfy the requirement for being a special technical feature it follows that it cannot provide the necessary technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention *a posteriori*.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2007/000829

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
WO	0015893	AU	23257/99	CA	2344337	EP	1131481
		US	5960501	US	5960649		
JP	8141270	NONE					
US	6881331	US	6192911	US	6342154	US	6405387
		US	6426053	US	6428756	US	6623635
		US	6723233	US	6951633	US	6967008
		US	7060180	US	7135108	US	7186334
		US	2001040122	US	2001042708	US	2002023866
EP	1362828	US	6824693				
US	5806120	NONE					
US	5313811	NONE					
US	562591	NONE					
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.							
END OF ANNEX							