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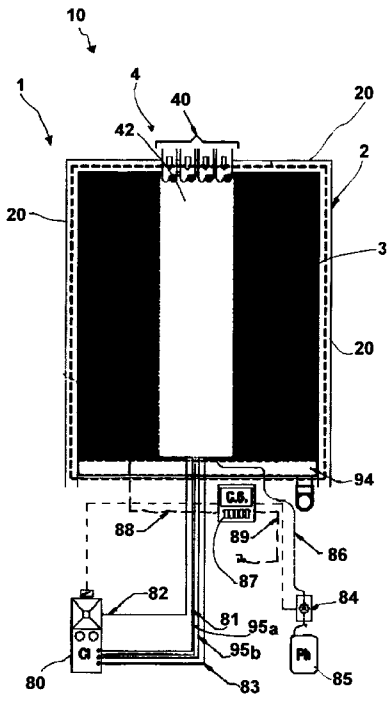

FIG. 4

(57) Abstract: The present disclosure relates to a filtering system (10, 100, 1000) for treating water polluted by organic matter, in particular for treating water in a swimming pool. The filtering system comprises a gravity filter (1), including a container tank (2) and a filtering mass (3) arranged inside the container tank (2), an apparatus (4, 42) for distributing polluted water on the filtering mass (3), a removal apparatus (5, 50) for removing water filtered by the filtering mass (3), and an apparatus for regenerating the filtering mass (3). The regeneration apparatus is configured to perform backwashing of the filtering mass (3) and comprises means (80, 81) for introducing a sanitizing product into the gravity filter (1). The sanitizing product is adapted to react with the organic matter accumulated in the filtering mass and perform disinfection, destruction or removal of the accumulated organic matter. The regeneration apparatus is configured to perform regeneration of the filtering mass (3) which comprises a mechanical action by means of backwashing and a chemical action by means of introduction of sanitizing product.

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FILTERING SYSTEM FOR TREATMENT OF WATER

DESCRIPTION

The present disclosure relates in general to the sector of filtering systems for the treatment of water. More specifically, the present disclosure relates to a gravity filtering system which can be used for the treatment of expanses of water, in particular swimming pools in general or public or private water purification plants.

A gravity filtering system is described for example in the international patent application publication No. WO 201 1/018721 A1. This known gravity-filtering system is installed in a water compensation tank of a swimming pool. The compensation tank is filled with a filtering mass which is supported by at least one plate which extends over the entire bottom surface of the compensation tank. The water in the compensation tank is purified by its passage through the filtering mass. Periodically, the filtering mass is regenerated by means of backwashing using water taken from the swimming pool itself. The washing water removes the dirt from the filtering mass and, after being collected, is discharged into the sewage system.

A drawback of this known filtering system is associated with the inefficient management of the water to be treated. In particular, the drawback is associated with the need to discharge the washing water into the sewage system. In fact it is required to replenish the swimming pool with the water which has been discharged as washing water and therefore an equivalent quantity of water must be taken from the mains water supply and heated to the temperature of the swimming pool.

Another drawback of the known systems consists in the difficulty of achieving a satisfactory regeneration of the filtering mass. This may involve a prolonged washing operation and a consequent high consumption of washing water and electric power for the circulating pumps.

The technical problem underlying the present disclosure is therefore that of providing a filtering system which is able to overcome the drawbacks mentioned above with reference to the prior art and/or achieving further advantages.

This is obtained by providing a filtering system according to the independent claim 1. The technical problem is also solved by a method for regenerating a filtering system according to claim 12.

Particular embodiments forming the subject of the present disclosure are defined in the corresponding dependent claims.

The subject of the present disclosure may be used for the treatment of water or expanses of water, such as swimming pools in general or public or private water purification plants.

In particular, the subject of the present disclosure is applicable to swimming facilities

which comprise a swimming pool or tub and a filtering system according to the present disclosure. The filtering system is configured to receive polluted water from the swimming pool and to return filtered water to the pool.

The subject of the present disclosure is applicable in general to a water treatment plant, which therefore comprises a filtering system according to the present disclosure. For example, it may be used for the treatment of process water in a winery plant or in other industrial sectors where the water consumption is to be reduced, with recovery of the discharge water and reuse thereof.

More specifically, the filtering system performs a filtering action by means of water falling through a filtering mass. Basically, the filtering system comprises a gravity filter. In other words, the gravity filter is configured to make use of the action of gravity in order to separate the polluted water from the organic matter which is retained on a filter sheet, the filter being of the gravity type. This is advantageous compared to pressure filters because it does not involve head losses in the pressure circuits and results in electric power savings.

In a particular embodiment, the filtering mass is formed by four layers of quartz sand of varying grain sizes which are positioned in layers: the first layer encountered by the water has a fine grain size for retaining the impurities present, while the other three layers have increasing grain sizes in order to ensure good drainage of the water. The filtering mass allows a very slow filtering speed to be achieved without creating preferential paths for the water. In particular the layer with the finest grain size is a top layer and the layer with the coarsest grain size is a bottom layer.

The filtering operation may be combined with the introduction of disinfectant products, such as chlorine or similar products and pH regulators, such as sulphuric acid or similar products.

During the ordinary filtering step the filtering mass becomes charged with organic matter present in the water. Basically, the layers of sand block the organic matter and remove it from the water, which is thus filtered. The organic matter is accumulated in the layers of sand, in particular in the first layer with a fine grain size. By means of monitoring with suitable instruments it is possible to identify when it is necessary to perform a regeneration of the filtering mass in order to remove the filtered organic matter which has accumulated.

According to an aspect forming the basis of the present disclosure, regeneration of the filtering mass is obtained by means of combination of a mechanical action and chemical action instead of by means of the sole mechanical action of the systems of the prior art.

The mechanical action is associated with backwashing, during which the washing

water passes through the filtering mass in the opposite direction to the direction during operation and removes the organic matter which has accumulated in the filtering mass. More particularly, in accordance with the present disclosure, the filtering system includes suction members for drawing off the fatty and lipid portion of the organic matter present in the filtering mass, wherein said suction members are arranged above the filtering mass. The suction members are adapted to be activated during a backwashing step. Owing to the presence of the suction members it is possible to limit the backwashing water consumption and accelerate the mechanical action, which otherwise would require a lot of time. The chemical action is associated with a sanitizing product which is introduced into the gravity filter during regeneration: the sanitizing product reacts with the accumulated organic matter and performs disinfection, destruction or removal thereof. The sanitizing product to be used varies depending on the type of plant and the type of pollution of the water to be treated.

In one embodiment, the sanitizing product is an acid solution which, acting if necessary in combination with a disinfecting product such as chlorine (which added in combination maximises the effect thereof) allows elimination of the bacterial content, in particular the bacterial content of an aerobic nature. Basically, the mechanical action in combination with the sanitizing solution (as well as with the disinfecting product already present or added) performs oxidization of the organic matter accumulated by the filter.

In another embodiment, the sanitizing product is a basic solution and allows a fat-removal operation to be carried out on the filter, i.e. removal of the fatty and lipid portion of the accumulated organic matter, and is also able to eliminate any bacterial content of the anaerobic type.

In yet another embodiment, both the types of solution may be used separately or in succession, depending on requirements.

There is a synergistic effect between the actions which occur during regeneration: the mechanical action, in addition to remixing the filtering mass and causing friction between its granules which produces separation of the organic matter, also favours mixing between the filtering mass, the disinfecting product already present, the sanitizing product and the organic matter brought to the surface with washing. This creates the conditions for an effective action of the sanitizing product and the disinfectant product during regeneration of the filtering mass of the filter.

This is useful for implementing a regeneration step which results in a regenerated filtering mass which is clean and substantially free of bacterial content. Moreover, this is useful for obtaining a washing water which, owing to the chemical sanitization

action, is also devoid of bacterial or organic content and may be recycled into the swimming pool or in any case into the plant which is served by the filtering system.

In other words, the subject of the present disclosure is useful for eliminating the need to discharge into the sewage system large amounts of washing water full of all the impurities present in the filtering mass. In fact, while the known technical systems produce washing water which is extremely polluted and must be discharged into the sewage system, the present filtering system produces washing water in which the polluting organic matter has been treated with the sanitizing product. In particular, the washing water is disinfected and oxidized and therefore may be reused in the facilities (swimming pool or the like) which are served by the filtering system.

This results in considerable savings in the management of the water to be treated. In particular, the water to be discharged into the sewage system may be reduced by 80% compared to the known systems and therefore also the required replenishing water is reduced by a corresponding amount. In the case where the water of the expanse of water must be kept at a certain temperature, as occurs for a swimming pool, there is a corresponding saving in the thermal energy needed to heat the replacement water.

In one embodiment, the regeneration apparatus comprises means for introducing an acid solution into the gravity filter, in order to lower the pH of the gravity filter and eliminate all the organic substances which are not resistant to an acid environment. More specifically, the gravity filter is acidified so as to bring the pH to a value of less than 3. A disinfecting substance, such as a chlorine-based product, may be introduced during the regeneration step for a stronger action on the bacterial content. In particular, the pH is adjusted to a desired value before introducing the disinfecting substance, in order to maximize the effect of the latter.

In one embodiment, the regeneration apparatus comprises means for introducing a basic solution (for example caustic soda) into the gravity filter. Therefore, it is possible to perform regeneration of the filtering mass using a basic solution which separates and eliminates all the organic matter of the lipid or fatty type which is present on the gravity filter, as well as the bacterial part which is non-resistant to a basic environment. Basically, there is a fat-removal step during which the fatty and lipid portion of the accumulated organic matter is removed, destroyed and discharged externally. In particular, the lipid or fatty substance removed may be discharged into the sewage system or treated in a special settling or degreaser tank which is arranged in series with the gravity filter, thus recovering said water.

A special step which uses a basic solution and which is different from the

backwashing step and any step which uses an acid solution, is useful for eliminating specifically the lipid and fatty portion and any anaerobic bacterial form of the organic matter in the filter, limiting discharging of this portion into the sewage system. This makes it possible to avoid discharging into the sewage system following backwashing or oxidation. Moreover, prior elimination of this organic matter part improves the efficiency of washing and oxidation and reduces the consumption of product for said oxidation.

In one embodiment of the present disclosure, the suction members are positioned just above, for example at a distance of 8-12 cm above the quartz sand. Basically, the suction members have an inlet or suction opening facing the top of the gravity filter in order to be able to draw off easily the impurity present in the upper zone of the gravity filter. These suction members include, for example, a flanged central header; a plurality of perforated comb-like headers with fins for facilitating during suction the conveying of the organic matter being backwashed; a circuit to be used for introducing a soap product onto the filter; nozzles located on the fins and connected to the circuit for diffusion of the soap in a homogeneous manner on the filter.

In one embodiment, the filtering system also comprises a storage tank which is useful both for increasing the compensation capacity of the filtering system and for supplying washing water to be used for the regeneration step.

The timing sequence which determines the use of the different modes (backwashing, acid sanitization or oxidation, fat-removal) for regenerating the filter and for removing the organic content retained is defined during construction of the filter system with a precise procedure depending on the type of treatment of the water to which the filtering system must be applied.

In particular, sanitization with an acid solution and fat-removal using a basic solution may be performed separately (i.e. during different regeneration operations) and with varying frequency; the frequency of use of either mode may be chosen during start-up, depending on the water to be treated and the organic matter retained on the filter. Alternatively, sanitization with an acid solution and fat-removal with a basic solution may be performed in combination, i.e. during a same regeneration operation.

In one embodiment, the filtering system also comprises a degreaser which is useful for retaining the lipid and fatty organic matter obtained with use of the basic solution; the degreaser allows settling of the organic substances and recovers the water.

Differently from some known systems, the filtering system according to the present disclosure must not be arranged inside a compensation tank of the facilities

(swimming pool or the like): it may be situated outside the compensation tank.

Further characteristic features and modes of use forming the subject of the present disclosure will become clear from the following detailed description of embodiments thereof, provided by way of a non-limiting example.

It is evident, however, that each embodiment forming the subject of the present disclosure may have one or more of the advantages listed above; in any case it is not required that each embodiment should have simultaneously all the advantages listed.

Reference will be made to the figures of the accompanying drawings in which:

- Figure 1 shows a vertically sectioned view of a gravity filter forming part of a filtering system according to the present disclosure;
- Figures 2 to 5 show, in schematic views from above, a first embodiment of a filtering system according to the present disclosure; for the sake of clarity of illustration, each figure shows only some of the components of the filtering system, in different operating conditions: an overall view of the filtering system can be obtained from the combination of the figures;
- Figures 6 to 10 show, in schematic views from above, a second embodiment of a filtering system according to the present disclosure; for the sake of clarity of illustration, each figure shows only some of the components of the filtering system, in different operating conditions: an overall view of the filtering system can be obtained from the combination of the figures:
- Figures 11 to 15 show, in schematic views from above, a third embodiment of a filtering system according to the present disclosure; for the sake of clarity of illustration, each figure shows only some of the components of the filtering system, in different operating conditions: an overall view of the filtering system can be obtained from the combination of the figures.

With reference to Figures 1 to 5, a first embodiment of a filtering system according to the present disclosure is indicated by the reference number 10. The filtering system 10 comprises a gravity filter 1, in turn comprising a container tank 2 and filtering mass 3 arranged in the container tank 2.

In particular, the container tank 2 has a floor 21 and modular walls 20, each of which has a skeleton structure formed by tubular elements with a square cross-section made of galvanized steel and welded together. This skeleton structure is lined with PVC sheets, for example with a thickness of 5 mm, in order to form the modular wall 20. The skeleton structures of the modular walls 20 are joined together, for example, by means of an interlocking fit, so as to form the perimeter of the container tank 2.

The walls 20, at the bottom, are fastened to the floor 21 by means of a suitable fastening system and, at the top, are fixed by means of ties so that the walls 20 are rendered self-supporting with respect to each other and can withstand the thrust which the filtering mass 3 and the water to be filtered exert in an outwards direction. The PVC sheets of the modular walls 20 are welded together and to PVC sheets arranged on the floor 21, in order to obtain a container tank 2 which is sealed.

Alternatively, the walls 20 may be made of reinforced concrete and, in this case, the walls 20 are simply lined with sheets of PVC which are welded together, for example with a thickness of 5 mm.

The dimensions of the container tank 2 are calculated in each case depending on the requirements and the location where the filtering system 10 must to be provided.

More specifically, the filtering mass 3 consists of quartz sand, for example with a grain size of between 0.4 and 0.8 mm. The filtering mass 3 may consist of a single layer. Alternatively, the filtering mass 3 may be formed by several layers with different grain sizes, for example between 0.4 and 15 mm. The filtering mass 3 may moreover be a heterogeneous mass, formed by high-efficiency micro-pearl quartz sand, anthracite, zeolite, expanded synthetic materials and other materials. In particular, the grain size of the layers increases from the top downwards: the layers with a finer grain size are situated in the top part of the filtering mass 3 and the layers with a larger grain size are situated in the bottom part of the filtering mass 3.

More specifically, four layers of quartz sand with different grain sizes are provided, being positioned in a layered arrangement: the first layer which the water encounters has a fine grain size for retaining the impurities present in the water, while the other three layers are formed with increasing grain sizes in order to ensure proper draining of the filtered water.

The quantity of filtering mass 3 is calculated on the basis of the volume of the container tank 2 and the load to be filtered.

The filtering system 10 comprises an apparatus 4 for distributing polluted water over the filtering mass 3. More specifically, the distribution apparatus 4 comprises hydraulic pipes or circuits 40 and a channel 42 which receives the water from the pipes 40 and distributes it in spray form over the filtering mass 3.

The pipes 40 may form part of hydraulic circuits which are already existing or especially designed and may be circuits operating under pressure or by means of gravity.

The channel 42, which is for example made of PVC, has dimensions suitable for collecting all the incoming water. In particular, it has a length equal to a plan dimension of the container tank 2. The channel 42 is arranged above the filtering

mass 3 and therefore is situated in a top region of the container tank 2 positioned approximately along a centre line. In one example of embodiment, the channel 42 has a parallelepiped form and is made with PVC sheets; the sheets of PVC are perforated, so as to spray the water received from the pipes 40; the channel 42 is suspended above the surface of the filter by means of suitable support brackets made of aluminium.

An advantage associated with the distribution channel 42 is that the water to be filtered falls onto the filtering mass 3 by means of gravity and no blower is required in order to force the water through the nozzles, as is instead necessary in some systems of the prior art.

In any case, irrigators or sprayers may be provided as an alternative to the channel 42.

The filtering system 10 comprises a removal apparatus 5 for removing the water which has been filtered by the filtering mass 3. This removal apparatus 5 comprises removal members 50 or draining circuits which are immersed in the filtering mass 3 and are located at the base of the container tank 2, on the floor 21. This technical solution does not require any perforated plate for supporting the filtering mass.

Each removal member 50 comprises a header 51 and a plurality of hollow pipes 54 in a comb arrangement on opposite sides of the header 51. The header 51 has for example a circular cross-section and is made of PVC; its two ends are closed by plates 52 which ensure that the water is removed only by the hollow pipes 54 connected to said header 51. The end plates may have a square shape for being able to rest stably the header 51 on the floor 21.

The hollow pipes 54, which hydraulically communicate with the respective header 51, are tube portions of suitable diameter which have a plurality of openings or slits 55 on their side wall. The water removed enters into the hollow pipes 54 through the openings or slits 55 and, from here, is sucked into the header 51. The number of openings or slits 55 is chosen so as to ensure the required drainage rate.

Each hollow pipe 54, which is also made of PVC, is fixed to the respective header 51 by means of welding. At the free end of the hollow pipe there is a PVC cover-piece 56 which closes the end and ensures that the water is removed only through the openings or slits 55. Moreover, the cover-piece 56 may act as a support foot for keeping the hollow pipe 54 stably supported on the floor 21.

The removal members 50 are connected to a water treatment unit 57 which comprises at least two centrifugal pumps 571, 572. The first pump 571 is intended for the filtration step, while the second pump 572 is a back-up pump for filtration and is also used for the step of regenerating or washing the filtering mass 3.

The two pumps 571, 572 are connected to two headers 58, 59: the first header 58 is situated on the intake side of the pumps, while the second header 59 is situated on the delivery side of the pumps. In other words, the two pumps 571, 572 are arranged between the two headers 58, 59.

Each pump 571, 572 is provided with a butterfly shut-off valve on the intake side; an analog pressure gauge for monitoring the pressure in the circuit, an anti-vibration coupling, a non-return valve and a shut-off valve are provided on the delivery side.

The following are connected to the first header 58 (or intake header): the pumps 571 , 572; pipes 61 connected to the removal members 50; one or more circuits 63 branched off from the tank in which the treated water is collected; a certain number of bypass circuits 65. The bypass circuits 65 are branched off from delivery pipes 67 which supply the tank for storing the treated water. The number of bypass circuits 65 is equal to the number of delivery pipes 67.

The following are connected to the second header 59 (or delivery header): the pumps 571, 572; the delivery pipes 67 which connect the filtration system to the tank for storing the treated water; bypass circuits 73 for performing backwashing.

The number of delivery pipes 67 is calculated depending on the flowrate of the filtration system, considering a flow speed of 2.5 m/s for each delivery pipe 67.

The second header 59 is also provided with air breather valve and an electronic pressure switch for controlling the delivery circuit, with the aim of preventing the presence of air inside the gravity filter 1.

The filtering system 10 comprises an apparatus for regenerating the filtering mass 3. The regeneration apparatus is configured to perform backwashing of the filtering mass 3. In particular, the regeneration apparatus comprises one or more circuits 73 which are connected to the second header 59 and to the removal members 50. Basically, the circuits 73 are circuits which bypass the first header 58 and are used during backwashing of the filtering mass 3 in order to activate reverse operation of the removal members 50 which emit washing water to the base of the filtering mass 3.

The regeneration apparatus further comprises means for introducing products and/or solutions into the gravity filter 1 and, consequently, into the filtering mass 3. In particular, these means comprise a doser or diluter 80 which is designed especially to serve the filtering system. In particular, the doser 80 comprises a hopper, a tank for containing a basic solution (for example based on caustic soda or similar products), a tank for containing an acid solution (for example sulphuric acid or a similar product) and a tank for containing a disinfecting substance (for example chlorine-based).

Via the hopper, a solid-state disinfecting product (for example calcium hypochlorite in tablet form or similar products) is diluted with water received from a loading duct 82; the diluted disinfectant product is supplied to the gravity filter via a duct 83, in order to maintain the chlorine concentration values (in ppm) during the filtration stage, as set by the operator. The acid solution is supplied to the filter 1 by means of a circuit 95a. The basic solution is supplied to the filter 1 by means of a circuit 95b. The disinfecting substance, in the liquid state, is supplied to the filter 1 by means of a circuit 81.

More specifically, the circuits or ducts 81, 83, 95a, 95b connect the doser 80 to the channel 42 and therefore the distribution of the respective products or solutions on the filtering mass takes place from above.

Basically, the regeneration apparatus comprises means for introducing a sanitizing product into the gravity filter 1. The sanitizing product may be an acid solution, a basis solution, a disinfecting substance, or a combination of these. In the specific embodiment described here, the regeneration apparatus comprises means 80, 95a for introducing an acid solution into the gravity filter 1, means 80, 95a for introducing a basic solution into the gravity filter 1 and means 80, 81 for introducing a disinfecting substance. These means further comprise a circuit 75 which connects the second header 59 to the channel 42.

Furthermore, the filtering system comprises means for adjusting the pH of the gravity filter 1 during the ordinary filtration stage. These pH adjustment means comprise a tank 85 for the acid substance (for example sulphuric acid or a similar product), a dosing pump 84 which receives the acid substance from the tank 85, a duct 86 via which the doing pump 84 doses the acid substance to the filtering mass 3. More specifically, the duct 86 connects the dosing pump 84 to the channel 42 and therefore the introduction of the acid substance onto the filtering mass 3 is performed from above.

An analyzer 87, with outflow probe carrier, performs chemical monitoring of the water. The analyzer 87 receives water via the circuit 88 which draws it from the channel 42. The analyzer 87 discharges the analyzed water via the discharge circuit 89 which is connected to the intake side of the pump 571.

During the ordinary filtration step, i.e. during operation of the filtering system 10, the analyzer 87 analyzes the water in order to measure the values of free chlorine, total chlorine and pH. In particular, the analyzer is electronic and automatic. On the basis of the measurements obtained and with reference to the set parameters, the chemical products are dosed in order to keep the values within the legal parameters. In order to maintain the chlorine values (in ppm), the analyzer 87 activates where

necessary the diluter 80 in order to dilute the solid disinfectant product and dose it onto the gravity filter 1 by means of the circuit 83. In order to maintain the pH value, the analyzer 87 activates where necessary the dosing pump 84 in order to add acid substance via the duct 86.

For this purpose, the analyzer 87 is operationally connected to the diluter 80 and the dosing pump 84, for example by means of a control unit.

During use of the filtering system 10, the water to be treated, which is polluted by organic matter with a bacterial organic content, is introduced into the gravity filter 1 via the channel 42, passes through the filtering mass 3 downwards and is drained through the hollow pipes 54 by means of the pump 571 which sucks the water from the removal members 50. As it passes through the filtering mass 3, the water releases the organic matter, which accumulates in the filtering mass 3, in particular into the layers of sand with a finer grain size at a greater height.

After a certain period of operation, when the filtering system 10 shows a deterioration in performance below a certain threshold, the operation of regenerating the filtering mass 3 is performed. This is carried out by means of a physical-mechanical process and a chemical process.

The physical/mechanical process consists in backwashing the filtering mass 3, by causing the water to circulate in the opposite direction to that of the filtering step. Therefore, the washing water passes through the filtering mass 3 via the sand with a large grain size towards the sand with a fin grain size, generating organic foam which contains the organic matter which previously accumulated in the filtering mass 3.

This step of regenerating the filtering mass 3 may occur without the aid of the chemical solutions. The second centrifugal pump 572 (and optionally also the first pump 571) draws water from the storage tank and/or the tank containing the treated water and introduces it into the gravity filter 1 through the backwashing circuits, with reversal of the flow with respect to filtration.

This reversal of the flow can be obtained by closing the shut-off valves along the pipes 61 connected to the removal members 50, closing the shut-off valves of the delivery pipes 67 which supply the storage tank, opening the shut-off valves of the circuits 73 connected to the second header 59 and to the removal members 50, and opening the shut-off valves of the circuits 63 branched off from the storage tank. Therefore, the pumps remove treated water from the storage tank and pump it into the removal members 50 from where it rises upwards through the gravity filter 1 being backwashed. The washing water also passes through the top layer of the filtering mass 3, namely the layer which is most impregnated with the organic matter

and the disinfecting substance which is introduced during filtration. In this way said organic foam is generated. Basically the backwashing brings to the surface all the organic matter and the bio-film.

According to a first operating mode, the chemical process envisages oxidizing the organic matter transported by the washing water, i.e. the organic foam. This is obtained by introducing the acid solution (and optionally also the disinfecting substance) after performing the backwashing operation described above: the acid solution and the disinfecting substance react with the organic matter brought to the surface of the filtering mass 3 and eliminate the bacterial content (in particular the aerobic bacterial content) present in the organic matter.

Basically, the sanitizing product is introduced into a volume of washing water which is charged with organic matter which has been removed by the filtering mass 3.

The details of the process are provided below.

Firstly, the gravity filter 1 is acidified so as to adjust its pH below 3. This is obtained by introducing the acid solution (sulphuric acid or similar products) with the aid of doser 80, through a duct 85a which connects the doser 80 to the channel 42.

When the pH value has been reached, the disinfecting substance (chlorine or similar products) is introduced by means of the doser 80 and the respective duct 81 which connects the doser 80 to the channel 42.

In order to favour mixing of the acid solution and the disinfecting substance with the organic matter and the consequent activation of the oxidizing reaction, it is possible to perform a further backwashing operation.

An intensely oxidizing chemical reaction is thus developed inside the filter 1 and generates a surface-active film (referred to as "filter oxidation") which eliminates the aerobic bacterial content of the organic matter.

After resetting the direction of flow in the filtering mass from the top downwards, the surface-active foam is again circulated in the gravity filter 1, with it being removed by the pick-up members 50 and introduced into the channel 2 via the circuit 75 which connects the second header 59 to the channel 42, with continuous recirculation of the filter oxidation. The acid solution and the disinfecting substance thus continue to react with the residual bacterial content inside the filtering mass 3, managing to eliminate up to 99.9% of the bacterial content.

After a sufficient amount of time for completion of the oxidizing chemical reaction has lapsed, the regeneration step is completed and the filtering system 10 is reset for normal use.

It should be noted that, during the regeneration step, there was no discharging of washing water externally. In fact, during the initial step the backwashing water

remained in the container tank 2, being accumulated above the filtering mass 3 and causing the level inside said tank 2 to increase. During the subsequent step of recirculation of the surface-active foam, that portion which was removed by the removal members 50 is reintroduced into the channel 2 by the circuit 75.

Basically the use of the acid solution and/or the disinfecting substance during the regeneration step ensures the elimination of the bacterial content of the washing water and the filtering mass. Consequently, at the end of the regeneration step, the washing water has been purified of a substantial part of its polluted content and therefore may be reused in the swimming pool - filtration - swimming pool cycle without any sanitary-related problems. In other words, the washing water is recovered and need not be discharged externally for disposal.

According to a second operating mode, the chemical process involves a fat-removal treatment for the filtering mass 3. This is achieved by means of introduction of the basic solution, which for example is based on caustic soda or similar products. This allows the bacterial content and the lipid and fatty organic matter retained in the filtering mass 3 to be eliminated.

In particular, the basic solution is introduced via the doser 80 and a duct 95b which connects the doser 80 to the channel 42.

A circuit for extracting the fatty and lipid organic portion comprises suction members 90 which, in a similar manner to the removal members 50, each comprise a header 91 and a plurality of perforated pipes 92 in a comb-like arrangement on opposite sides of the header 91. The suction members 90 are arranged above the filtering mass 3, namely in the top part of the container tank 2.

The suction members are connected to intake pipes 93.

Upstream of a pump (in particular the second pump 572), between the shut-off valve and the impeller of said pump, there is a connection with a bypass circuit 69 which is connected to the suction pipes 93 of the circuit for extracting the organic portion.

Downstream of a pump (in particular the second pump 572), above the non-return valve, there is a connection with a bypass circuit 77 which is connected to the sewage outlet for the circuit for extracting the fatty and lipid portion. In particular, the bypass circuit 77 is connected to a foam collector or skimmer 94 from which discharge into the sewage system is performed via an overflow 940.

When it is required to perform removal of the lipids and fat during the regeneration step, firstly the physical and mechanical backwashing step is performed; thereafter the basic solution is introduced into the filtering mass by means of the doser 80 and the duct 95b. A certain amount of time is allowed to pass so that the basic solution is able to act on the organic matter and penetrate into the filtering mass 3. This time

is also calculated depending on the size of the gravity filter 1.

This is followed by further backwashing of the filtering mass 3, during which the fatty and lipid organic matter is detached from the sand of the filtering mass 3 and, upon reaching the surface, is removed by the circuits 93 with the aid of the pump 572 and introduced into the skimmer 94; the fatty and lipid organic matter is thus removed from the surface of the filter. Basically this is performed by opening and closing the appropriate valves and operating the second pump 571: the organic matter sucked in by the suction members 90 passes from the suction pipes 93, the bypass circuit 69, the second pump 572 and the bypass circuit 77 and finally reaches the foam collector 94, from where it is conveyed into the sewage system.

After performing mechanical removal of the fatty and lipid portion, the pH of the filter is adjusted so as to reset it to an operating value for filtration (the value of the pH must be calibrated depending on the type of application). Once the pH value is reached, disinfectant product is introduced in order to eliminate the aerobic bacteria and restore the concentration of disinfectant during filtration. This operation is activated by means of backwashing which causes mixing of the disinfectant with the water. Then the water is recirculated in the filter (with removal by means of the removal members 50 and reintroduction into the channel 2 by the circuit 75) in order to favour mixing and homogenization of the pH and the disinfecting product; the filtering system is then reset for operation in filtration mode.

Optionally, after removal of the fatty and lipid portion it is possible to perform backwashing and the reaction step (i.e. oxidation, as already described above), closing the cycle for washing of the filtering mass 3.

The gravity filter 1 and the headers 51 are designed with dimensions depending on the drainage rate requirements, attempting to maintain a filtration speed of 20 m/h. The filtration speed is calculated by dividing the nominal polluted water flowrate by the surface area of the filter 1 (i.e. the plan surface area occupied by the filtering mass 3).

For example, with a nominal flowrate of Q_i=100 m^3/h and a filtration speed v_f=20 m/h, a filter surface area of $S = Q_i / v_f = 100/20 = 5\ m^2$ is obtained.

The number and the diameter of the hollow pipes 54 are calculated depending on the washing flowrate. In order to ensure that, during the regeneration step, the washing water is distributed homogeneously over the entire surface, the washing speed must be at least equal to 40 m/h. An example of the dimensional values is given below.

Washing speed: V_l=40 m/h

Washing flowrate: $Q_l = S^* V_l = 5*40 = 200\ m^3/h$

Flowrate of a hollow pipe: Q_{tc} = 14.4 m^3/h , speed 2.5 m/s

Diameter of a hollow pipe: ⌀ = 50 mm

Number of hollow pipes: N = Q , / Q_{tc} = 200/14.4 = 13.88

This calculated value is rounded up to 16: the number of hollow pipes must be an even number and the same number, divided by two, must give an equal number. In other words, the number of hollow pipes must be a multiple of four.

Owing to the fact that it is not required to discharge into the sewage system all the washing water, the filtering system according to the present disclosure results in substantial savings. For example, in one embodiment, the following savings compared to known plants are obtained:

- water to be discharged into the sewage system: -80%;
- new water to be added: -80% owing to the water not discharged into the sewage system;
- savings in thermal energy for maintaining the temperature, if the user requires the water in the plant to be kept at a certain temperature;
- savings in electric energy since the gravity filter does not generate head losses in the pressure circuits downstream of the centrifugal pumps used to move the water. This saving must be calculated depending on the type of application; the saving may also be as high as 50% compared to conventional pressure filters;
- use of chemical products: -40% owing to reduced amount of water to be added.

With reference to Figures 6 to 10, a second embodiment of a filtering system according to the present disclosure is indicated by the reference number 100. In addition to the filtering system 10 described above, the filtering system 100 also comprises a storage tank 200. The storage tank 200 may be constructed with modular walls, in a similar manner to the container tank 2. The container tank 2 and the storage tank 200 are arranged alongside each other and separated by a dividing wall 210 which is also modular. All the PVC-lined walls are welded together.

The storage tank 200 is connected to the first header 58 by one or more pipes 230 provided with shut-off valves.

An underwater pump 220 for recovery of the water collected from the overflow 225 of the gravity filter 1 towards the container tank 2 is arranged in the storage tank 200. The pump 220 propels the water into the tank of the gravity filter 1 from where the water is conveyed to the swimming pool, avoiding the addition of new water. The storage tank 200 has its own drainage circuit 240 with water meter.

The storage tank 200 has the function of increasing the compensation capacity of the container tank 2 of the gravity filter 1, in the case where the latter is unable to cope with the wave movement produced by swimmers in the swimming pool

connected to the filtering system. Moreover the storage tank 200 is used for the washing operations: the water to be used for regeneration of the filtering mass 3 is removed from the storage tank 200 (via the pipes 230) instead of from the swimming pool, avoiding any disturbance of the level of the water in the swimming pool.

During the regeneration step, the state of the process is monitored by removing water from the storage tank 200 by means of a circuit 260 which is connected to an analyzer 265 with an outflow probe carrier. A discharge outlet 270 reintroduces the analyzed water into the storage tank 200. The values which are monitored during regeneration are as follows:

Redox (mV), with reading range from 1 to 2000 mV;

Conductivity (μS), with reading range from 1 - 2500 μS;

pH, with reading range from 1 to 15.

With reference to Figures 11 to 15, a third embodiment of a filtering system according to the present disclosure is denoted by the reference number 1000. In addition to the filtering system 10 and a storage tank 200 as described above, the filtering system 1000 also comprises a degreaser 300.

The degreaser 300 may also be constructed with modular walls, in a similar manner to the container tank 2 and the storage tank 200. The container tank 2, the storage tank 200 and the degreaser 300 are arranged alongside each other and are separated by dividing walls 210, 310, 315 which are also modular. All the PVC-lined walls are welded together.

The degreaser 300 is divided up into a settling tank 301 and a separation tank 302, each having its own drainage circuit 340 with water meter.

The degreaser 300 has the function of treating the lipid and fatty organic matter which is accumulated on the foam collector 94 during washing of the filter with the basic solution, in order to separate the organic matter and recover the water. The degreaser 300 receives the water mixed with lipid and fatty organic matter, which is present in the foam collector 94, via a discharge outlet 940.

The degreaser 300 separates the organic matter from the water. The recovered water, free from the lipid and fatty organic portion, is introduced into the storage tank 200 for use again within the plant, while the organic matter (which is more concentrated) is periodically removed manually and disposed of as special organic sludge, avoiding the introduction of polluted water into the sewage circuits.

The criterion for determining the size of the degreaser 300 consists in fixing a hydraulic residence time (dwell time) so that the separation of the lighter substances takes place. Other process parameters to be verified are the effective surface area and the useful volume of the second separation chamber on the basis of the

indications provided by the standards DIN 4040.

The hydraulic residence time is variable depending on the type of discharge, namely the amount of oils and fats present therein. This parameter defines the volume of the tank on the basis of the flowrate of the incoming discharge:

Q = instantaneous peak flowrate;

T_r = Residence time (the residence time must be between 3 minutes and 15 minutes);

V = volume of the tank;

$V = T_r * Q$.

A calculation example is shown here:

Flowrate of centrifuging pump 8 Q = 100 m^3/h = 0.0278 m^3/s

Tr = 7 min = 0.1 167 hours

V = 0.1 167 * 100 = 11.67 m^3

Once the value of the volume of the degreaser tank has been determined, it is necessary to determine the correct horizontal surface area which must be obtained in order for the degreaser to work in an optimum manner.

S = Q/v, where Q is the instantaneous peak flowrate and v is the ascending speed of the fat particles (defined in 4 mm/s).

S = 0.0278 + 0.004 = 6.95 + m^2

Height of working water level of degreaser:

h = V/S = 11.67/6.95 = 1.68 m

During the regeneration step, the state of the process may be monitored by removing water from the outlet of the degreaser 300 by means of the circuit 260 which is connected to an analyzer 265 with outflow probe carrier.

It should be noted, as already mentioned above, that the water used for regeneration of a filtering system according to the present disclosure does not have to be necessarily discharged externally or even into the sewage system, apart from the limited quantity of water output from the foam collector 94 or the degreaser 300. In fact, the water used for the physical/mechanical backwashing step remains in the container tank 2 (making use of the volume available in the container tank 2 above the filtering mass 3), where it is treated during the chemical step so that it may be used again in the plant.

With reference to the description provided above it may be noted that the filtering system includes pumping units for pumping water from the top into the gravity filter. Preferably, there are two pumps, for example two centrifugal pumps used for filtration, one of which remains switched off and the other one is operated with the aim of ensuring that one pump is available if the other one is out of order.

With regard to the centrifugal pumps it is pointed out that filtration is performed by the action of the centrifugal pumps which allow a vacuum environment to be created inside the filtering mass and the water sprayed onto the filter passes through the four layers with increasing grain size. In this way the centrifugal pumps are designed with dimensions such that the head losses produced by the pressure filters are eliminated with a reduction in the consumption of electrical power equal to 50% for the same performance characteristics.

The present invention, compared to the known technologies, is able to achieve improved filtration of the fresh water, together with microfiltration and biological purification of the water.

During backwashing of the filter one of the pumps draws the water from the storage tank (the storage tank is an optional component which the user may dispense with knowing that the savings in water instead of 98% will be less) and introduces it into the gravity filter, while the other pump draws off the organic matter from the circuit via the suction members and conveys it to the degreaser (as for the storage tank, the user may dispense with ordering the degreaser, knowing that the backwashing water cannot be recovered).

Basically, backwashing of the filtering mass is performed in a direction opposite to the direction of filtration and the backwashing water is drawn off by the suction members which, conveying the dirty water into the degreaser, arranged in series with the filter, recover the water which is subsequently used again, avoiding the need to discharge it into the sewage system.

In this way, compared to the known technologies, the consumption of water for washing the filtering mass is reduced by 95%, avoiding having to introduce new water from the mains water supply and with a saving in thermal energy in the case where the water is heated.

With regard to the suction members, they are preferably arranged at a short distance from, for example 8-12 cm, above the quartz sand. These suction members are structured so as to facilitate, during suction, conveying of the organic matter being backwashed.

A drainage header for filtration of the water is also present, said header being positioned at the base of the filter underneath the filter bed. The drainage header is configured to facilitate suction of the water, filtering it, as a result of the vacuum created by one of the aforementioned pumps. During backwashing the water drawn from the storage tank is introduced from the drainage header inside the filtering mass and in this way the water flows in the opposite direction to the direction in which it flows during filtration. In this way, the force of the water ensures that the

first layer of fine sand situated close to the aspirator is cleaned of the organic matter retained during filtration.

With regard to the storage tank, it is at the service of the filter in order to make up for lack of compensation of the filter in the case where a large number of swimmers are present in the swimming pool and, owing to the wave movement effect, the water flow towards the channel is increased. The filter is provided with an overflow 13 which is connected to the storage tank. An underwater pump is positioned inside the storage tank and automatically draws off the incoming water and introduces it over the filter, avoiding the addition of new water.

The storage tank is moreover used during backwashing of the filter. In order to start the backwashing step the pumps are switched off and the swimming pool overflows are allowed to drain off all the water on the filter. By means of valves it is possible to remove the water present on the filter and displace it into the storage tank. During this step the underwater pump is switched off.

The backwashing cycle uses the same stored water in accordance with the following process:

The pump draws off the water from the storage tank and introduces it through the drainage header, the pump draws off via the organic matter aspirator the dirt removed by the pump and the water containing the organic matter is conveyed to the degreaser where the heavy organic matter is deposited inside the first tank and the water free of organic matter is conveyed to the storage tank and repeats the same path until the filter is cleaned.

During this backwashing step, in order to accelerate the time needed to regenerate the filtering mass and ensure small dimensions of the degreaser, two chemical products are used: a soap product for removing the fat from the organic matter present on the filter, based on silicate plus sodium or similar products, and a second product composed of aluminium plus sulphate or similar products, for freeing the silica from the soap product and allowing it to settle by means of gravity in the tank 16 of the degreaser.

With regard to the static gravity degreaser, it consists of an inlet, two settling tanks and outlet for the purified water.

Separation and storage of the released silica containing the organic matter is performed inside the first tank.

Separation of the floating suspended matter is performed inside the second tank.

The purified water is then introduced into the storage tank ready for being used again.

Each backwashing step terminates when the pH of the backwashing water reaches a neutral pH value of 7.

The subject-matter of the present disclosure has been described hitherto with reference to preferred embodiments thereof. It is understood that other embodiments relating to the same inventive idea may exist, all of these falling within the scope of protection of the claims which are illustrated hereinbelow.

CLAIMS

1. A filtering system (10, 100, 1000) for treatment of water polluted by organic matter, comprising:

- a gravity filter (1) configured to make use of the action of gravity in order to separate the polluted water from the organic matter which is retained on a filtering mass (3), wherein the gravity filter includes a container tank (2) and the filtering mass (3) arranged in the container tank (2);

- a distribution apparatus (4, 42) for distributing polluted water onto the filtering mass (3);

- a removal apparatus (5, 50) for removing water filtered by the filtering mass (3);

- a regeneration apparatus for regenerating the filtering mass (3);

wherein the regeneration apparatus is configured to carry out a backwashing of the filtering mass (3),

the regeneration apparatus further comprising means (80, 81, 95a, 95b) for introducing at least one sanitizing product into the gravity filter (1), the sanitizing product being adapted to react with the organic matter accumulated by the filtering mass and to cause a disinfection, a destruction or a removal of the accumulated organic matter,

the regeneration apparatus being configured to carry out a regeneration of the filtering mass (3) which includes a mechanical action by backwashing and a chemical action by introducing the sanitizing product, wherein the regeneration apparatus includes suction members (90) for drawing off the fatty and lipid portion of the organic matter present in the filtering mass (3), wherein said suction members (9) are arranged above the filtering mass (3) or in a top zone of the filtering mass (3).

2. The filtering system (10, 100, 1000) according to claim 1, wherein the regeneration apparatus comprises means (80, 95a) for introducing an acid solution into the gravity filter (1) to lower the pH in the gravity filter during regeneration of the filtering mass (3), the acid solution being said sanitizing product or being a part of said sanitizing product.

3. The filtering system (10, 100, 1000) according to claim 1 or 2, wherein the regeneration apparatus comprises regeneration means (80, 81) for introducing a disinfectant substance into the gravity filter (1), said disinfectant substance being said sanitizing product or being a part of said sanitizing product.

4. The filtering system (10, 100, 1000) according to claim 1, 2 or 3, wherein the regeneration apparatus comprises means (80, 95b) for introducing a basic

solution into the gravity filter (1), said basic solution being said sanitizing product or being a part of said sanitizing product,

wherein the basic solution is adapted to act on a fatty and lipid portion of the organic matter accumulated by the filtering mass (3), in order to separate this fatty and lipid portion from the filtering mass (3), the regeneration apparatus being configured to carry out a regeneration of the filtering mass which comprises a fat-removing step for the filtering mass.

5. The filtering system (10, 100, 1000) according any one of the preceding claims, wherein the suction members (90) include a plurality of perforated comb-like headers with fins for facilitating, during suction, conveying of the organic matter being backwashed.

6. The filtering system (1000) according to claim 4, comprising a degreaser (300) configured to treat a stream of fatty and lipid organic matter which is separated from the filtering mass (3) during the fat-removing step, said degreaser (300) being adapted to obtain water recovered from said stream of fatty and lipid organic matter.

7. The filtering system (10, 100, 1000) according to any one of claims 1 to 6, wherein said distribution apparatus (4, 42) for distributing polluted water comprises a channel (42) positioned above the filtering mass (3), said channel (42) being configured to receive polluted water and to spray it over the filtering mass (3), and wherein said regeneration apparatus is configured to introduce the sanitizing product into said channel (42), the sanitizing product being introduced into the gravity filter (1) via said channel (42).

8. The filtering system (10, 100, 1000) according to any one of claims 1 to 7, wherein said means (80, 81, 95a, 95b) for introducing the sanitizing product comprises a doser (80) for dosing the sanitizing product into gravity filter (1).

9. The filtering system (100, 1000) according to any one of claims 1 to 8, comprising a storage tank (200), the filtering system (100, 1000) being configured to draw water for backwashing from said storage tank (200).

10. Swimming facilities comprising a swimming pool and a filtering system (10, 100, 1000) according to any one of claims 1 to 9, wherein the filtering system (10, 100, 1000) is configured to receive polluted water from said swimming pool and to return filtered water to said swimming pool.

11. A water treatment plant, comprising a filtering system (10, 100, 1000) according to any one of claims 1 to 9.

12. A regeneration method for regenerating a filtering system (10, 100, 1000) for treatment of water polluted by organic matter, the filtering system (10, 100, 1000)

comprising a gravity filter (1) configured to make use of the action of gravity in order to separate the polluted water from the organic matter which is retained on a filtering mass (3), wherein the gravity filter includes a container tank (2) and a filtering mass (3) arranged in the container tank (2),

wherein the regeneration method provides for carrying out a regeneration of the filtering mass (3) by means of a mechanical action by backwashing of the filtering mass (3) and by means of a chemical action by introducing at least one sanitizing product into the gravity filter (1), the sanitizing product being adapted to react with the organic matter accumulated by the filtering mass (3) and to cause a disinfection, a destruction or a removal of the accumulated organic matter and wherein, in order to reduce water consumption and accelerate the regeneration time, the backwashing envisages drawing off the fatty and lipid portion of the organic matter present in the filtering mass from a head or top zone of the filtering mass.

13. The regeneration method according to claim 12, wherein the sanitizing product is introduced after backwashing, the sanitizing product being introduced into a volume of backwashing water which is charged with organic matter that has been removed from the filtering mass (3).

14. The regeneration method according to claim 12 or 13, comprising a step for removing the fat from the filtering mass (3) by introducing a basic solution into the gravity filter (1) during regeneration of the filtering mass (3).

15. The regeneration method according to claim 14, comprising a step of suction of a fatty and lipid portion of the organic matter which is separated from the filtering mass (3) during the fat-removing step, wherein said suction step allows said fatty and lipid portion of the organic matter to be removed from the surface of the gravity filter (1).

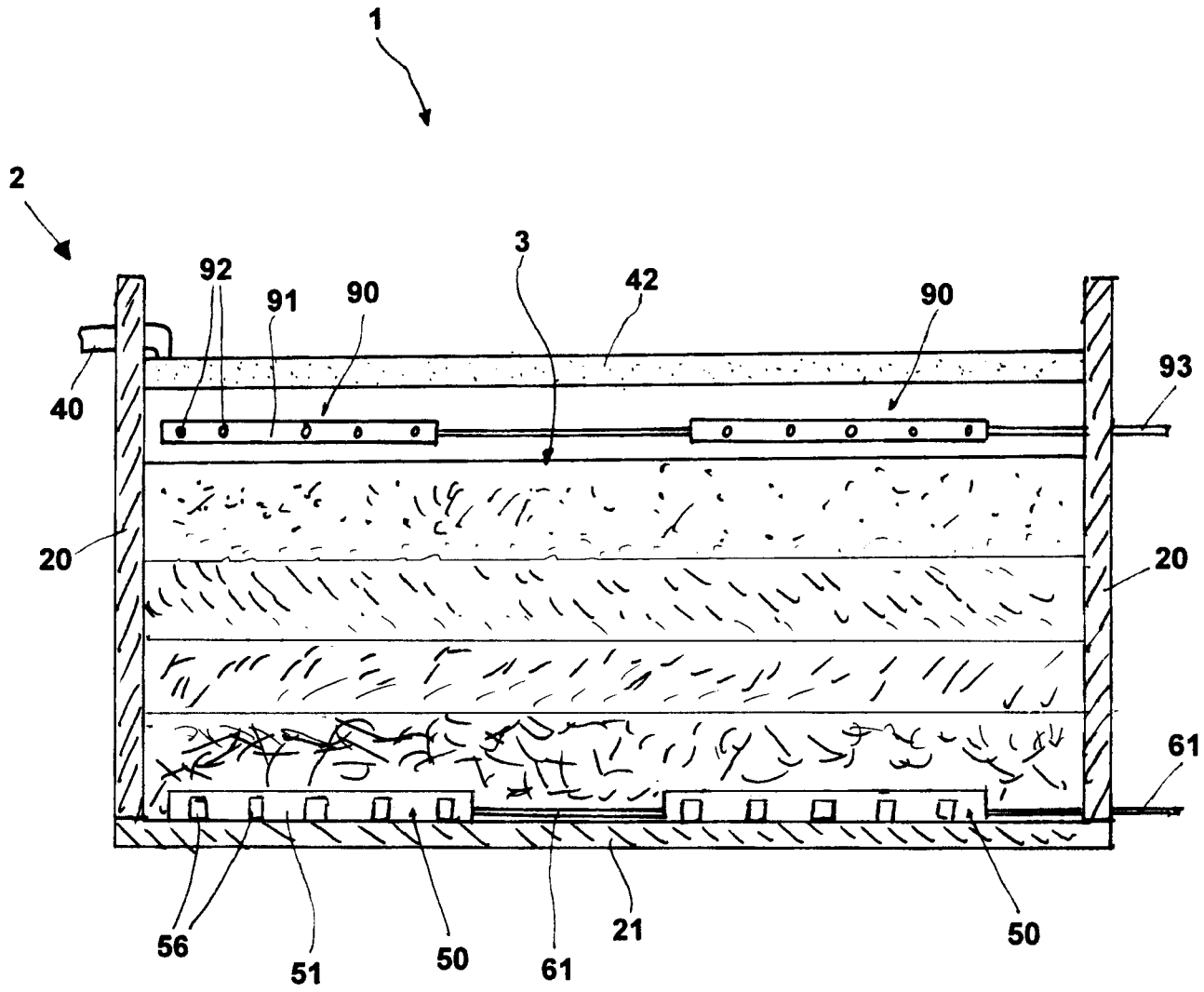

FIG. 1

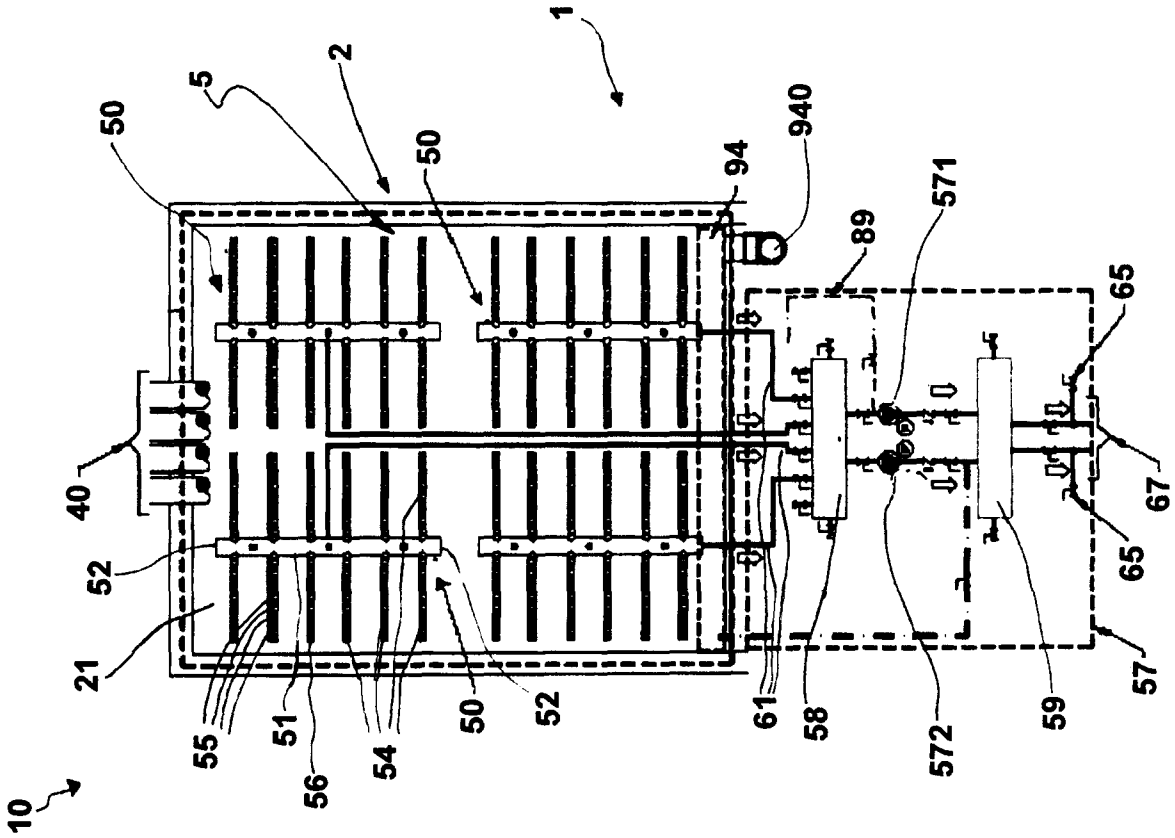
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FIG. 3

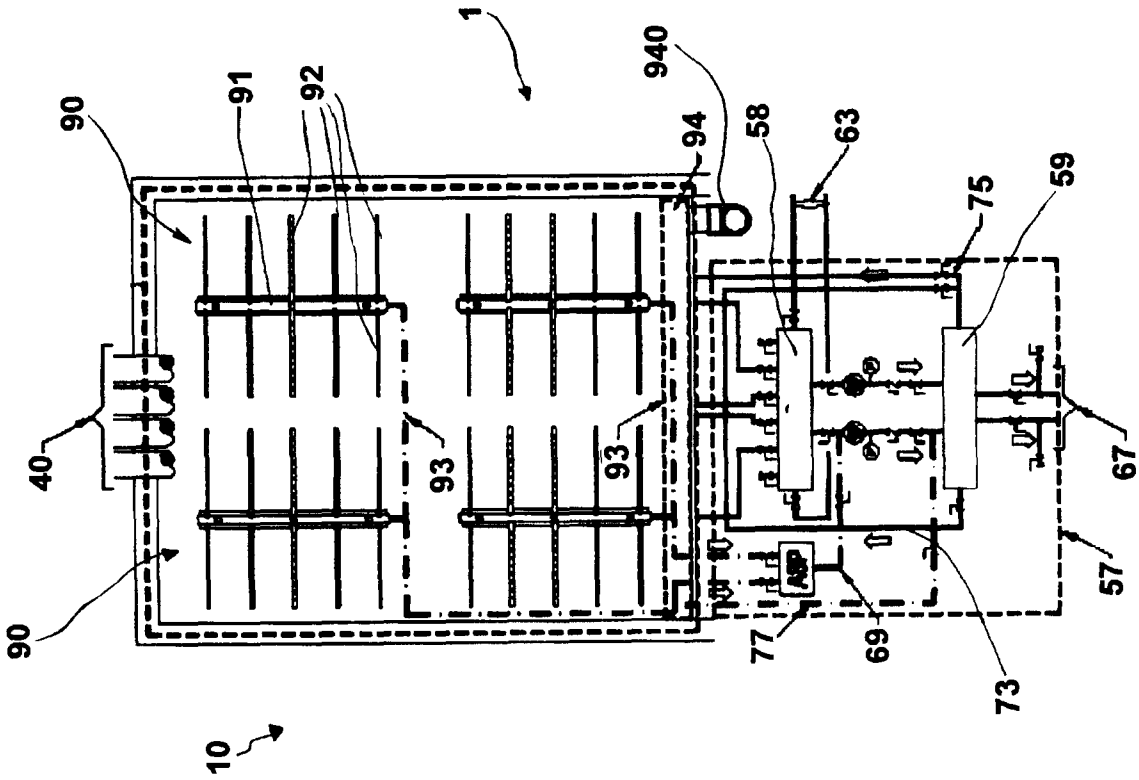
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FIG. 2

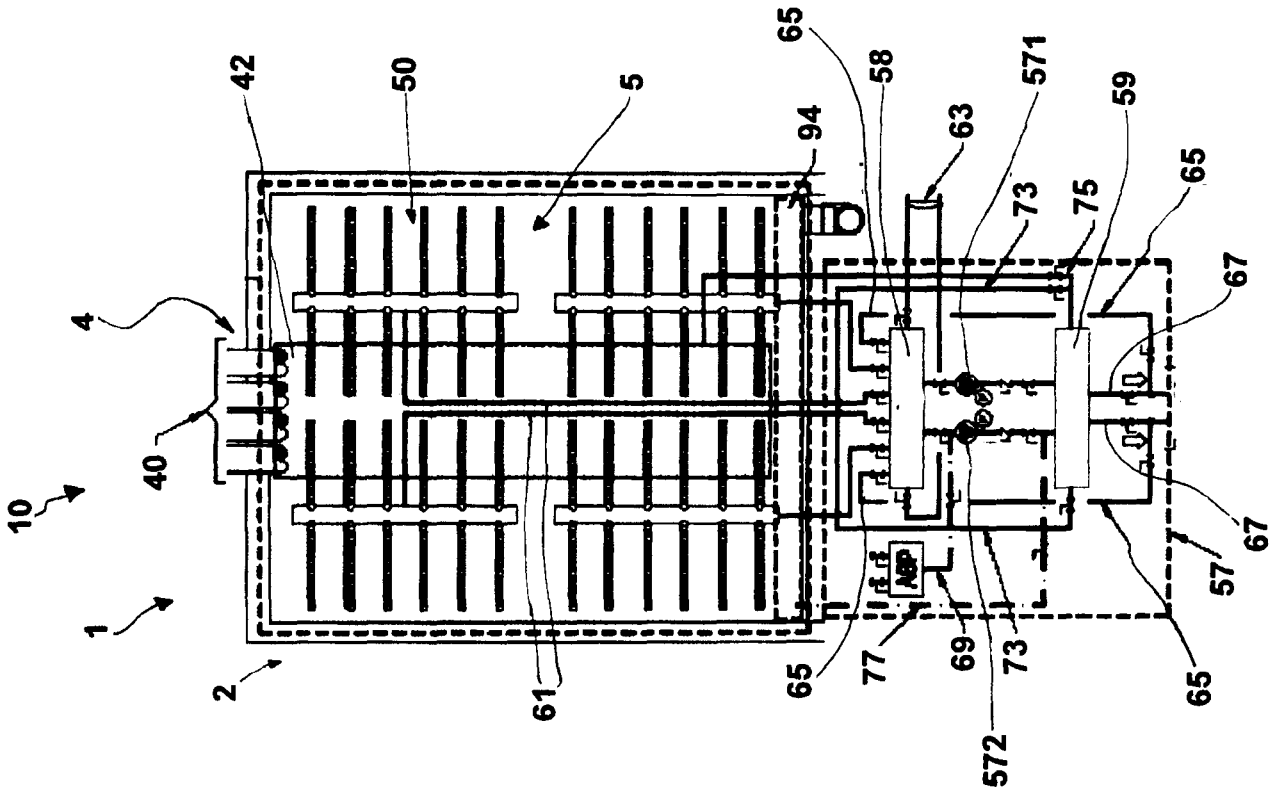
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FIG. 5

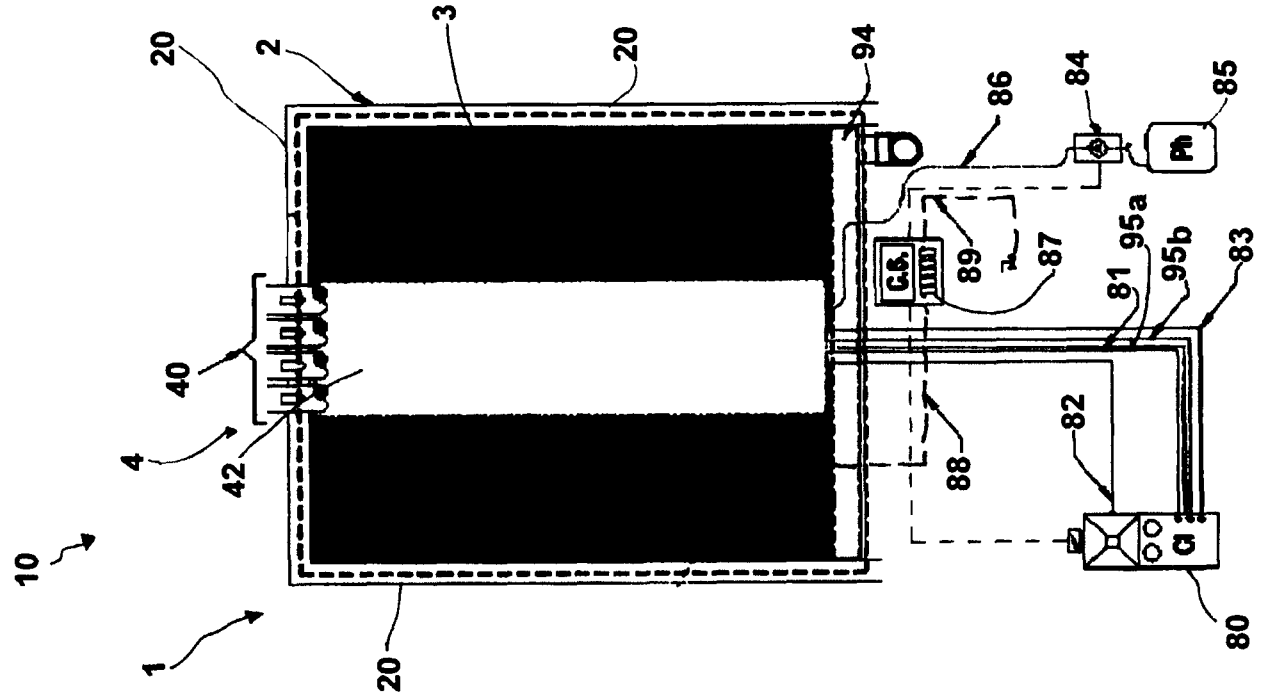
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FIG. 4

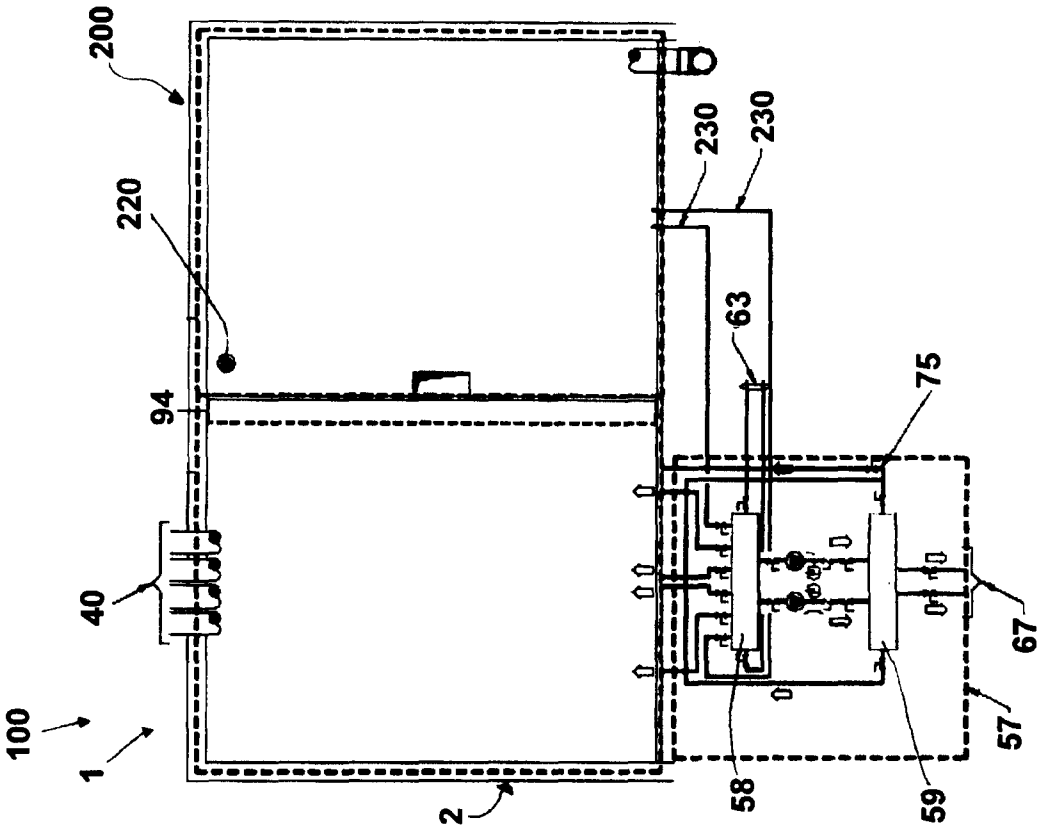
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FIG. 7

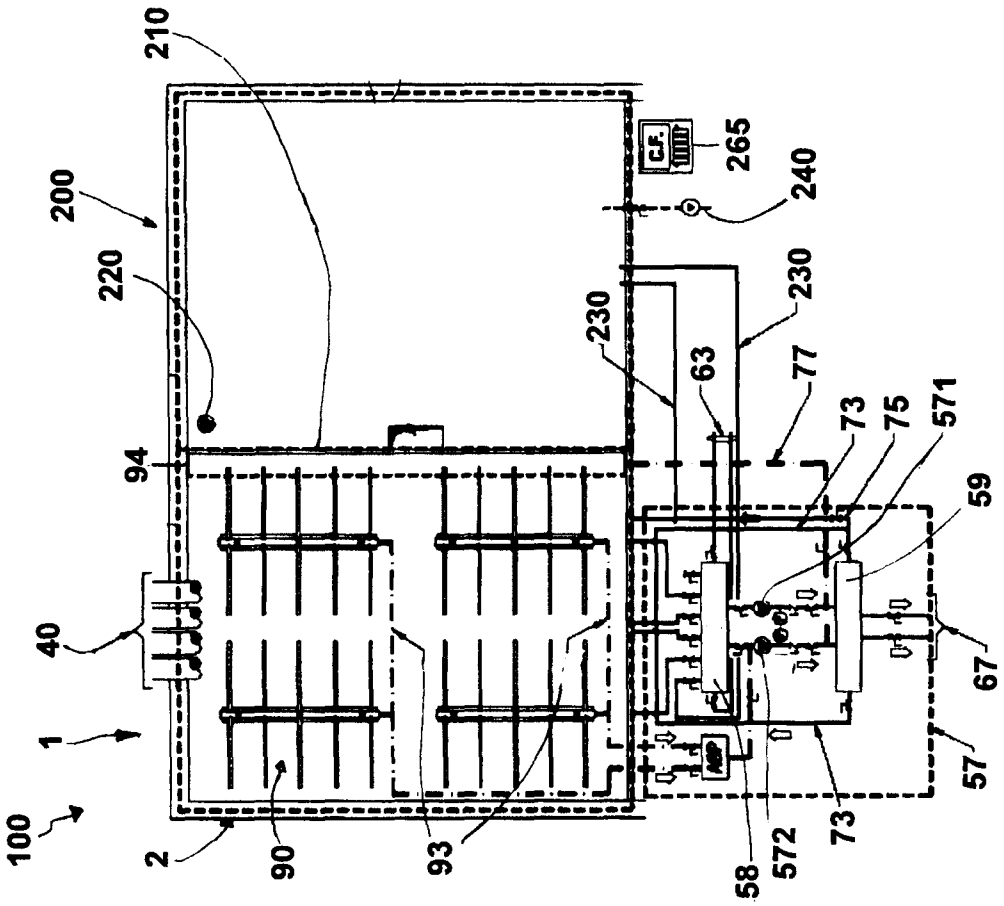
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FIG. 6

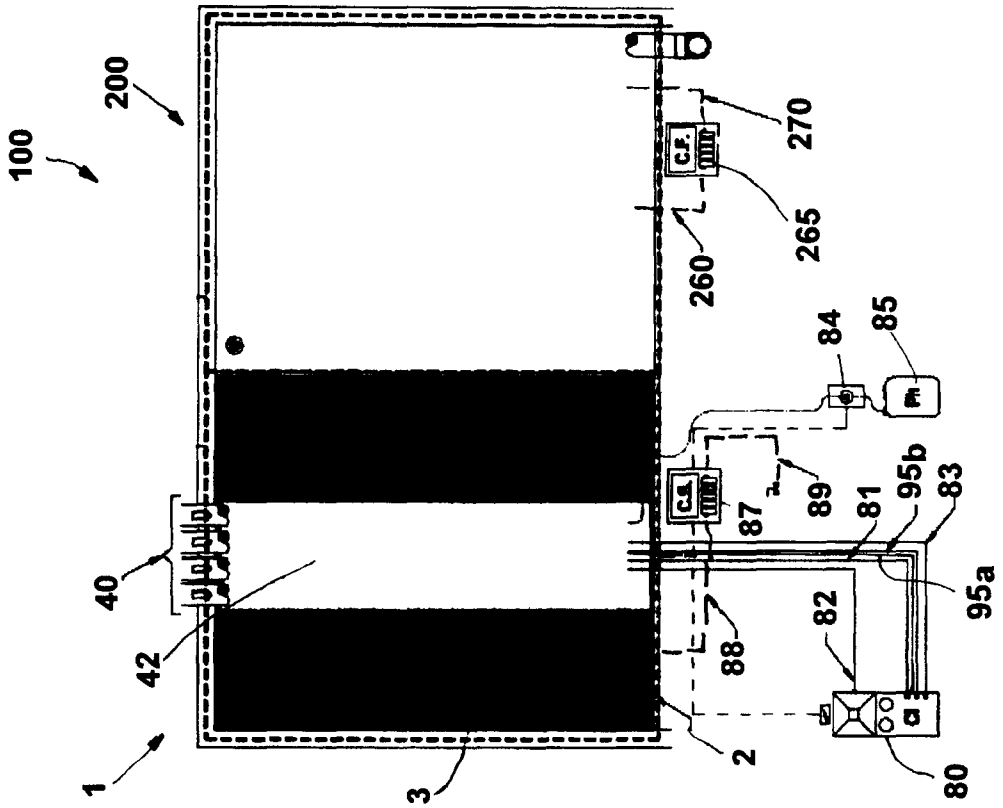
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FIG. 9

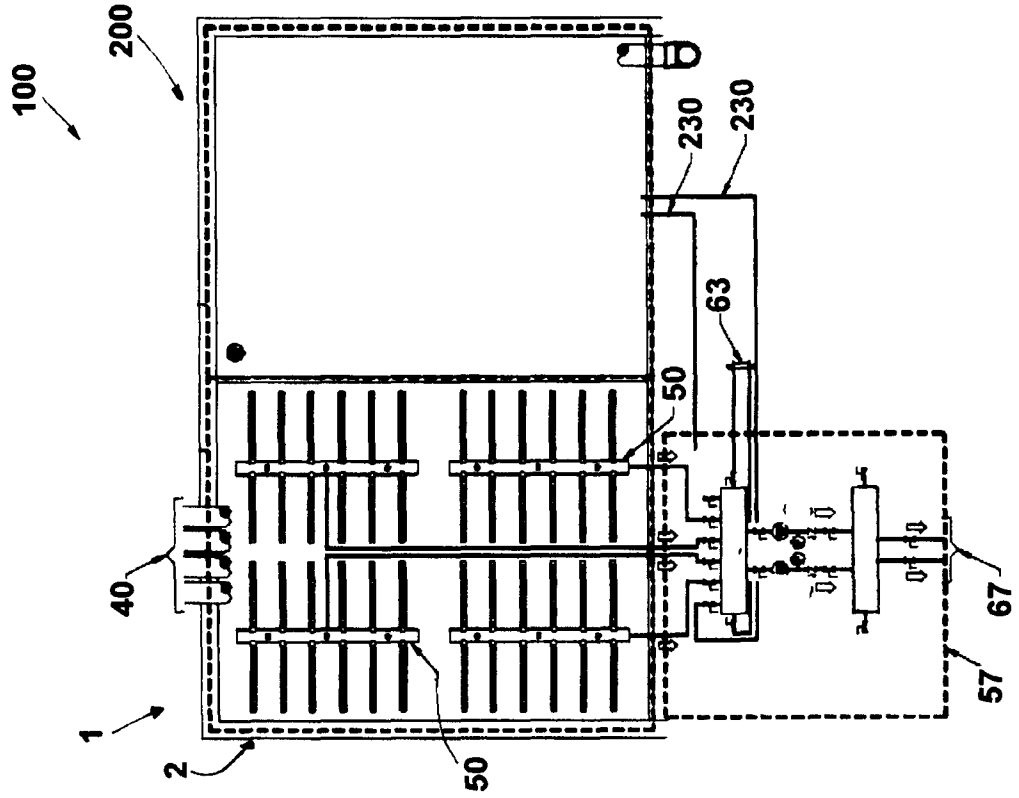
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FIG. 8

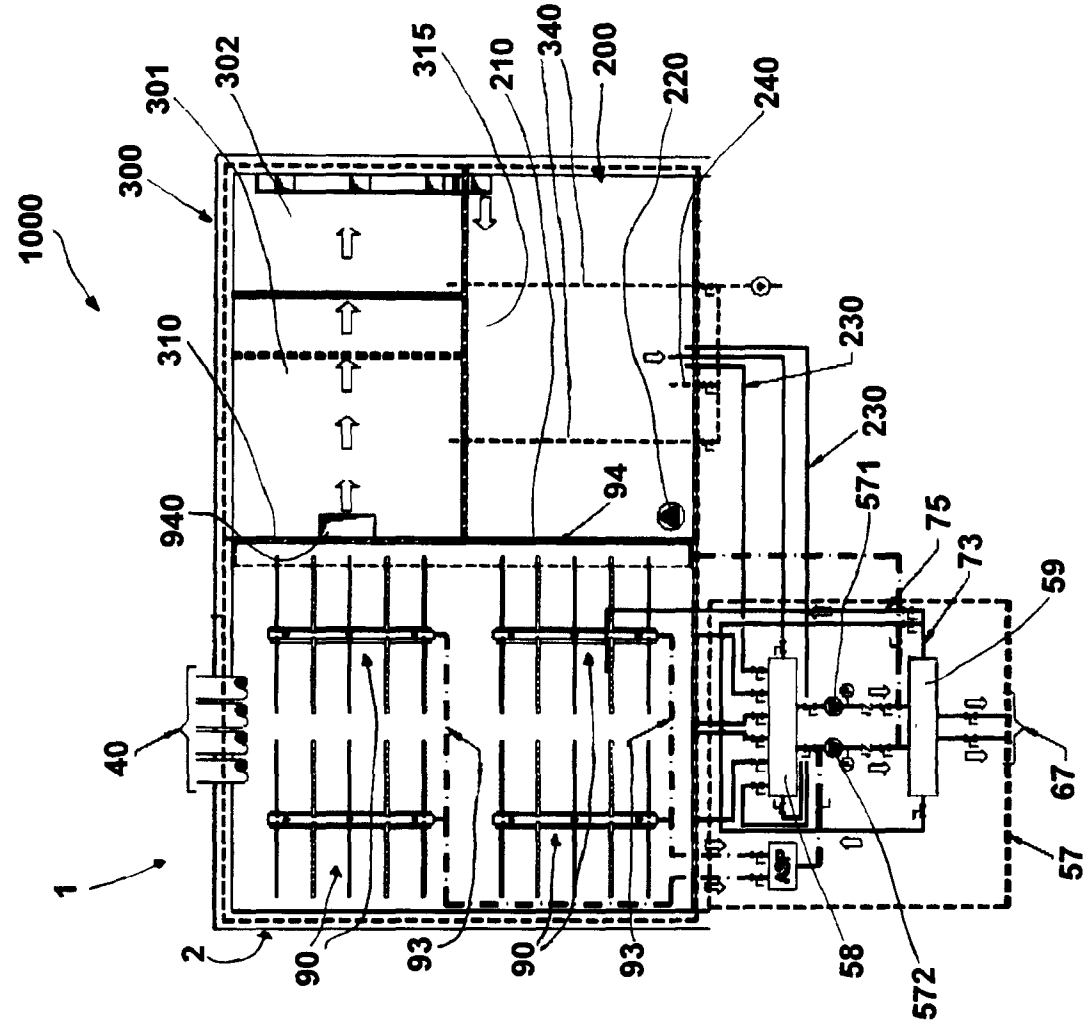
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FIG. 11

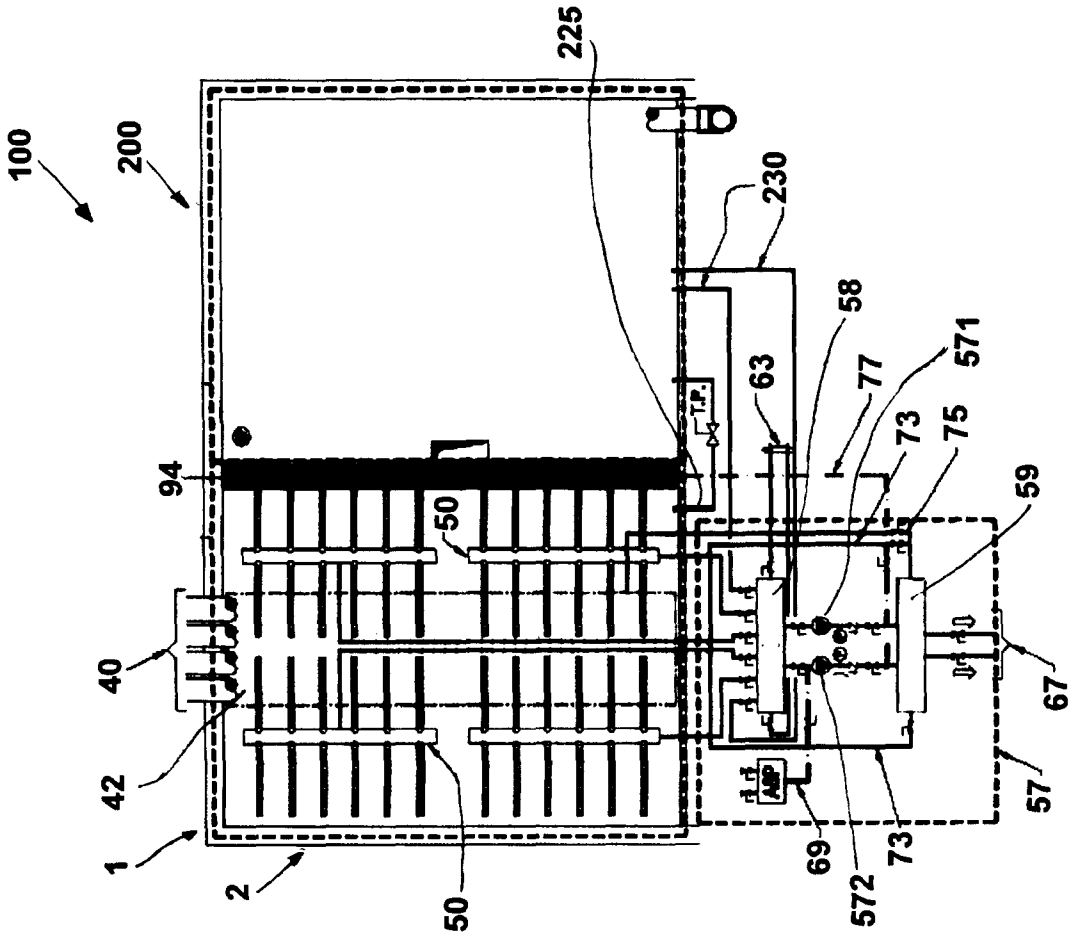
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FIG. 10

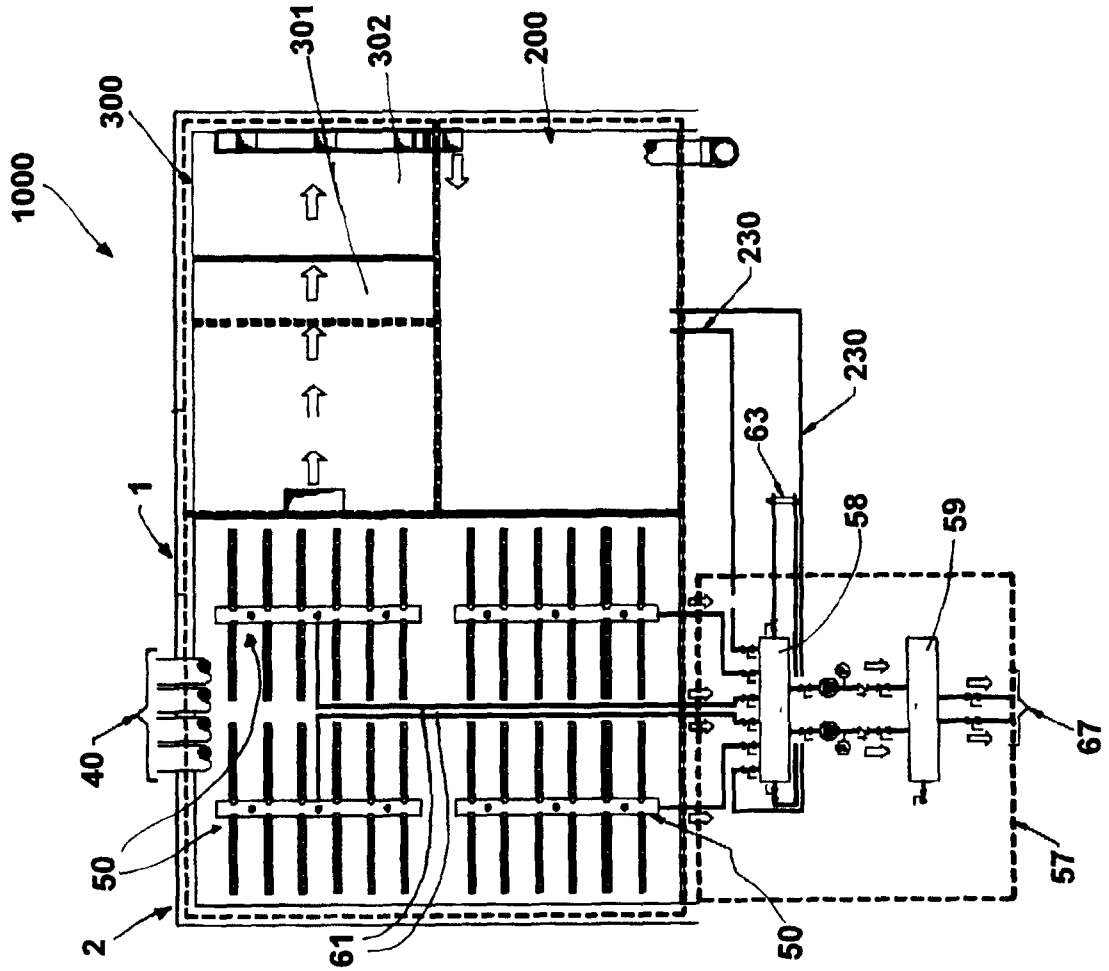
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FIG. 13

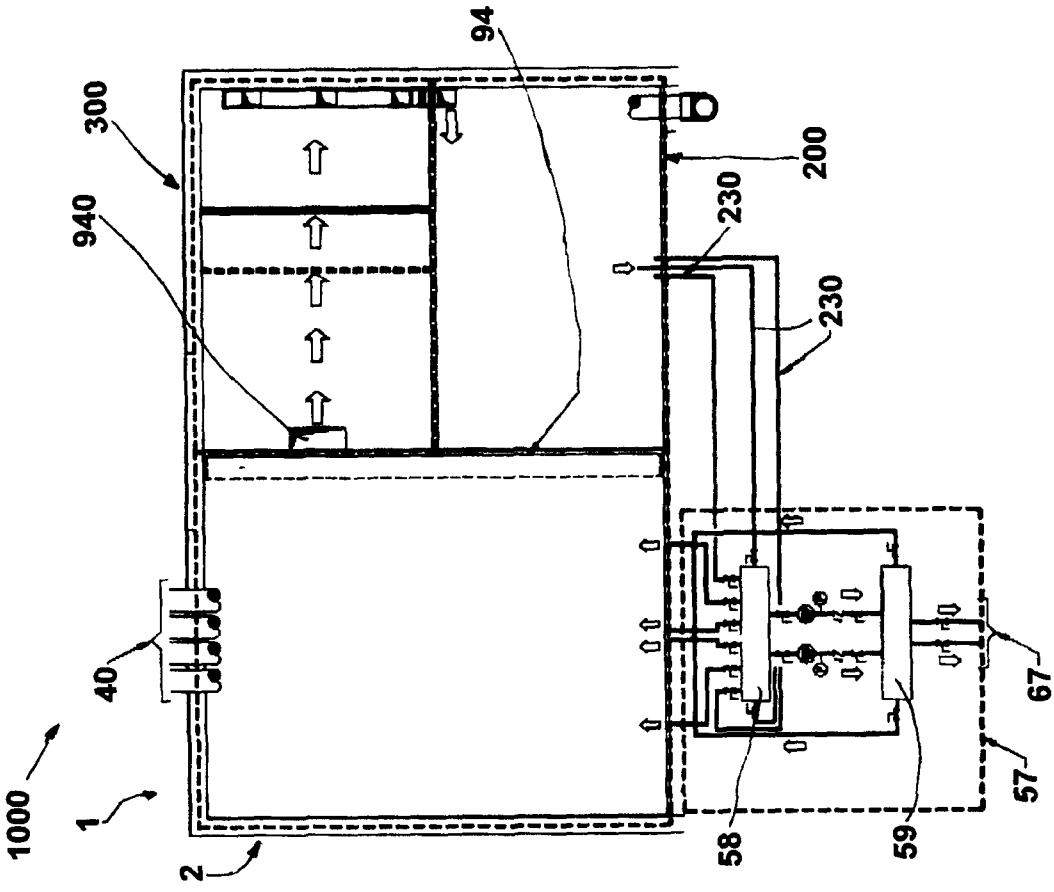
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FIG. 12

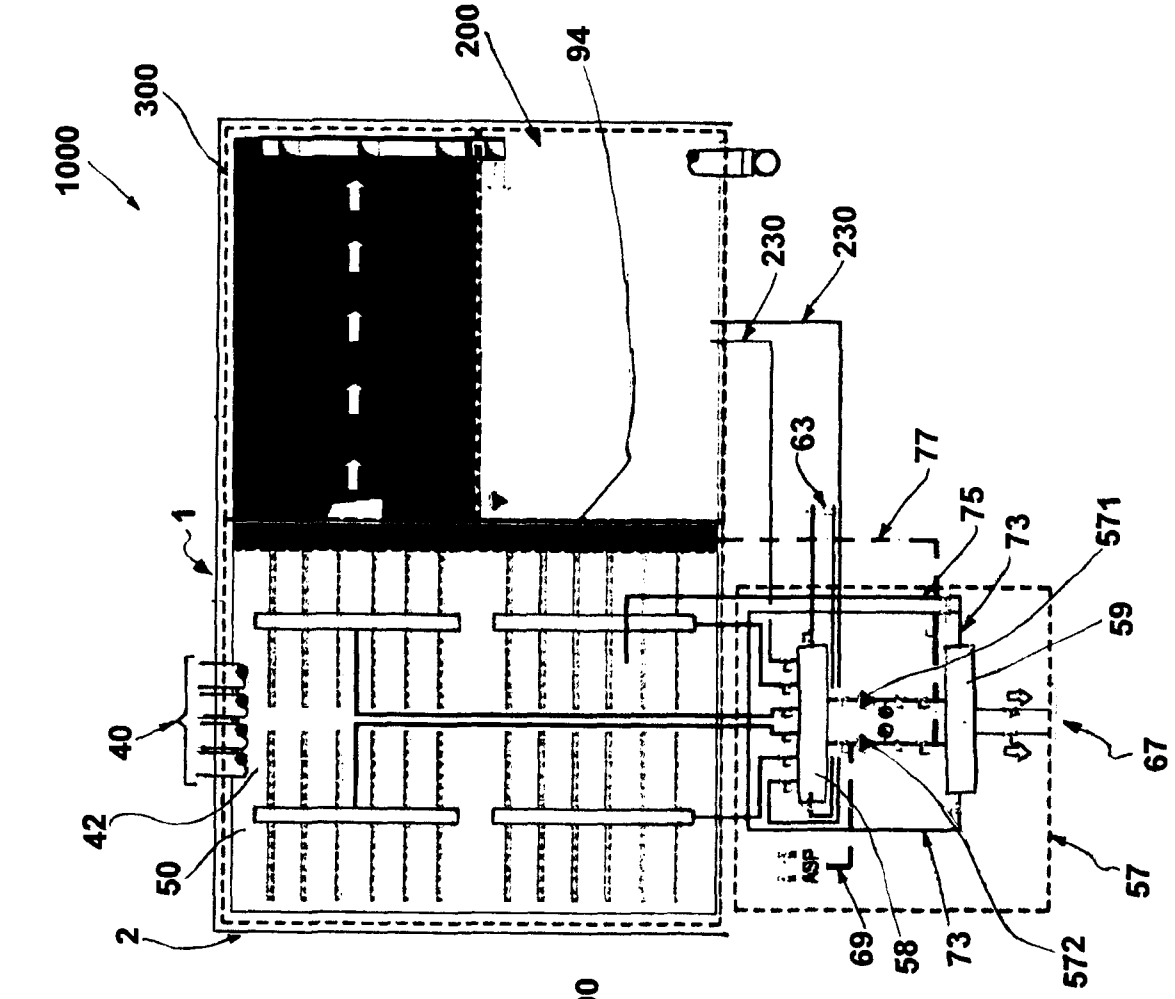
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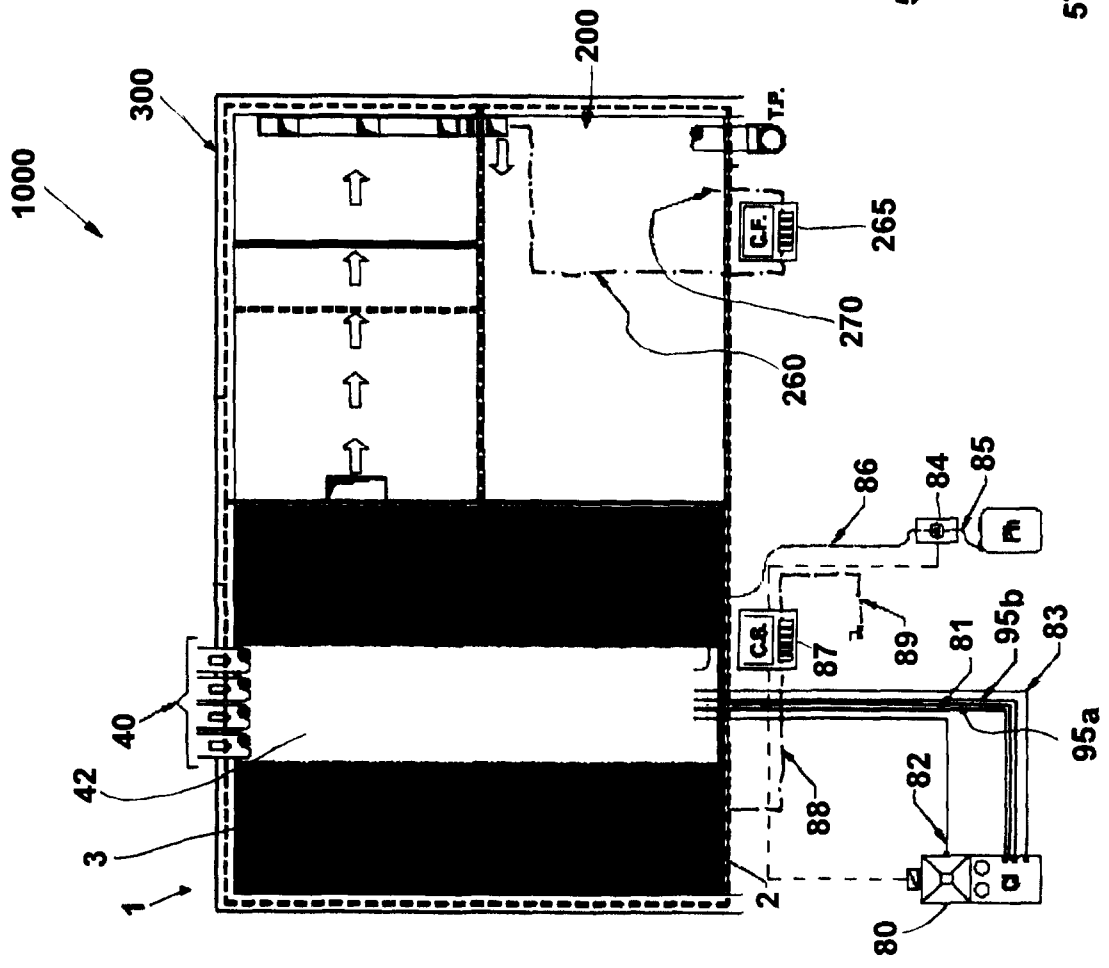
FIG. 15


1000
300
200
T.P.
C.F.
265
270
260
86
84
85
87
89
81
95b
83
95a
88
82
80
1
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3
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42

FIG. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/052586

A. CLASSIFICATION OF SUBJECT MATTER
INV. C02F1/Q0 B01D24/O0
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C02F B01D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2007/158278 Al (DESCHENES DENIS [CA]) 12 July 2007 (2007-07-12) paragraphs [0001], [0004], [0006], [0007], [0011], [0021] - [0030], [0059], [0061], [0069]; claims 1-3,5,6,7,8-12	1-15
Y	US 4 104 163 A (GRUTSCH JAMES F) 1 August 1978 (1978-08-01) column 2 , lines 4-33 column 3 , lines 1-4; 25-68	1,4, 11-15
A	JP H10 470 A (MATSUSHITA ELECTRIC IND CO LTD) 6 January 1998 (1998-01-06) the whole document	1-15

-/ - -

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 June 2015	09/07/2015

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

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/052586

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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