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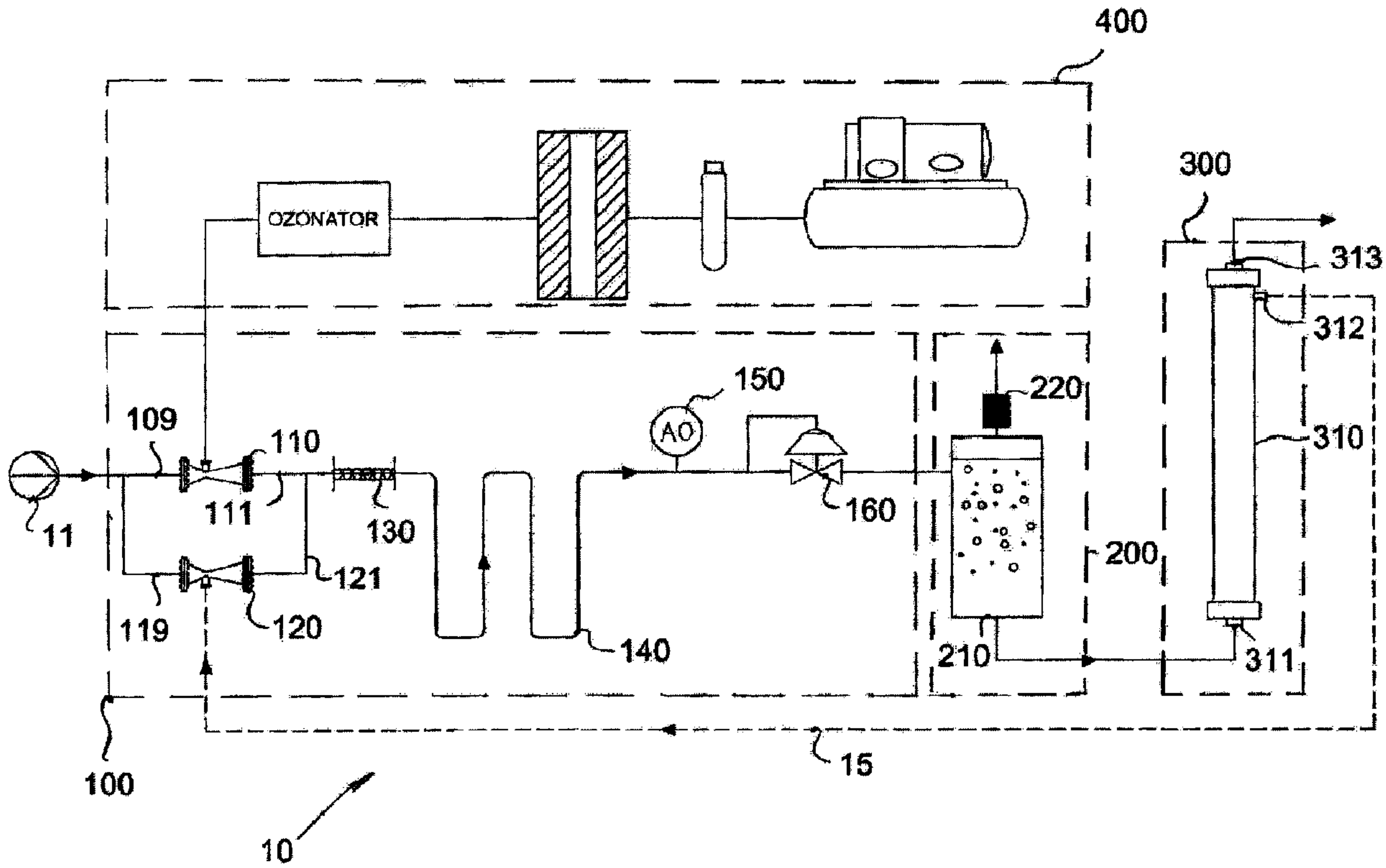
(54) **Titre :** APPAREILLAGE D'EPURATION DES EAUX
(54) **Title:** WATER TREATMENT APPARATUS




(57) **Abrégé/Abstract:**

An apparatus for an ozone-based treatment of polluted water is disclosed. The apparatus generally comprises three stages. The first stage is an ozone treatment stage wherein the polluted water is treated with ozone gas. The second stage is a degassing stage wherein excess undissolved gases are removed from the water whereby the water exiting the degassing stage is essentially saturated with gases. The last stage of the apparatus is a membrane filtration stage wherein the gas-saturated water generally undergoes micro-filtration or ultra-filtration. Microbubbles formed during this final stage generally prevent the accumulation of particles and pollutants on the surface of the membranes and/or inside the openings or pores thereof; thereby acting as a self-cleaning mechanism for the membrane filter.

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# WATER TREATMENT APPARATUS

## Abstract

An apparatus for an ozone-based treatment of polluted water is disclosed. The apparatus generally comprises three stages. The first stage is an ozone treatment stage wherein the polluted water is treated with ozone gas. The second stage is a degassing stage wherein excess undissolved gases are removed from the water whereby the water exiting the degassing stage is essentially saturated with gases. The last stage of the apparatus is a membrane filtration stage wherein the gas-saturated water generally undergoes micro-filtration or ultra-filtration. Microbubbles formed during this final stage generally prevent the accumulation of particles and pollutants on the surface of the membranes and/or inside the openings or pores thereof; thereby acting as a self-cleaning mechanism for the membrane filter.

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## Title of the Invention

[0001] Water Treatment Apparatus.

## Cross-Reference to Related Applications

[0002] There are no cross-related applications.

## Field of the Invention

[0003] The present invention generally relates to apparatuses, systems and/or methods used in the purification and filtration of liquids. More particularly, the present invention relates to apparatuses, systems and/or methods using essentially ozone and filters for the purification and filtration of water.

## Background of the Invention

[0004] In today's world, water sources for human consumption or other uses can often contain contaminants and various pollution elements such as pathogens which may cause various infections (e.g. bacteria, viruses, etc...) and organic and inorganic substances which may cause unwanted odor and color to the water sources. Naturally it is desired to reduce the amount of contaminants in water, especially if the water is destined to be consumed by people.

[0005] In the past, water treatment systems have been mainly managed by municipalities, in order to accommodate the drinkable and recreational water needs of their population, and also treat waste water. Lately, the increasing concerns regarding the environment, the standards associated to its protection and the emergence of larger scale projects in construction have changed the requirements and the mission of water treatment systems. Also, available water sources can be of different nature, including surface waters or ground water.

[0006] These days, water treatment systems need to be more adaptable to various types of environments. They must use products and offer water quality following very strict environmental regulations and at the same time, be less expensive to be attractive to smaller municipalities and private interests.

[0007] Previous methods and systems for reducing contaminants in water have used, for example chlorine and ozone. Of these substances ozone has recently become more and more popular since ozone is one of the most powerful oxidizers and disinfectants available.

[0008] On the one hand, the most commonly used disinfectants are hypochlorous acid and HOCl (customarily referred to as chlorine in the pool industry). Also used but to a lesser degree are hypobromous acid and HOBr (likewise, referred to as bromine). However, most compounds that produce chlorine in water sources influence the pH thereof. It is therefore necessary to add either an acidic or a caustic substance to maintain a certain pH. This means that the water treatment systems need to have two injection systems: one for the selected disinfectant, and another one for the pH control.

[0009] On the other hand, ozone exhibits biocidal qualities in concentrations over 0.4 parts per million, when dissolved in water. Ozone is a semi-stable gas formed of three oxygen atoms, instead of the two atoms that form oxygen gas. Ozone is most typically produced by an electrical arc discharged through air causing oxygen atoms to combine with an oxygen free radical that is formed. Ozone rapidly undergoes reaction to revert to more stable oxygen, releasing an oxygen free radical in the process. Two such free radicals can combine to form an oxygen molecule or the free radicals can oxidize an oxidizable substance.

[0010] Ozone not only kills bacteria, but also inactivates many viruses, cysts and spores. In addition, ozone oxidizes many organic chemical compounds, including chloramines, soaps, oils and other wastes thereby rendering them harmless to the environment.

Accordingly, ozone may be used for a number of purposes, including: purification of water used for drinking, in food cleaning and processing, in ice machines, in swimming pools and spas and waste water treatment.

[0011] Although ozone is especially beneficial for breaking down certain contaminants in water, obtaining an effective concentration of ozone in water may be difficult and may represent a more expensive solution in a water treatment system. At a high concentration, ozone is a toxic and corrosive gas which is considered to be a pollutant by The United States Environmental Protection Agency (EPA), such that special provisions must be made for the containment and removal of the excess ozone.

[0012] Though the use of ozone in water treatment apparatuses and systems has generally proven to be effective, it remains that ozone can seldom be used alone since some pollutants need to be physical removed from the water. Hence, in prior art water treatment apparatuses and systems, ozone treatments were generally combined with filtration treatments, before and/or after the ozone treatments, in order to remove larger pollutants and/or particles from the water. For example, U.S. Patent Nos. 5,427,693 (Mausgrover), 5,711,887 (Gastman) and 6,464,877 (Mori) all teach such prior art apparatuses or systems.

[0013] Yet, one major drawback of prior art water treatment apparatuses and systems is the need to regularly clean the filters which tend to become clogged with pollutants over time. Generally, cleaning filters implies the physical and/or chemical cleaning of the filters. This, in turn, necessitates that the apparatus or system be shut down while the filters are cleaned or changed.

[0014] Notwithstanding the existence of prior art ozone water treatment apparatuses and systems, it remains clear there is a need for an improved water treatment apparatus which mitigates the shortcomings of the prior art apparatuses and systems.

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**Objects of the Invention**

[0015] Accordingly, one of the main aspects of the present invention is to provide a water treatment apparatus which comprises at least an ozone treatment module and a membrane filtration treatment module.

[0016] Another aspect of the present invention is to provide a water treatment apparatus which essentially saturates the water with gases prior to the membrane filtration treatment module.

[0017] Yet another aspect of the present invention is to provide a water treatment apparatus which uses a white water creation stage during the membrane filtration treatment as a self-cleaning mechanism for the membranes.

[0018] Still another aspect of the present invention is to provide a water treatment apparatus wherein the cleaning of the membranes is effected in a substantially continuous manner while the apparatus is in filtration mode.

[0019] Other and further objects and advantages of the present invention will be obvious upon an understanding of the illustrative embodiments about to be described or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

**Summary of the Invention**

[0020] The aforesaid and other objectives of the present invention are realized by generally providing a novel water treatment apparatus which advantageously uses the oxidative property of ozone to purify and disinfect polluted water and which advantageously uses a white water creation stage during the passage of gas-saturated water through the membrane filters as a self-cleaning mechanism therefor. Hence, the apparatus of the present invention essentially uses ozone both to purify water and to clean the membrane filters.

[0021] As used above and hereinafter, the expression "white water" designates a mixture of water and nascent gas or gases obtained by the depressurization of gas-saturated pressurized water made up of a mixture of gas or gases and water in equilibrium at a predetermined pressure. Hence, the white color of the water thus obtained is caused by the formation of microbubbles and hence refers to the color of the water at the moment of the depressurization.

[0022] The apparatus of the present invention generally comprises a fully pressurized water treatment chain having several stages or modules. Hence, after being pumped into the apparatus by a pumping unit, the raw water generally flows toward an ozone treatment module in which ozone is first injected into the raw water, generally by means of a venturi or other known means, and is then allowed a generally predetermined contacting time in a pressurized contacting chamber. The contacting chamber is generally designed to allow an efficient dissolution of the ozone into the water and also to give the dissolved ozone time to react with at least a portion of the pollutants contained in the water.

[0023] The water exiting the contacting chamber then flows toward a degassing module. The degassing module removes essentially all the excess undissolved gases (e.g. oxygen, nitrogen, ozone) remaining in the water in order to provide water saturated with gases (e.g. oxygen, nitrogen, ozone). The degassing module also has the additional advantage of removing at least a portion of the volatile compounds which may still be present in the water. Understandably, since the undissolved gases removed from the water can comprise toxic and/or corrosive gases, it is preferable to send the removed gases to a gas treatment unit for further processing and/or destruction.

[0024] The gas-saturated water exiting the degassing module is then sent to the membrane filtration module for filtration treatment.

[0025] According to an important aspect of the present invention, as the gas-saturated water flows through the membranes, the particles still present in the water are removed. Also, the water is subjected to a depressurisation as it passes through the membranes. This, in turn, will cause the formation of a substantial amount of microbubbles, some of which will be formed inside the openings (e.g. pores) of the membranes and/or at the periphery of the surface thereof. The formation of the microbubbles will cause the water to turn into milky white water.

[0026] According to an important aspect of the present invention, the microbubbles formed during the passage of the gas-saturated water through the openings of the membrane filters will generally coagulate the small particles still present in the water, will generally prevent the accumulation of particles on the surface of the membranes, will generally dislodge particles present on the surface of the membranes and/or will also generally expel particles which may have been clogging openings of the membranes. Hence, the formation of microbubbles acts as an efficient self-cleaning mechanism for the membranes.

[0027] As the gas-saturated water enters the membrane filter, a portion thereof (hereinafter “the filtrate water”) actually goes through the membrane and is effectively filtered thereby. However, according to another aspect of the present invention, the remaining portion of the gas-saturated water (hereinafter “the retentate water”) that does not actually go through the membrane is generally looped back to the ozone treatment module where it is mixed with raw water and further treated by the apparatus.

[0028] The features of the present invention which are believed to be novel are set forth with particularity in the appended claims.

## Brief Description of the Drawings

[0029] The above and other objects, features and advantages of the invention will become more readily apparent from the following description, reference being made to the accompanying drawings in which:

[0030] Figure 1 is a schematic view of an embodiment the water treatment apparatus of the present invention.

## Detailed Description of the Preferred Embodiment

[0031] A novel water treatment apparatus will be described hereinafter. Although the invention is described in terms of specific illustrative embodiments, it is to be understood that the embodiments described herein are by way of example only and that the scope of the invention is not intended to be limited thereby.

[0032] The water treatment apparatus of the present invention generally comprises three stages or modules: an ozone treatment module 100, a degassing module 200 and a membrane filtration module 300. Generally speaking, the ozone treatment module 100 is generally responsible for the injection of ozone into the water and for the mixing and contacting of the ozone and the water. The degassing module 200, located downstream the ozone treatment module 100, is used to remove essentially all the non-dissolved gases (e.g. oxygen, nitrogen, ozone) which may still remain in the water following the ozone treatment module 100. The degassing module 200 is also used to provide gas-saturated water to the membrane filtration module 300 located thereafter. As the name implies, the membrane filtration module 300 filters the ozone treated water with a membrane filter or a plurality of membrane filters in order to remove remaining solid particles and pollutants still present in the water.

[0033] Referring now to Fig. 1, initially, the polluted or raw water (hereinafter "raw water") to be treated in first pumped into the apparatus 10 via a pumping unit 11. The pumping unit 11 generally provides the necessary pressure and flow to the raw water for the proper functioning of the apparatus 10. According to the preferred embodiment, the pumping unit 11 provides between 100 and 200 psig of pressure to the raw water.

[0034] Downstream of the pumping unit 11, the raw water is split between a first pipe 109 and a second pipe 119.

[0035] The first pipe 109 leads to an ozone injecting unit 110 such as, but not limited to, a first venturi, where ozone gas in injected into the raw water. Understandably, the "gas" effectively injected into the raw water is more or less a mixture of ozone (e.g. ~10-12%), oxygen (e.g. ~83-86%) and nitrogen (e.g. ~4-5%).

[0036] The ozone injecting unit 110 is connected to an ozone generating module 400. Ozone generating modules 400 are generally known in the art (e.g. U.S. Patent No. 6,180,014) and will not be described any further. Different ozone generating modules 400 can be used for the purpose of the present invention. The present invention is not limited to any particular ozone generating modules 400.

[0037] The second pipe 119 leads to a retentate water injecting unit 120 such as, but not limited to, a second venturi. The retentate water injecting unit 120 injects a portion of the retentate water coming from the membrane filter or filters 310 into the raw water. The membrane filtration module 300 will be described further below.

[0038] The two flows of raw water exiting the ozone injecting unit 110 and the retentate water injecting unit 120 are recombined via pipes 111 and 121 respectively and then directed to a static mixer 130 wherein the raw water containing ozone and the raw water containing retentate water are thoroughly mixed. The water exiting the static mixer 130 is thus essentially a mixture of raw water, retentate water, ozone (dissolved and non-dissolved) and other gases (e.g. oxygen and nitrogen) (dissolved and non-dissolved).

[0039] At the exit of the static mixer 130, the water flows into a pressurized contacting chamber or reactor 140. According to the preferred embodiment, the pressure inside the contacting chamber 140 varies between 20 and 120 psig. Preferably, the contacting chamber 140 is configured to provide an optimal mass transfer between the ozone and the water and an optimal contacting time between the dissolved ozone and the pollutant present in the water. Preferably, at the exit of the contacting chamber, the colours and odours of the water are reduced, the pathogens are mostly neutralized and/or inactivated and the organic (e.g. oils and greases) and inorganic (e.g. metals) particles and pollutants are mostly oxidised.

[0040] The skilled addressee will understand that the contacting chamber 140 can be provided in different shapes and/or configurations. Nevertheless, in order to reduce the footprint of the apparatus 10, a preferred configuration for the contacting chamber 140 would be one or more coiled pipes. Still, other configurations are possible; the present invention is not so limited.

[0041] Preferably, an ozone sensor 150 is disposed downstream of the contacting chamber 140 in order to measure the level of dissolved ozone still remaining in the water. The level of dissolved ozone remaining in the water after an ozone treatment is generally used by governmental regulatory bodies to determine if the ozone treated water is compliant with their water regulations. Preferably, but not exclusively, the level of dissolved ozone downstream of the contacting chamber 140 should be between 0.3 and 1 mg/L.

[0042] Preferably, the ozone sensor 150 is in electronic communication with the ozone generating module 400, directly or via a central control system (not shown), in order to feed the ozone measurements back to the ozone generating module 400 whereby the ozone generating module 400 can increase or reduce its generation of ozone accordingly.

[0043] In order to maintain the pressure in the contacting chamber 140, a pressure regulating unit 160 such as, but not limited to, a sustaining valve, is disposed downstream thereof.

[0044] The water exiting the pressure regulating unit 160 effectively exits the ozone treatment module 100 and enters the degassing module 200.

[0045] The degassing module 200 mainly comprises a degasser unit 210 and a gas treatment unit 220. The water exiting the ozone treatment module 100 is mainly composed of ozone-treated water, ozone (dissolved and non-dissolved) and other gases (e.g. oxygen and nitrogen) (dissolved and non-dissolved). As the water circulates through the degasser 210, essentially all the undissolved gases (e.g. oxygen, nitrogen and ozone) are removed. Additionally, should the water still contain undissolved volatile compounds, these compounds are also preferably removed from the water.

[0046] Since some of the gases removed by the degasser 210 could be corrosive and/or toxic, the removed gases are preferably sent to a gas treatment unit 220 for further treatment (e.g. neutralisation or destruction).

[0047] At the exit of the degassing module 200, the ozone-treated water is now essentially saturated with gases (e.g. oxygen, nitrogen and ozone). This ozone-treated gas-saturated water is then sent to the last module of the apparatus 10, namely the membrane filtration module 300, where it will undergo a membrane filtration treatment.

[0048] The membrane filtration module 300 generally comprises one or more membrane filters 310 (only one is shown for clarity). Should more than one membrane filter 310 be used in the present apparatus 10, they would generally be disposed in parallel whereby each membrane filter 310 would filter a portion of the gas-saturated water. Membrane filters 310 are generally known in the art and shall not be described any further. Still, positive pressure membrane filters 310 having openings corresponding with micro-filtration and ultra-filtration are preferred for the proper functioning of the present invention.

[0049] As the gas-saturated water enters the membrane filter 310 via the filter inlet 311, it is separated into a first portion (e.g. ~90%) which will undergo membrane filtration and a second portion (e.g. ~10%) which will not undergo membrane filtration. This second portion of the water is instead directly sent to the retentate water outlet 312 of the filter 310.

[0050] According to an important aspect of the present invention, as the first portion of the water, which is saturated with gases, passes through the openings of the membranes, it undergoes a depressurisation or pressure drop. In the preferred embodiment of the present invention, the pressure drop varies between 10 and 80 psig. As the gas-saturated water passes through the openings of the membranes and is depressurized, an important quantity of microbubbles, composed mainly of oxygen, ozone and nitrogen, is formed substantially simultaneously. The presence of these microbubbles generally gives a milky white colour the water, hence the term "white water".

[0051] The formation of these microbubbles is an important aspect of the present invention. Indeed, since the depressurisation of the water occurs during the passage of the water through the membranes, a large portion of the microbubbles are formed either near the surface of the membranes or inside the openings thereof. The microbubbles formed near the surface of the membranes generally act as a shield preventing particles remaining in the water from sticking to the membranes. Additionally, some of these microbubbles effectively dislodge at least a portion of the particles which may have accumulated on the surface of the membranes. Furthermore, the microbubbles formed inside the openings generally prevent the clogging thereof and/or can dislodge particles which may be stuck therein. Finally, the remaining microbubbles tend to coagulate particles still present in the water and to bring these coagulated particles to the top of the filter 310, near the retentate outlet 312 from which they are sent back for further treatment.

[0052] The formation of microbubbles thus serves as a self-cleaning mechanism for the membrane or membranes of the membrane filter 310. Furthermore, since the passage of gas-saturated water through the openings of the membranes is essentially continuous, the membranes are subjected to an essentially continuous cleaning, thereby substantially reducing the need to mechanically and/or chemically clean the membranes of the filter 310.

[0053] Understandably, once on the other side of the membranes, the first portion of the water, now essentially clean, exits the filter 310 through the filtrate water outlet 313 and then exits the apparatus 10.

[0054] As mentioned above, a second portion of the gas-saturated water is directly sent toward the retentate outlet 312 of the membrane filter 310. As this second portion of the gas-saturated water flows toward the retentate outlet 312, it captures and carries along undissolved gases (e.g. coalesced microbubbles) and a portion of the particles which have accumulated in the filter 310 (e.g. coagulated particles). The retentate outlet 312 being fluidly connected to the retentate water injecting unit 120 via a return pipe 15, this second portion of the gas-saturated water, now containing undissolved gases and particles, is effectively returned to the ozone treatment module 100 of the apparatus 10 where it will be treated along with the raw water as explained hereinabove. As this retentate water is recycled through the apparatus 10, the undissolved gases and the particles contained therein will be further treated and/or removed from the water.

[0055] Hence, as the skilled addressee would understand, the apparatus 10 of the present invention not only continuously treats and filters raw water, it also further continuously treats and filters pollutants and particles which have been removed from the membrane filter 310 and which are recycled through the apparatus 10.

[0056] Additionally, even though the present apparatus 10 has been described as a stand-alone apparatus, the skilled addressee would understand that the present apparatus 10 could form part of a larger filtration system. The present invention is not so limited.

[0057] While illustrative and presently preferred embodiments of the invention have been described in detail hereinabove, it is to be understood that the inventive concepts may be otherwise variously embodied and employed and that the appended claims are intended to be construed to include such variations except insofar as limited by the prior art.

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## Claims

1) A water treatment apparatus for treating water, said apparatus comprising:
   a) an ozone treatment module for treating said water with ozone;
   b) a degassing module, located downstream said ozone treatment module and fluidly connected thereto, for removing undissolved gases from said water and for providing substantially gas-saturated water;
   c) a filtration module, located downstream from said degassing module and fluidly connected thereto, for filtering said gas-saturated water, said filtration module comprising a membrane adapted to cause a pressure drop as said gas-saturated water passes therethrough, said pressure drop causing the formation of microbubbles.

2) A water treatment apparatus as claimed in claim 1, wherein said membrane comprises openings and wherein a portion of said microbubbles are formed within said openings of said membrane.

3) A water treatment apparatus as claimed in claim 1, wherein said apparatus further comprises an ozone source, connected to said ozone treatment module, for providing said ozone thereto.

4) A water treatment apparatus as claimed in claim 1, wherein said ozone treatment module further comprises an ozone injecting unit for injecting said ozone into said water.

5) A water treatment apparatus as claimed in claim 4, wherein said ozone injecting unit is a venturi.

6) A water treatment apparatus as claimed in claim 3, wherein said ozone source is comprised within said ozone treatment module.

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7) A water treatment apparatus as claimed in claim 3, wherein said ozone treatment module further comprises a contacting chamber, located downstream said ozone injecting unit and fluidly connected thereto, for favouring the dissolution of at least a portion of said ozone into said water.

8) A water treatment apparatus as claimed in claim 6, wherein said ozone treatment module further comprises a contacting chamber, located downstream said ozone injecting unit and fluidly connected thereto, for favouring the dissolution of at least a portion of said ozone into said water.

9) A water treatment apparatus as claimed in claim 1, wherein said membrane filtration module comprises at least one membrane filter.

10) A water treatment apparatus as claimed in claim 1, wherein said membrane filtration module comprises a plurality of membrane filters.

11) A water treatment apparatus as claimed in claim 10, wherein said membrane filters are disposed in parallel.

12) A water treatment apparatus as claimed in claim 1, wherein said membrane comprises openings and wherein said pressure drop is caused as said gas-saturated water passes through said openings in said membrane.

13) A water treatment apparatus as claimed in anyone of claims 1 to 12, wherein said apparatus is fully pressurized.

14) A water treatment apparatus for treating raw water, said apparatus comprising:

a) a ozone treatment module comprising:

i) an ozone injecting unit for injecting ozone into said raw water;

ii) a contacting chamber, located downstream said ozone injecting unit and fluidly connected thereto, for dissolving at least a portion of said ozone into said raw water;

b) a degassing module, located downstream said contacting chamber and fluidly connected thereto, comprising a degasser for removing undissolved gases from said ozone treated water and for providing substantially gas-saturated water;

c) a filtration module, located downstream said degassing module and fluidly connected thereto, comprising at least one membrane itself comprising a plurality of openings through which said gas-saturated water can pass;

whereby the passage of said gas-saturated water through said membrane provokes the formation of microbubbles which dislodge and prevent the accumulation of particles therein.

15) A water treatment apparatus as claimed in claim 14, wherein said apparatus further comprises an ozone source, connected to said ozone injecting unit, for providing said ozone thereto.

16) A water treatment apparatus as claimed in claim 14, wherein said ozone injecting unit is a venturi.

17) A water treatment apparatus as claimed in claim 14, wherein the passage of said gas-saturated water through said openings provokes a depressurization of said gas-saturated water, whereby said depressurization provokes the formation of said microbubbles.

18) A water treatment apparatus as claimed in claim 14, wherein said ozone treatment unit further comprises a retentate water recirculation means to recirculate a portion of said gas-saturated water before it passes through said openings.

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19) A water treatment apparatus as claimed in claim 18, wherein said retentate water recirculation means comprise a retentate water injecting unit for injecting said portion of said gas-saturated water into said raw water, said retentate water injecting unit being fluidly connected to a retentate water outlet of said filtration module.

20) A water treatment apparatus as claimed in claim 19, wherein said retentate water injecting unit is a venturi.

21) A water treatment apparatus as claimed in claim 19, wherein said retentate water injecting unit is disposed in parallel to said ozone injecting unit, whereby said ozone injecting unit receives a first portion of said raw water and said retentate water injecting unit receives a second portion of said raw water.

22) A water treatment apparatus as claimed in claim 20, wherein said ozone treatment unit further comprises a mixer, located downstream said ozone injecting unit and said retentate water injecting unit and upstream said contacting chamber, for mixing said first portion of said raw water, second portion of said raw water, said retentate water and said ozone.

23) A water treatment apparatus as claimed in anyone of claims 14 to 22, wherein said apparatus is fully pressurized.

24) A water treatment apparatus for treating raw water, said apparatus comprising:

a) an ozone treatment module comprising:

i) an ozone injecting unit for injecting ozone into a first portion of said raw water, said ozone injecting unit being connected to an ozone source;

ii) a retentate water injecting unit for injecting retentate water into a second portion of said raw water;

iii) a mixer, located downstream said ozone injecting unit and said retentate water injecting unit and fluidly connected thereto, for mixing

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said first and second portions of said raw water and for providing mixed water;

iv) a contacting chamber, located downstream said mixer and fluidly connected thereto, for favouring the dissolution of at least a portion of said ozone into said mixed water;

b) a degassing module, located downstream said contacting chamber and fluidly connected thereto, comprising a degasser for substantially removing any undissolved gases from said ozone-treated mixed water and for providing substantially gas-saturated water;

c) a filtration module, located downstream said degassing module and fluidly connected thereto, comprising at least one membrane filter itself comprising openings through which said gas-saturated water can pass, an inlet for receiving said gas-saturated water, a first outlet for allowing filtered water to exit said filtration module and a second outlet connected to said retentate water injecting unit;

wherein the passage of said gas-saturated water through said membrane provokes the formation of microbubbles which prevent the accumulation of particles therein.

25) A water treatment apparatus as claimed in claim 24, wherein said apparatus further comprises an ozone source, connected to said ozone injecting unit, for providing said ozone thereto.

26) A water treatment apparatus as claimed in claim 24, wherein said ozone injecting unit is a first venturi.

27) A water treatment apparatus as claimed in claim 24, wherein said retentate water injecting unit is a second venturi.

28) A water treatment apparatus as claimed in claim 24, wherein the passage of said gas-saturated water through said openings provokes a depressurization of said gas-saturated water and the formation of said microbubbles.

29) A water treatment apparatus as claimed in anyone of claims 24 to 28, wherein said apparatus is fully pressurized.

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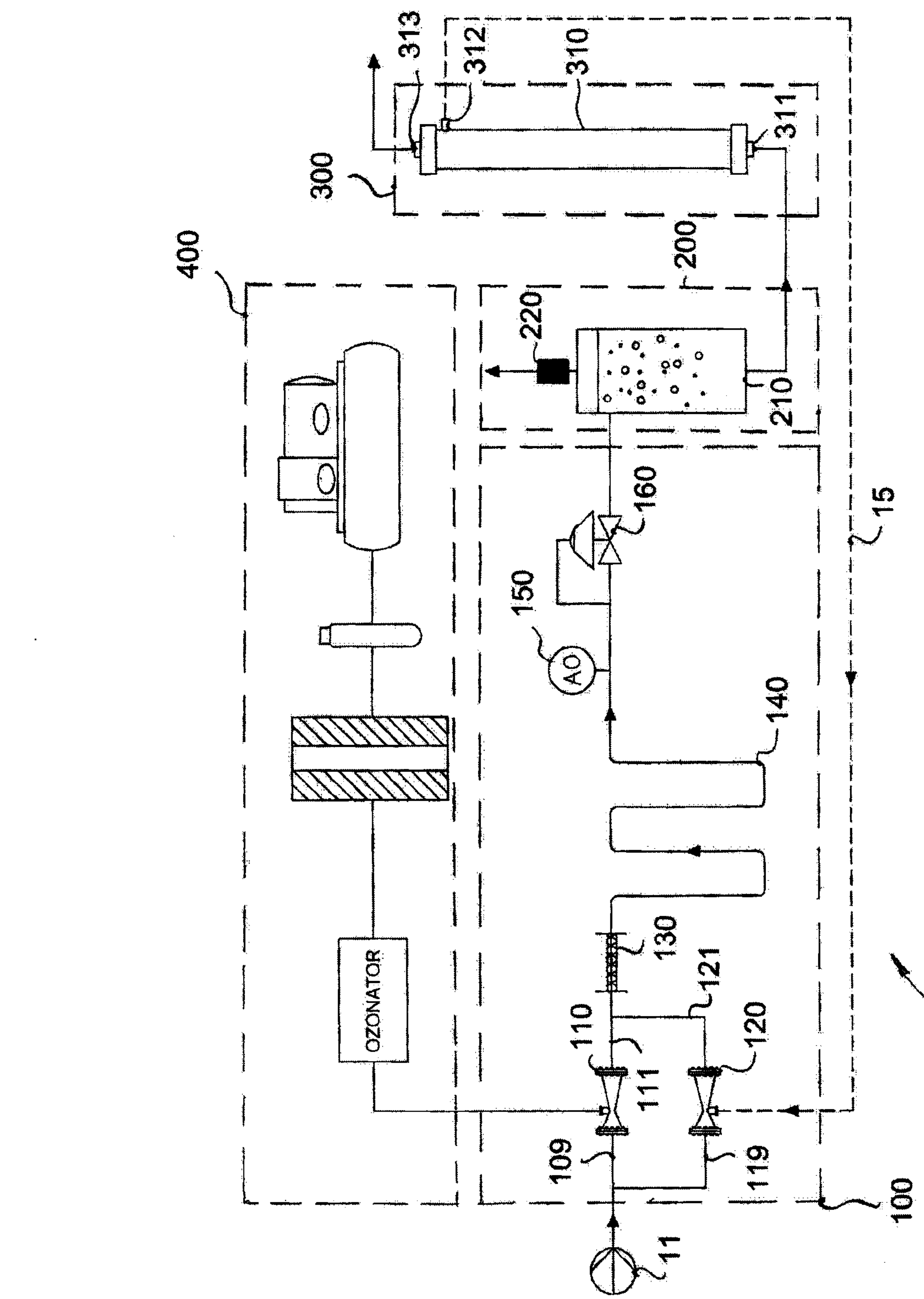
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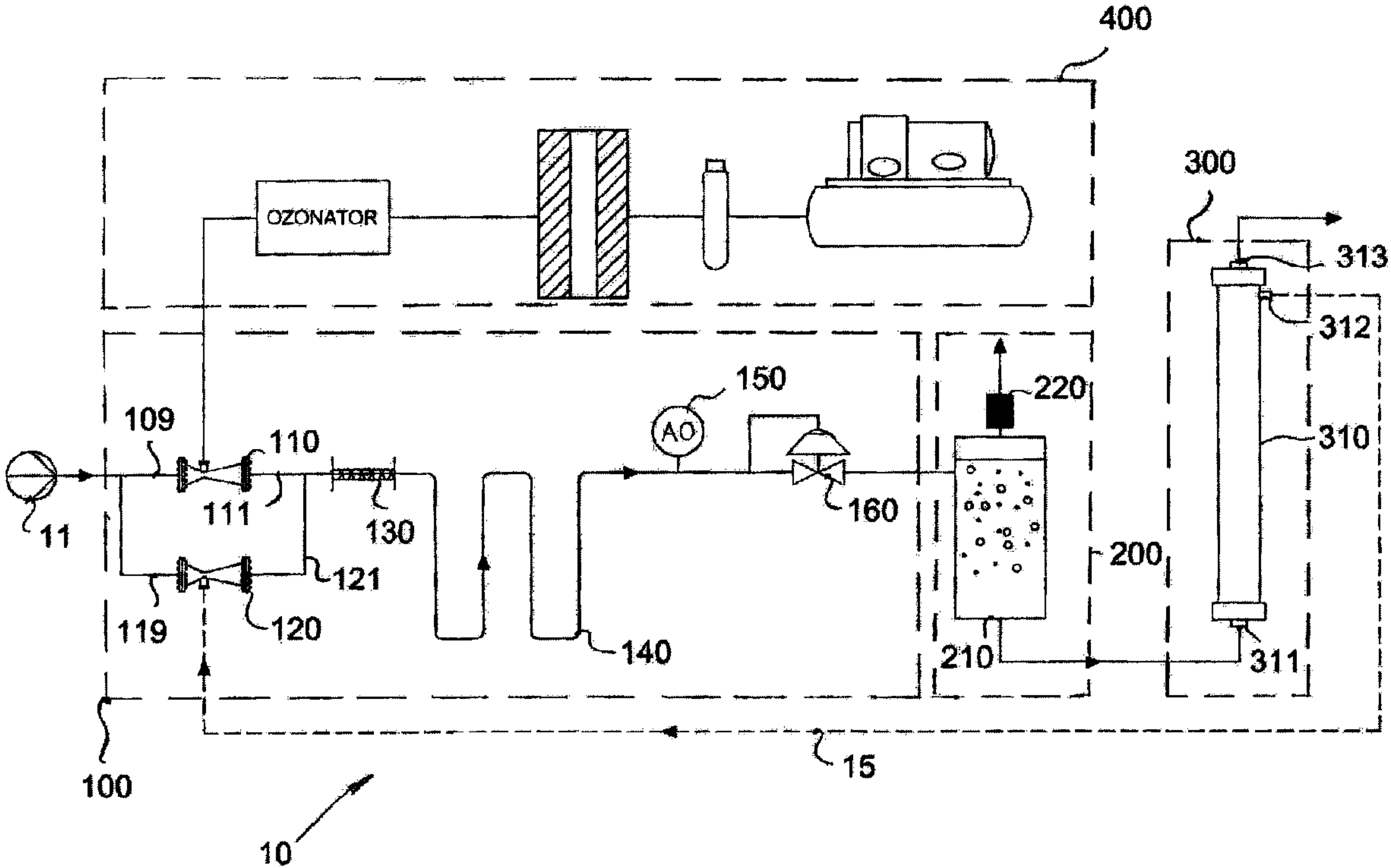
FIGURE 1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