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(57) Abstract: This invention refers to an extremely simple and low cost method of capturing dioxins which are included in the combustion gasses deriving during the combustion of chloride organic matters included, mostly, in the urban wastes. This method is based on the property of some insoluble into the water organic substances, like the animal or vegetable fats and the products of their processing, to dissolve the dioxins and it foresees the traversing of the combustion gasses through appropriately formed apparatuses in which the organic dioxin solver has a extended enough surface exposed to the flow of combustion gasses, situated on or in the appropriate solid or liquid substratum. At the same invention are included low cost methods and devices which are ensuring the constant effectiveness of the proposed method through the decrease of the quantity of the produced soot and the in time capturing of the flying ashes before their sitting upon the surface of the organic dioxin solver turns it inactive. In preferred embodiments of this invention there is a provision for the capture of the dioxin particulates from the gases which are produced from the combustion of wastes in open or semi-open furnaces.



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## METHOD FOR CAPTURING DIOXINS FROM COMBUSTION GAS

5 This invention refers to an extremely simple and low cost method of capturing dioxins which are included in the combustion gases deriving during the combustion or pyrolysis of chloride organic matters, which matters are included in the urban wastes, the concentrated liquid wastes as well as in many other wasted objects, among which the vehicles tires. At the same invention are also included low cost methods and devices which are ensuring the constant effectiveness of the proposed method, especially in these cases where the combustion of wastes is taking place under conditions which are non-compliant to environmental legislation.

As it is known, the dioxins and especially the 2,3,7,8 TCDD are extremely toxic compounds, which, up to this moment, are not totally searched for their physical and chemical properties. However, the specific dioxin, the 2,3,7,8 TCDD, is a crystalline compound with a specific gravity which, although not specified as far as its exact value concern, is lower than the specific gravity of water.

The current invention, in its different embodiments and applications, is based on the almost zero solubility of the dioxins in the water, and, simultaneously, on their great solubility in a series of organic compounds, hereafter called as "organic dioxin solvents", most known of which is the animal fat. Similar properties are demonstrating the vegetable fats (like, for example, the vegetable oils before or and after their hydrogenation or esterification) as well as many other organic compounds either found in the nature or produced by synthesis. The organic dioxin solvent can be used either pure in kind or diluted in a suitable organic solvent, as for example, in the case where we want the dioxin solvent to dispose specific flowing properties.

In applications of the current invention where the main criterion is the low cost, the proposed – but not restrictive – choice of dioxin solvent is the one of (vegetable or animal) fat, or, in some cases, the one of the emulsion of fat which derives either through the addition of a suitable emulsifier in the mixture of water and dioxin solvent or is produced in an appropriate device of fat emulsifying, according to the methods which are provided by the technical level or derive by the technical level with an obvious manner. Hereafter, any reference to a dioxin solvent contains, additionally, the meaning of emulsion of dioxin solvent in the water and the solution of one or more dioxin solvents in another, suitable, chemical compound or combination of chemical compounds.

The spirit of the current invention is based on the passing of the combustion gases that are contaminated by dioxin particulates and aerosols in front of immovable or moving, solid or liquid surfaces coated or soaked by organic dioxin solvent. Due to its solubility in the specific substances, the dioxin is captured at the surface and, then, it is diffused in the interior of the solvent where it remains until it is finally collected and removed.

The almost zero solubility of the dioxins to the water doesn't cancel the importance of the contribution of water to some of the proposed devices. In practice, the water is capable to capture the dioxins at the surface by electrostatic forces, and to bring them forward to the surface of the organic dioxin solvent where they will be embodied or diluted. In many of the proposed applications

there is a simultaneous exploitation of the water mobility as well as of the property mentioned above, aiming to the improvement of the pursued result, always according to the spirit of the invention. It should be noted that, at this point, in any case the presence of water, in liquid or air form, is inevitable in the environment where the proposed application functions, given that this constitutes an integral product of the combustion of the usual organic compounds.

As it becomes obvious, the effectiveness of the method is based on the development of the largest possible exposed surface of solvent, in order for the surface to capture, respectively, the largest possible quantity of passing micro-crystals of dioxins. In specific applications of the current proposal, the role of water is supportive of the enlargement of the exposed surface of the organic dioxin solvent. Another element that influences the effectiveness of the method is the forming of the flow of combustion gases in a manner that the dioxin crystals are hitting against the surface of the organic dioxin solvent so that they are captured by it.

Equally important, in order to have an effective application of the proposed method, is to avoid having other kind of particles or particulates flying inside the stream of combustion gases apart from the one of the dioxins. In a contrary way, the floating particulates of ashes and carbon soot will sit upon the exposed surface of the dioxin solvent with a final result of its isolation from the flow of combustion gases and the annihilation of any further capability of the dioxins for sitting upon the solvent or, generally, having a contact with it.

Following the mentioned above, it becomes obvious that in most of the cases we need two stages of cleaning of the passing combustion gases. The first stage concerns the removal from the combustion gases of the solid compounding of floating ashes and soot while the final cleaning will occur at a second stage during which it is secured, as much as possible, the capturing of the particulates of dioxins. It is understood that the cleaning methodology of the first stage may be totally different to the cleaning methodology of the second stage.

In the proposed methods of dioxin capturing, according to the spirit of the current invention, there are also some devices whose effectiveness is based on the high purity of the passing combustion gases as far as it concerns the content of floating particulates of ashes or soot. These devices, that will be called hereafter as second stage devices, may be used, at the beginning, in usual, manufacturing applications of the technical level that concern incineration ovens and already equipped with auxiliary systems for detainment of the floating particulates from their combustion gases, which are known from the technical level. At a second and final stage, the capture of the dioxins occurs with innovative devices that are proposed by the current application.

As it will be explained later on, an element of the current invention concerns the improvement of even the first cleaning stage, proposing devices that result from the technical level but not with an obvious way. On top of that, these proposed first stage cleaning devices are used with an innovative way and in an application different to them for which, up till now, were used. The need for using these innovative proposed devices for elimination of the dioxins at a first stage concerns special cases where this is necessary because of the total absence of other, conventional devices for first stage cleaning. But even in the case where there is a first stage device, the present invention proposes methods of more effective usage of this device from what is proposed by the technical level.

In practice, there are many applications where the conventional devices for first stage cleaning of the particulates of ashes and soot and dioxin are totally absent, while it hasn't been proposed, up till now, a method for substituting them. This, for example, occurs as a rule in cases where the combustion or (partially) the pyrolysis of the organic matters takes place in open furnaces, even if the furnaces of this type are not compliant with environmental legislation. Examples of this type of furnaces are the non-certified areas of wastes dumping of some municipalities or communities and the furnaces of burning used car tires through which some farmers are pursuing the anti-frost protection of the cultivations. In both those cases the great problem of the public health which results is the freeing of dioxin in the atmosphere and their entrance in the organisms either directly or indirectly through the food chain.

In such cases and given that the proposed method for dioxin capturing, at a second stage, is based on the naked exposed surface of the means of dioxin capturing, the direct application of the previewed method becomes unsuccessful since the surface adulteration of the active area of the solvent is very fast. According to the above mentioned this is due to the absence of the necessary "preliminary" devices of the technical level that are detaining the floating particulates of ashes and soot before they meet the dioxin solvent area. Consequently, there is a need for finding a way or ways for protecting the dioxin solvent surface through preventive methods of extinction of the floating ashes and soot. However, it is of great importance also the fact that, even if such type of first stage cleaning devices are invented their cost should be analogous to the already low cost of the proposed device of final capturing of dioxin at a second stage. In this case, the proposed methods of avoiding the production of soot and floating ash are integral part of the proposed devices of dioxin capturing, especially as far as open combustion furnaces it concerns. In these same methods it is included the property of accidental splitting of a part of the produced dioxins, a little after the moment of their generation, because of their heating at temperature higher than 750-800° C. This is achieved because of the high temperature of the random combustion of some of the ingredients of the combustion gases of which the content is also random. One of these ingredients is the hydrogen which results from the partial oxidation of the particulates of carbon in the presence of oxygen and water steam, as it will be explained below.

At this point one should note that, besides the fact that in the developed countries police measures are taken for the combustion of chloride organic compounds in open furnaces, however there is still the need of developing devices for capturing the dioxins that are produced from such furnaces. The reason resides on the fact that these practices of surface charring of wastes are used in many third world countries from which the developed countries are importing food. This food, in many cases, is contaminated with dioxins which it has been absorbed either through the land surface or through the watering of the cultivations.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 represents, indicatively, the layout of devices, provided by the technical level, for the cleaning of the combustion gases which are being produced inside an oven or closed furnace. In the figures 7-11 are shown, indicatively, various alternative preferred embodiments, according to the spirit of the present application, for devices and apparatuses destined for the environment protection from combustion gases which are produced by open or semi-open combustion furnaces.

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In these cases, the purification of the emissions is done at a first and a second stage while, in some cases, there is another, preliminary stage, before these other two stages.

The innovative cleaning devices of "second stage" where the final capturing of the dioxins is taking place, are presented in the figures 2-6 and concern closed furnaces as well as open or semi-open furnaces. It is obvious that the innovative devices of the figures 7-11 are based on the innovative devices shown in figures 2-6 and their operation principle.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In figure 1 is shown, indicatively, one known from the technical level device of closed incineration oven, of partial combustion or pyrolysis of organic mass. This device, in most of cases, is equipped by a unit for the initial detainment of floating ash or/and soot, according to what is foreseen by the technical level. In this case the oven (1) has an entry of air provision (2) while its outlet (3) ends to a combustion gases cleaning unit (4). The combustion gases cleaning unit (4) has as a main purpose the capturing of the floating particulates and can operate with any method foreseen by the technical level, such as filters, cyclone, water showering etc. According to the further foreseen utilization of the combustion gases (in combination with the type of the initial organic substance from which these gases are coming from) it is possible to be connected either in series with the particulates cleaning unit (4) or to be included in it some additional combustion gases cleaning units (4A) through which one may achieve the removal of the sulphur and the acid gases and volatile compounds. These additional cleaning devices are operating according to what is foreseen by the technical level without disposing any special equipment for the capturing of the produced dioxins.

One part of the produced dioxins during the combustion of organic mass remains in the interior of the oven, mixed with the deposited ash in the area of the furnace or the walls, one part is stick in the interior of the exhaust hood (3) and one part is detained on the walls and, through molecular electrostatic forces, at the aqueous concentrates of the additional cleaning units (4A) where it remains undiluted. One part, finally, detained together with the ash and the soot in the particulates cleaning unit (4) and the remaining escapes to the atmosphere, if it hasn't been foreseen a way for its detainment in the interior of the exhaust smoke stack or in the pipes channeling the combustion gases for further processing. Consequently, the dioxins cleaning unit, based on its type, and according to what will be following mentioned, can be installed at a different, per case, point of the route of the combustion gases, before or after the already existing cleaning units (4, 4A) or between them, based on choice criteria that derive from the type of the combustion gases cleaning units as well as from the type of the dioxin cleaning unit type itself.

A first, simplified embodiment of the current invention is the one of figure 2a. A fibrous or foliated or granule or sponge filter (5), permeable by the combustion gases, interferes in the tail chimney duct of the combustion gases (3A) in such a place where the floating particulates of ash and soot are already detained from the respective device (4, 4A). The material of the filter is soaked with dioxin solvent and because of the form of the material it presents a very large exposed surface compared to its overall volume and weight.

In cases where a long term use for the specific filter is needed without an intermediate replacement of it, it is foreseen for devices of constant renew of the dioxin solvent on its exposed surface (figure 2b). The first of them is based on a constant flow of fluid organic dioxin solvent through the dioxin solvent feeding pipe (6) and a second constant dumping on the filter (5) of a fog of cold or hot dioxin solvent through the dioxin solvent injector (7). In an appropriate point of the combustion gases duct there might be a collection pot (8) of the solvent which flows from the filter (5). In figure 2c the filter (5) has a spiral shape, which fact increases its effectiveness, in comparison to the volume that possesses, providing a longer route for the combustion gases with smaller interfered resistance to their flow, due to the filter presence.

In one more complex but more effective, in its operation, device (figure 3a) the combustion gases are passing through a cyclone (9) in the interior of which resides the filter (5) as indicatively is shown in figure 3b. The filter (5) has a ring form and is located in the internal periphery of the cyclone (9) in the interior of which the combustion gases are following a cyclic route either through a physical circulation or due to forced flow, with the help of injected steam or mechanically turned fins. The capturing of the dioxins is accomplished either with the centrifugal collision with the surface of the filter, as in figure 3b or with the centrifugal passing of the combustion gases through the filter, as in figure 3c.

In figure 3b are shown, indicatively, two proposed alternative ways of constant renewal of the dioxin solvent which damps the filter, according to what has been referred. The first way foresees the feeding of dioxin solvent to the filter either through a fluid dioxin solvent feed pipe (6) or via the injection of the solvent by a dioxin solvent injector (7).

In figure 3d is shown a similar form of the proposed method of figures 3a, 3b, 3c with the difference that, in the current case, the combustion gases follow a complex route, axial and tangent simultaneously, passing through the holes of successive disc-shaped (in this figure) filters (5A, 5B) of which, every other two neighboring filters, have different speed of rotation. The difference of rotation speed may be due to the fact that others are immovable and others are moving or by that, each pair of them is moving to different directions. The dioxin solvent which covers the rotating filters either remains stable on the discs until the cleaning of the specific filter or can be constantly renewed. This, indicatively, can be accomplished through one dioxin solvent injector (7) or through a dioxin solvent feed pipe (6) which operation is based on a mechanical or electrical pump or simply on gravity. If, for example, the device shown in figure 3d is turned by 90° it results with an obvious way (figure 3e) to a device of horizontal flow of the combustion gases in which the rotating filter is passing, gradually, through a bath of dioxin solvent which is concentrated in a dioxin solvent pan (10) which is shaped due to the form of the apparatus, at its lower part. Every point of the filter that is re-baptized, periodically, in this bath, is dumping solvent in it which has already captured dioxins and replaces it with fresh solvent. It is obviously derived that this device can be supplemented by an additional system of contact renewal of the solvent, through a pump or other appropriate system. Profoundly, this device will perform more efficiently if the single filter of fig. 3a is replaced by a number of successive filters which are not shown for simplicity reasons. In this certain figure, as an example, the filter has a screen shape without this shape being restrictive.

It is obvious that the discoid form of the filters 3a and 3b is not obligatory for the operation of the invention. The successive filters may have any other suitable form, as for example, co-axial

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cylinders or cones through which the combustion gases are passing depositing the dioxins by which are contaminated.

A rather practical approach is the usage, as flexible bedding for the deposit of dioxin solvent, of long bands from metal or even organic substance such as gauzes. With this way one may give any complex shape of dioxin filter without any deviation from the spirit of the current invention. In figure 3f we have the indicative example of a "gauze" formed strip (69) which unfolds from the drum 69B and it folds to the drum 69A and, during this route, passes through a bath of dioxin solvent residing in the appropriate pan (10). In figure 3g is shown, indicatively, the capability of improvement of the effectiveness provided by the long flexible materials. In such case, a gauze (69) from organic or non-organic material, driven from multiple, successive drums (69A), can provide a very long exposed surface to the organic dioxin solvent with which is soaked.

In figure 4a is shown a more complex form which follows the basic principle of the invention concerning the maximization of the exposed surface of the organic dioxin solvent to the flow of combustion gases. Here, the organic dioxin solvent is situated into a pan of organic dioxin solvent (10) and is kept at a temperature much higher than the one of water boiling. One water feeding pipe (11A) channels controlled quantities of water to the surface of the solvent which, in its way – and because of its temperature – forces the water to be vaporized, creating a fog (12) in the interior of the specific dioxin capturing chamber (100) of the combustion gases duct. This fog consists of micro-beads of water each one of which, due to the developed electrostatic forces, is covered by a membrane of organic dioxin solvent. With this way, one may achieve the maximization of the exposed surface of dioxin solvent, compared to its weight.

In figures 4b and 4c the capturing of dioxin is achieved through the water showering or the injection of fluid dioxin solvent or emulsion of dioxin solvent in the interior of the flowstream of the passing combustion gases in the dioxin capturing chamber (100). The combustion gases in the current case are moving, indicatively, at a vertical direction without excluding any other direction or motion of their movement. In figure 4b, as it is shown indicatively, the dioxin solvent is injected by a dioxin solvent injector (7) and moves, due to gravity, at the opposite of the flow of combustion gases, while in figure 4c an injector of dioxin solvent (7) injects the solvent at an opposite direction compare to the one caused by gravity and to the same direction with the one of the combustion gases.

In both cases shown in figures 4b and 4c, the dioxin solvent or the emulsion of the dioxin solvent, after its passing through the flow of combustion gases and the capturing of the floating dioxins, is collected into the collection pot (8) for further processing after one or more passages through the combustion gases flow.

In figures 5a and 5b are shown various improved devices of operation coherent to respective devices already presented in figures 4a, 4b and 4c.

In figure 5a is shown an improved embodiment of the one shown in figure 4a. The combustion gases, through the combustion gases tail duct (3A) are transferred to a specially formed dioxin capturing chamber (100) the bottom of which is shaped so that to constitute an organic dioxin solvent collection pot (10). The solvent is kept at a suitably high temperature and its surface is

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receiving controlled quantities of water, through the water feeding pipe (11A), for the creation of a "greasy" or "oily" fog (12) according to what have been already mentioned. After the capturing of the dioxins, the beads of fog are being adhered on the internal walls of the dioxin capturing chamber (100) from where they are collected for further processing or reuse, in a collection pot (8) which is fed by the peripheral channel 8A.

In figure 5b the fog of water-solvent meets a heated filter (14) or a screen of which the temperature is kept comparatively higher than the one of water vaporization, but lower than the respective of the organic solvent. The result is to escape water in the form of gas and that the organic solvent is sat upon the filter cumulatively from where gradually it flows through the peripheral channel (8A) to a collection pot (8).

In figures 6a, 6b, 6c and 6d are shown similar embodiments of the application of the proposed method in combination with a known method from the technical level through which is achieved a detainment of the floating particulates with the method of channeling the combustion gases through a tank of water ("bubbling tank") or through successive such tanks.

In figure 6a the combustion gases are being transferred inside a tank (15) in which the organic dioxin solvent is in emulsion form (16). The combustion gases are brought forward into the emulsion, under pressure, through a dipped duct (17) of which the exit is situated in a depth at a distance from the emulsion surface. Following, the combustion gases are elevated to the surface, in the form of bubbles, pushed by the lifting power of buoyancy. During this elevation, each bubble of combustion gases is dumping, on the surface of the surrounding liquid, a part or whole of the floating particulates which contains. In this case it is advisable to put a bubble screen (18) or multiple bubble screens through which the passing bubbles of combustion gases are acquired a significantly smaller diameter. With this way, the exposed surface of combustion gases to the emulsion is respectively increased, increasing also its effectiveness as far as dioxin capturing it concerns. Additionally, there may be an appropriate mechanical mixer (109) with the help of which is increased the contact of the tank liquid mass and the combustion gases, with a consequence the more effective capturing of solid particulates of soot, ash and dioxin from the tank liquid. In this case, the solid particulates, depending on their specific gravity, tend either to fall at the bottom of the tank or to elevate at the emulsion surface. On the contrary, the dioxin crystals remain diluted in the emulsion from where they can be removed (embedded in the fat which is being used or, generally, in an organic dioxin solvent with similar properties) through any kind of processing from the ones that the technical level foresees such as the centrifugation.

In figure 9b an organic dioxin solvent (animal fat, for example) being in a solid state and in the shape of particles (19), floats on the surface of the tank in the interior of which there is either water or emulsion of water and solvent. In case where the content of the tank is only water, it is most possible to shape, on the water surface, a membrane (20) of greasy dioxin solvent through which are passing the bubbles of combustion gases, rendering to it the included dioxin. Following to that, exiting the water surface, the bubbles are hitting on the floating solid particles of the solvent (19) leaving on their surface the remaining contained dioxins. In a feasible application of this method, the stirring of the solid solvent particulates (19) has as a result their repetitive contact with the surface membrane and the transfer to the membrane of all the dioxin which is entrapped upon their

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surface. In another feasible embodiment, the floating particles are made from a insoluble to water material and their texture is such that allows them to float on the water surface. Their exterior surface is covered by a greasy dioxin solvent, upon which are entrapped the included in the combustion gases dioxins until they come, due to the constant stirring, in contact with the liquid membrane of dioxin solvent (20) on which they are going to let the dioxin crystals that they have temporarily captured.

In practice, the best results are achieved with an in series combination of two or more of the capturing dioxin devices that have already been presented. As an example, in figure 6c is shown, connected in series, two particulate capturing units, in the form of airtight tanks, from which, indicatively, the first tank (15A) includes water and captures the particulates of soot and ash, while the second tank (15B) where the dioxin crystals are captured, contains water and organic dioxin solvent. The organic dioxin solvent may be in a floating solid particulates form (19), in a floating insoluble liquid form, in emulsion form or in a combination of at least two of the already mentioned forms.

In figure 6d is shown a variation of the device already proposed, in another form in figure 6c. In an appropriate height of the dipped duct (17) of the combustion gases, is placed a water pipe (11) which showers water into the flow of the combustion gases, washing away the particulates of ash, soot and (partially) dioxin towards the walls from where they are collected to an appropriate collection pot (8). Next, the combustion gases are passing from the interior of the tank (15) in which there is organic dioxin solvent that can be in a floating form of solid particulates, in a floating insoluble liquid form, in emulsion form or in a combination of at least two of the mentioned forms.

In case that the furnace is not situated into a closed chamber but, on the contrary, it is open, the operation of the dioxin capturing device requires the usage of a device for protecting the dioxin solvent surface from the sitting of ash and soot. The capturing of such flying particulates is possible to be achieved by screens of which the surface is submitted to constant washing with water while the decrease of the produced soot particulates may be performed in-situ, with the addition of water steam and the bringing forward of air stream in this area of the furnace. With this way, the minute diameter carbon particulates are being combusted or gasified at a great percentage.

An example of the application of the proposed method of dioxin capturing from the combustion gases derived from an open furnace, is shown in figure 7. The waste (21), old tires for example, are placed on a metallic or ceramic furnace (22) which is closed from all its sides except from the top side, while a so-called cover-screen (23) which is a thick metallic screen of large dimensions, resistant to the chemical corrosion and of cone or dome shape, is placed on the furnace (22). (In the figure, for simplicity reasons, the cover-screen is shown less thick as it is in reality). The water injectors (11) are injecting continuously, with fine droplets, the whole surface of the cover-screen (23), with the help of a pump (200). Profoundly, it is feasible -although costly- to inject, through the injectors 11, an emulsified dioxin solvent in the place of pure water.

If the water quantity falling on the cover-screen (23) is sufficient, the soot particulates will be temporarily adhere on the cover-screen (23) until they are burned by the flame (25) of the furnace (22) and gasified, partially, to carbon oxides and hydrogen, in the presence of oxygen and water

steam.. The remaining part of the ash and soot particulates is washed away by the water that runs the surface of the cover-screen (23) and ends up to the peripheral water collector (26). The dioxin which is included in this water can be captured from an organic dioxin solvent using one of the methods already described.

5 The combustion gases that are passing through the cover-screen (23) and which, due to their temperature, are moving on an upward route, still include significant amounts of floating dioxins. For their final capturing, it may be used one of the already presented devices, which will be considered suitable for the specific case, or a combination of respective, successive devices. In  
10 figure 7, for example, there is, at a start, a filter (5) consisting of a screen or a series of screens, coated with organic dioxin solvent. On the surface of this screen are being entrapped, apart from the floating dioxin crystals, all the particulates of ash and soot that escaped from the first cleaning, at their passing from the water-injected cover-screen (23). Following that, there is a second stage of dioxin capturing. In the specific case, for example, there is a collector (27) of which the terminal  
15 opening exit (28) has a device consisting of one series of screens divided, preferably, to rotating screens (5A) among still screens (5B), a configuration which is similar to this that have already been presented in figure 3d, without this choice to become restrictive, since, in this specific case, it is possible to use any other suitable device from the ones that are already presented or the ones that result with an obvious manner from the ones presented, in combination with the current  
20 technical level. In the specific, however, device of figure 7, the constant regeneration of the capturing capability of the rotating screens surface is ensured by the bringing-forward of dioxin solvent, through the dioxin solvent feeding pipe (6), in a place near the center of the rotating screens. The solvent, then, is submitted to centrifugation covering the whole surface of the rotating screens until it escapes from their edges, ending to peripheral collection channels (not shown) from  
25 where it is channeled, by the gravity, to the ring-shaped collection pot (8).

In figures 8-11 are shown two proposed alternative forms of a device, according to the spirit of the present invention, through which is achieved the combustion, in an open furnace, of old tires and waste with minimized emissions of dioxins in the atmosphere. The minimization of the emitted  
30 dioxins is accomplished by successive stages of which the first stage achieves the local increase of temperature in the interior of the furnace, in order to achieve the splitting part of the already created dioxins, at a temperature higher than 800° C. The operation principal of this stage provides a supplemental benefit which is the concentration of the flow of combustion gases to a specific, desirable direction in order to avoid their spread outside the combustion gases duct where they are  
35 further processed. The next stage foresees the capturing of the floating particulates of soot and ash, in which is included a large amount of dioxins, by water injection to the flow of the combustion gases. At the last stage, before their escape to the atmosphere, the combustion gases are passing through a final device of capturing the remaining in them dioxin. This is achieved through their surface contact with the organic dioxin solvent, according to what has already been described.

40 In figures 8a and 8b, is shown a model of the first of the two proposed forms of the same device, according to the spirit of the present application. As we can see, this device disposes, tentatively and for the sake of this example, the extra capability of moving, according to the point of the current furnace, because of the wheels it is equipped with. Above the point of the waste (21)  
45 combustion, a combustion gas collector (27) is installed through which the upward moving

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combustion gases are driven to the mixer (32). The mixer is a gas duct the one end of which, or entrance (32A), is open to the atmosphere while the other end, or exit (32B), ends up to another gas exit duct (39), in the interior of which the final processing of the combustion gases for the dioxin capturing occurs. A characteristic of the mixer (32) is the communication slots (32C), a series of holes or fissures which exist alongside, in its part that penetrates the combustion gases collector (27) and at a height that is lower than the maximum flame height (25) of the combustion gases. With this way, the combusted gases are entering, through the communication slots (32C) into the interior of the mixer (32) and through it they are channeled to the gases exit duct (39) and from there to the atmosphere.

The operation principle of the device of figure 8a is based on, initially, the fact that in the interior of the mixer (32) there is a provision for conditions of lower pressure, compared to the pressure that prevails inside the flame (25) of the furnace ( $P_{25} > P_{32}$ ). The result of that difference is the suction of the flow, to the interior of the mixer, of the whole combustion gases quantity, making impossible their leakage from the side of the collector (27).

With this way it is minimized the possibility of a non-wanted result which is of having these combustion gases escaped in the atmosphere without having them appropriately processed, prior to getting into the atmosphere. For that, it is suggested to place (around the furnace or between the below area of the collector and the ground) some protective panels (are not shown) so that the furnace will remain intact from the wind that may blow.

The creation of significant difference in pressure between the furnace and the mixer is achieved through a rushed flow in the interior of the mixer of a fast moving fluid which can be combustion gases, water steam or a mixture of both. In the example of the figure 8a the method of steam is used which is as following:

In the entrance (32A) of the mixer (32), a steam injector (35) is located, oriented to a direction toward the interior of the mixer. The water for the steam is coming from a water tank which, due to gravity (or a pump, not shown in the figure), is channeled to a heat exchanger, situated preferably in the interior of the furnace where it is vaporized. The water pump may be operating either by an electric motor or by a small sized auxiliary internal combustion engine or finally through the usage of the produced steam from a special device (steam engine or steam turbine) of transforming part of the steam pressure to mechanical work.

The steam jet that escapes, at a high speed, from the steam injector (35) causes to its surrounding region a low pressure condition, according to the Bernoulli law. The result is to enter in the entrance (32A), apart from the steam, a significant amount of air, preferably heavily heated by a special heat exchanger which is not shown in the figure. Due to the turbulent flow which occurs at the initial length of the mixer, between the entrance (32A) and the communication slots (32C), the air is mixed with the steam before the steam-air mixture meets the combustion gases which have entered the mixer. The choice of an appropriate shape of communication slots (32C) of the mixer will have as a result the Venturi phenomenon in the interior of this perforated part of the mixer, resulting to the continuous absorption of the combustion gases and in such an extend so as to have a visible flame even after their entrance in the interior of the mixer. The bringing forward of

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the steam and warm air mixture to the combustion gases which are moving in the interior of the mixer will have as a result the combustion of the soot of the combustion gases and also the continuation of its combustion in a significant part of the interior of the mixer. The final result would be the transformation of large part of the combustion gases soot to carbon oxides and hydrogen, with the simultaneous decrease of the particulates amount in the combustion gases. But, it is very likely to have, also, the molecule breakage of part of the dragged along dioxins, due to the increased local temperature that will occur during the combustion of the hydrogen produced in the interior of the mixer – in case, of course, that the then current condition will favor its starting. And here the preliminary stage of combustion gases processing for the specific application is finalized.

At its other edge, the exit (32B), the mixer (32) ends up to the interior of the gas exit duct (39) where occurs, initially, the next stage of combustion gases processing. Here, the flying particulates (as well as part of the dioxins) are detained from the injected drops that are coming from one or more water injectors (11) or steam injectors. After the entrapment of the particulates, the droplets adhere to the internal walls of the gas duct or on the collective screens (37) and, finally, end up to the water collection tanks (26) from where they will be removed, in liquid state, through the exit pipe (41) in order to be rejected after the appropriate process. At one embodiment, this water, that includes particulates, may be re-channeled to the mixer (32) after its vaporization, through the steam injector (35). At another embodiment, it may be channeled directly to the mixer (32), in a liquid or steam form, or at a third embodiment, it can be brought forward to the center of the furnace (25). At this point, the second stage of combustion gases process is concluded.

The final stage of processing inside the proposed device of figures 8a and 8b, foresees the capturing, within the special unit (38), of all the dioxins are still flying in the combustion gases after the conclusion of the second stage. Being a fact that the combustion gases are now free from ash and soot particulates, the capturing of the dioxins may be achieved with any suitable -according to the spirit of the current application- method that has already been described (for example, a filter with exposed surface covered by dioxin solvent, rotating screens, cyclone of forced flow with peripheral filter etc).

The exit of the combustion gases to the atmosphere occurs through the mouth (39A) of the combustion gas exit duct. At this point, it is suggested to include a ventilator that will assist in keeping a sufficiently low pressure in the interior of the mixer (32), which fact will allow the improvement of the operation of the system.

In figure 8b is shown the connection of the device of figure 8a with one internal combustion engine (43), in order for this engine to be fed (either as a sole or as a supplementary fuel) by the gas products of the incomplete combustion (in the presence of steam) that are created in the interior of the mixer (32). In this case the pressure drop that occurs in the intake system of the engine or at the entrance of a turbo super charger (if it exists), creates the necessary pressure difference, compared to the furnace, for the proper functioning of the mixer (32) minimizing the necessity of having the ventilator of figure 8a. In such an application, it is suggested that there is a chemical cleaning unit (44), based on the current technical level, in the interior of which will occur the de-sulphuration of the combustion gases and the capturing of their acid ingredients. This unit will intervene between the exit mouth (39A) and the engine (43).

From the previously mentioned it is obvious that, under the circumstances, it is feasible to bring forward again a part of the combustion gases of the engine (43) to the entrance of the mixer (32) or to the area of the furnace as it is shown through the dotted lines of figure 8b which represent the respective re-circulating ducts (300) of combustion gases. By this way, the combustion gases of the engine (enriched, preferably by extra steam deriving, for example, from the vaporization of injected water in the interior of the re-circulating duct (300) or in any other suitable place of the engine combustion gases route) may be used further for empowering the flow of incoming air to the interior of the mixer (32) or/and empowering the flow in the combustion area, with or without their enrichment by extra air.

As it is understood, the described in figures 8a and 8b total method of combustion gas preparation and final dioxin capturing doesn't concern only the cases where there is an open furnace. The same method may be used and in the case of a special form of closed furnace, in the interior of which organic substances are combusted and which substances, under normal conditions, produce large amounts of soot as for example the used car tires or the plastic objects. A necessary term for the proper operation of this furnace is to keep the pressure of the mixer interior at a lower level than the one of the pressure of the furnace in order to ensure, with this way, the access of the combustion gases of the furnace to the interior of the mixer.

In case that the combustion temperature of the materials in the furnace is low, without enough height of flame (in case where, for example, the combusted materials have high humidity) or/and with small concentration of soot in the combustion gases, it is possible the empowerment of the mixer operation with a burner which will function supplementary to the mentioned before steam injector (35) or and, under certain circumstances, to replace it totally. In figure 9a is shown, indicatively, the most common form of such a burner, consisting of one centrifugal air compressor (80) combined with one or more fuel injectors (81). This fuel, usually, is a fluid hydrocarbon and, preferably, a "medium to heavy" distillate of the crude oil refining process.

In figure 9b is shown a proposed application where the fuel is coal (82) or another flammable solid material, residing on a bed (83), moving or immovable, situated in the interior of the mixer (32). In this case, the air compressor (80) provides a strong stream of air to the interior of the mixer (32) forcing the combustion gases of the external furnace (25) to penetrate, through the communication slots (32C) to the interior of mixer and to get in contact with the glowing carbon resulting to their decomposition. Depending on the magnitude of temperature that occurs, any time, in the interior of the mixer, there is, also, the decomposition of a small or large percentage of the already produced dioxins.

In figure 10a is shown the device of figure 8a, which is, in the specific case, situated, air-tightly, above a furnace pot (45) which is closed to all sides except the one above, with the exception of some side openings (46) through which the flame (25) of the furnace is fed with air.

In figures 10b and 10c is shown a developed embodiment of the devices that have been described in figures 8a and 9a. A fire-proof "tent" (47) covers an extended area of a burning place of waste deposit, in order to be sucked, by the low pressure inside the mixer (32), the combustion gases of the whole area so that they get processed according to the method already described. This tent is

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strained by belts (47A) or strings of which their ends are anchored to selected fastening points (47B). For the most effective operation of this specific device, in case that the furnace is open as the one of figure 8a, it is suggested to concentrate the flame right below the collector (27) through a local accumulation of flammable materials. On the contrary, a closed furnace device doesn't have this special need, as the one shown in figure 10a. It requires however, foreseeing for the constant access of air to the side openings (46) of the furnace pot (45).

In figure 11 is shown an improved embodiment of the device already described and that has been shown in figure 8a. In the specific case, the entrance of necessary air for the combustion of waste (21) is achieved by the side openings (46) while, in another embodiment, the transfer of air may occur through a forced circulation, if there is the appropriate infrastructure. At least one steam injector (35) is situated in the furnace in such a position that is surrounded by the flame (25). In appropriate position, in the interior of the area where the flame is shaped, there is at least one or local air ducts (46B) through which it is ensured the restriction of the soot production, in the interior of the flame, due to incomplete combustion. It is obvious that the combination of steam injectors (35) and local air ducts (46) increases the possibility of temporary creation of hydrogen and, consequently, the splitting of some of the dioxins at a first stage, simulating, by this way, the operation of the combination of "combustion gas collector – mixer" that has already been described and shown in figures 8,9 and 10.

In a more remote point of the flow of the combustion gases, these gases are submitted to a washing procedure through a water-spring that is created by one or more water injectors (11) of which their range is restricted by the water-collective screens (37). This spring washes away ash, soot and, at a second stage, dioxin and it flows through the walls to the peripheral basin (48) from where the water either is being removed or is being redirected to the steam injectors (35) after it passes from a heat exchanger (34). At the end of this route the combustion gases are passing through a final unit (38) of dioxin capturing, the way of operation of which is chosen among them that have already been described in figures 2-6 or is being derived, with an obvious way, from them. The possible presence of a ventilator (40), through which the suction of the combustion gases will increase, constitutes an improvement element of the efficiency of the proposed device.

From all that have been referred up till now, the conclusion is that there are unlimited ways, devices and combinations of them which result, by obvious way, in order to take advantage of the basic operation principle of the proposed, innovative method for capturing the dioxins as well as for the preparation of combustion gases so that this dioxin capturing can remain efficient throughout extended operational periods of the indicatively proposed, up till now, appliances and devices.

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# CLAIMS

- 5 1. Method of capturing the dioxins produced during the combustion of organic matter in a closed or open furnace during which the combustion gases are forwarded to a partially or totally enclosed place wherein they are coming in contact with a solid or liquid organic solvent in which solvent the dioxin particles are being dissolved and this organic dioxin solvent is in the form of solid  
10 particulates or granulated parts or liquid drops or it resides on or in an appropriate solid or liquid substratum  
**and is characterized in that**  
the organic dioxin solvent possesses an extended, exposed contact surface to the flow of the combustion gases  
**and in that**  
15 the flow of combustion gases is in such manner that the included in the gases molecules of dioxin and the molecules of the organic dioxin solvent are being enforced to get in contact, resulting in that the molecules of dioxin are being captured by the molecules of the dioxin solvent and, at the end, the dioxin particles are being dissolved into the mass of the organic dioxin solvent .
- 20 2. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1, where the combustion gases are being enforced to pass through a permeable solid filter (5) comprising of fibers, small ribbons, granules or communicating spaces of a porous or sponge mass in such manner as to expose an extended contact surface to the flow of the combustion gases  
25 **and is characterized in that**  
the organic dioxin solvent is a coating on the surfaces of this aforementioned permeable solid filter (5)  
**and in that**  
during the trespassing of the combustion gases through the filter and during the contact of the  
30 gases with the material of the filter, the molecules of dioxin are being deposited on the surfaces of the filter and are being dissolved in the organic dioxin solvent by which these surfaces are coated.
3. Method of capturing the dioxins produced during the combustion of organic matter, according to claims 1 and 2,  
35 **characterized in that**  
the solid material on which the organic dioxin solvent resides, is situated on the periphery of a cyclone (9) in which the gases follow a cyclic route  
**and in that**  
the particulates of dioxin, following a centrifugal movement, are getting in contact with the surface  
40 of the organic dioxin solvent.
4. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,  
**characterized in that**  
45 the organic dioxin solvent is a coating on the surfaces of one or more successive permeable

screens (5A, 5B) which screens are moving with different speeds among them  
**and in that**

during the passing of the gases through these screens, the particulates of dioxin are getting in contact with the surfaces of the screens and are dissolved in the organic dioxin solvent by which these screens are coated.

5. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

the organic dioxin solvent is moving in the interior of the flow of the combustion gases in the shape of a jet of drops which jet is being discharged by a dioxin solvent injector (7).

6 Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

the dioxin particulates are transferred to the dioxin solvent after their attachment, via electrostatic forces, on the surfaces of the droplets of a water-droplets stream which stream is being discharged inside the flow of gases from at least one steam or liquid water injector (11).

7. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

the organic dioxin solvent is moving in the interior of the flow of the gases attached to the small droplets of fog (12) that results from the contact of water with the organic dioxin solvent which solvent has a temperature higher than the boiling temperature of the water.

8. Method of capturing the dioxins produced during the combustion of organic matter, according to claims 1 and 5,

**characterized in that**

the organic dioxin solvent is injected in the interior of the flow of gases, in the form of a water emulsion.

9. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

the organic dioxin solvent is situated, in liquid form, in a tank (15)

**and in that**

the combustion gases are imported inside the tank in an area which is lower than the surface of the solvent and in such a manner that the combustion gases are traversing, in a bubbling form, a route inside the mass of the liquid dioxin solvent before they exit from it through its surface.

10. Method of capturing the dioxins produced during the combustion of organic matter, according to claims 1 and 9,

**characterized in that**

the organic dioxin solvent, inside the tank (15), resides in an emulsion form.

11. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

the organic dioxin solvent which is lighter than the water and is not water-dissolvable, resides in a liquid form, into a water containing tank (15), wherein it is forming a separating surface with the water

**and in that**

the combustion gases are forwarded into the tank in an area which is lower than the separating surface of the two liquids in a manner that the combustion gases are traversing, in a bubble form, a route in the water mass before they enter in the liquid dioxin solvent mass, and, after that, to exit through its surface.

12. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

the organic dioxin solvent resides in a form of solid particles (19) floating at the surface of the liquid content of a tank (15)

**and in that**

the combustion gases are imported into the tank in an area which is lower than the liquid surface in a way that the combustion gases are traversing, in a bubble form, a route into the liquid mass before they exit through its surface, passing around the floating solid particles of dioxin solvent.

13. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1, where the combustion gases prior their contact with the organic dioxin solvent are partially or totally free of particles of soot and ash, and these particles of soot and ash are captured by an intermediate cleansing jet which is a jet of water or water-solvable fluid or emulsion or steam and the said cleansing jet is showered or injected into the flow of the combustion gases

**and is characterized in that**

the intermediate cleansing jet meets the flow of the combustion gases in a place which resides between the furnace and the contact point of the combustion gases with the organic dioxin solvent

**and in that**

the intermediate cleansing jet sweeps away a part of the dioxin particulates, capturing them by electrostatic forces.

14. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1, where the combustion gases which are contacting the organic dioxin solvent at a certain distance from the furnace, are partially or totally free of soot and ash particles and these particles are captured by an intermediate cleansing medium which medium consists of water or steam or water-solvable fluid or emulsion

**and is characterized in that**

the intermediate cleansing medium saturates, through a series of injectors (11), the surface of at least one cover-screen (23) which cover-screen is a permeable screen of sufficient dimensions and from a corrosion resistant material and which cover-screen and preferably a set of successive cover-screens, interferes in the flow of combustion gases and is situated in an area which is located between the furnace and the point where the combustion gases are getting into their final contact with the organic dioxin solvent

**and in that**

the intermediate cleansing medium sweeps away a part of the dioxin particulates, capturing them through electrostatic forces.

15. Method of capturing the dioxins produced during the combustion of organic matter, according to claims 13 and 14,

**characterized in that**

the water wherein the particles of combustion gases were captured, is being re-forwarded to the furnace and it is steamed.

16. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

the combustion gases which are contacting the organic dioxin solvent are free, in most of its part, of particles of carbon soot through the gasification of the soot in the furnace where the soot is being mixed with steam and atmospheric air

**and in that**

the combustion gases which are contacting the organic dioxin solvent are partially free from dioxin molecules which molecules are thermochemically decomposed during the combustion of hydrogen inside the flame of the furnace, which hydrogen is being momentarily produced during the gasification of the carbon soot, in the presence of a mixture of steam and atmospheric air, in the interior of the furnace flame.

17. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1, where the combustion gases which are contacting the organic dioxin solvent are being produced from the combustion of wastes (21) in a partially open furnace and in such a way as to be avoided any leakage of unprocessed combustion gases to the atmosphere and, additionally, in such a way so, prior the contact of the combustion gases with the dioxin solvent, their content in soot and organic vapors and particulates is being reduced so the quick contamination of the dioxin solvent is being avoided

**and is characterized in that**

the combustion of wastes is taking place below a combustion gas collector (25) which collector is formed in a way so that the gases from the combustion of the wastes is channeled to its interior and this combustion gases collector is traversed by a mixer (32) which mixer is a duct of which duct the two ends are situated outside the combustion gas collector and of these ends, the first is the entrance (32A) and the second is the exit (32B) and the combustion gas collector is communicating with the interior of the mixer through appropriate openings on the surface of the mixer which openings are being called communication slots (32G) which communication slots reside on the mixer in a manner so that the combustion gases, which are deriving from the collector, are entering inside the interior of the mixer,

**in that**

inside the interior of the mixer, a part of the combustion gases and particulates is reacting, chemically, with the enforced flow of a mixture of atmospheric air and water steam which mixture traverses the mixer in a direction from the entrance (32A) to the exit (32B)

**and in that**

through the oxidation which occurs inside the mixer, it is being performed an initial decrease of the carbon soot particles and volatile products of the combustion of the wastes and the result is a

partial elimination of the particulates and combustible vapors which are being contained inside the flow of the combustion gases.

18. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 17,

**characterized in that**

the vigorous flow of air and water vapors in the interior of the mixer (32), having a direction from the entrance (32A) to the exit (32B), is creating a pressure difference between the interior of the mixer (32) and the area of the flame (25) of the combustion,

**in that**

the pressure inside the mixer is lower than the pressure which exists in the area inside the gases collector (27) and, especially, the area surrounding the mixer

**and in that**

this aforementioned pressure difference is promoting a suction of the combustion gases which are being contained, temporally, inside the combustion gases collector (27) and the result is that the combustion gases are being enforced to move from inside the gases collector to the interior of the mixer (32), passing through the communication slots (32G).

19. Method of capturing the dioxins produced during the combustion of organic matter, according to claims 17 and 18,

**characterized in that**

an extended part of the waste combustion area, around the combustion gases collector (27), is covered by a fireproof tent (47) in a manner that the combustion gases which are deriving from the combustions occurred under this tent, are channeled to the interior of the combustion gases collector (27) and through said collector they are being forwarded to the inside of the mixer (32) which traverses the collector.

20. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

at least one ingredient of the organic dioxin solvent, is of a vegetable oil origin, means that it is a vegetable oil or a vegetable fat or a processed product of them, deriving, preferably, from their hydrogenation or esterification or saponification.

21. Method of capturing the dioxins produced during the combustion of organic matter, according to claim 1,

**characterized in that**

at least one ingredient of the organic dioxin solvent is of an animal fat origin, means that it is animal fat or grease or a processed product of them.

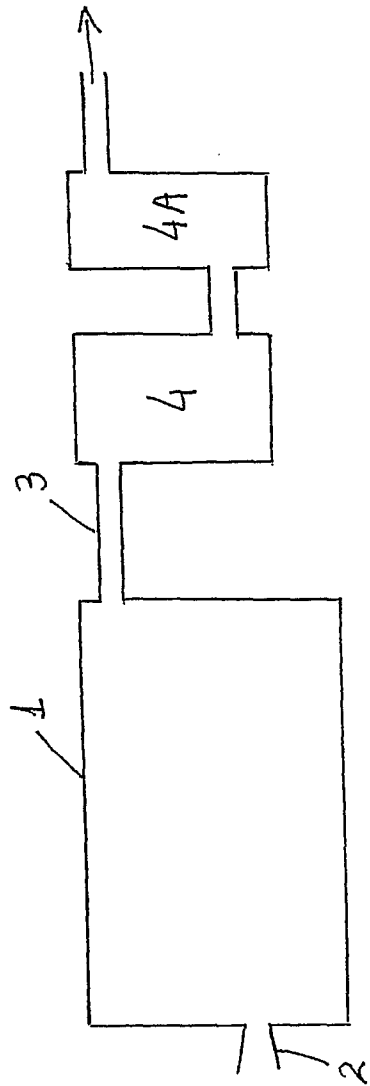


Figure 1

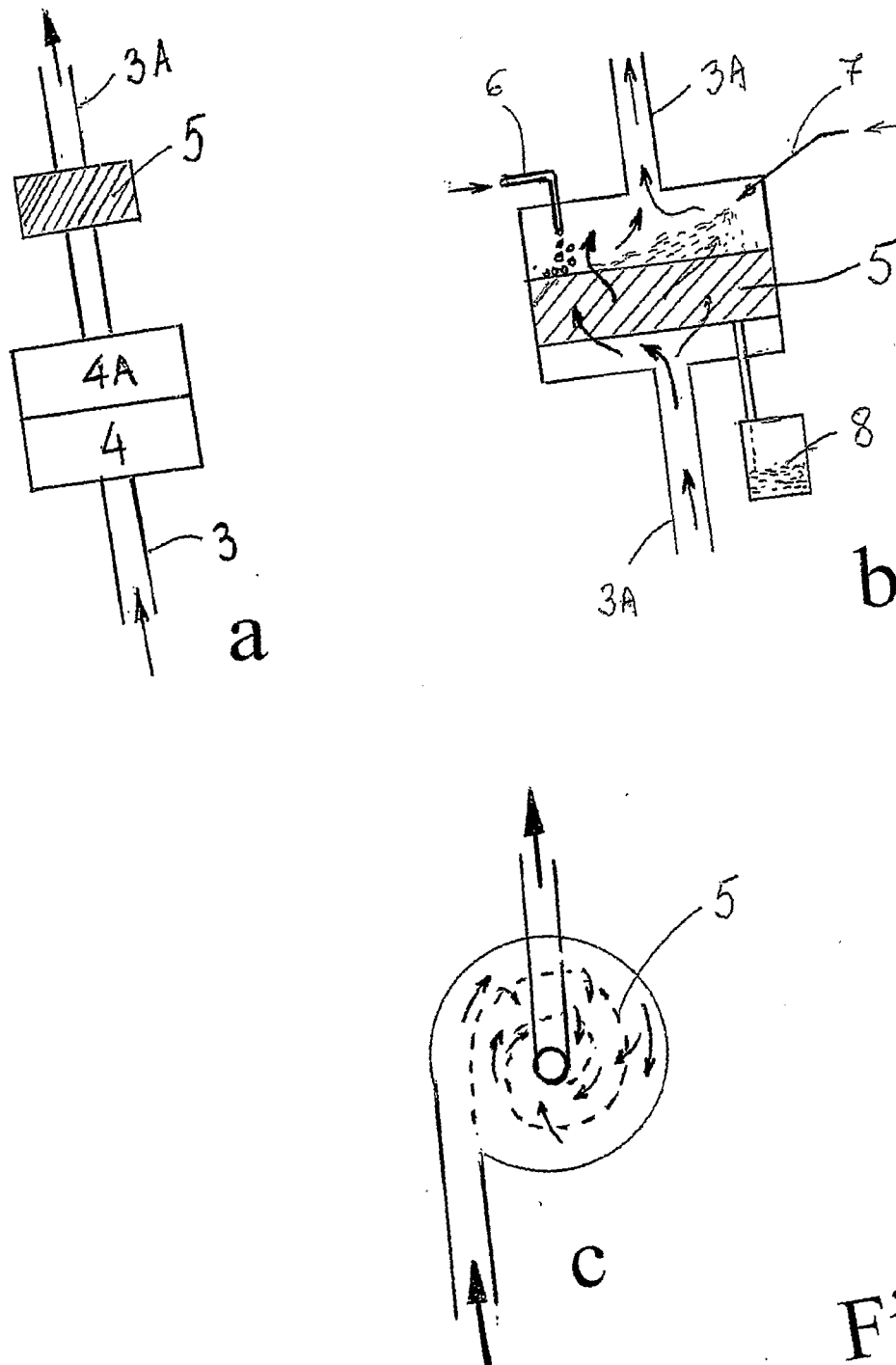


Figure 2

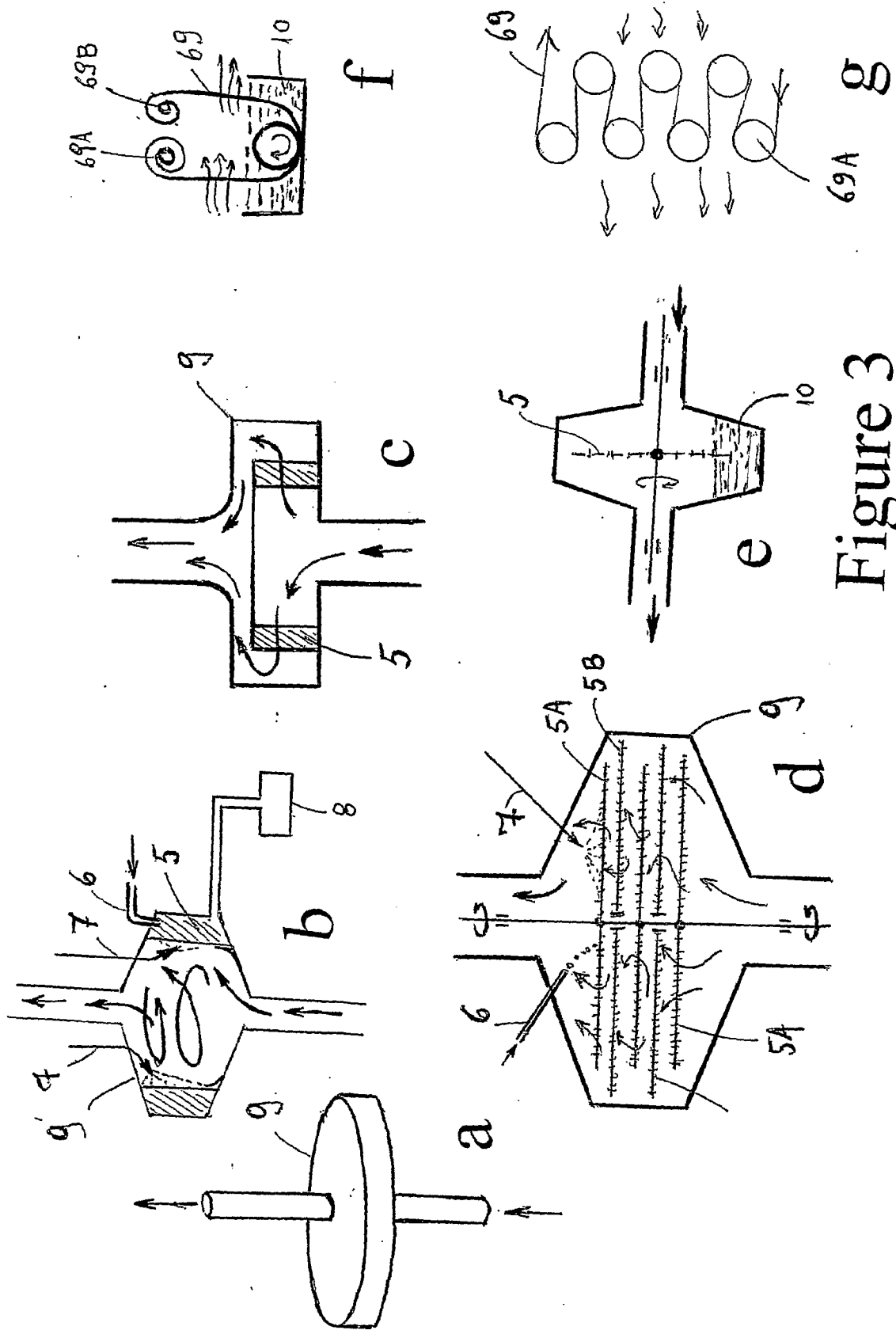
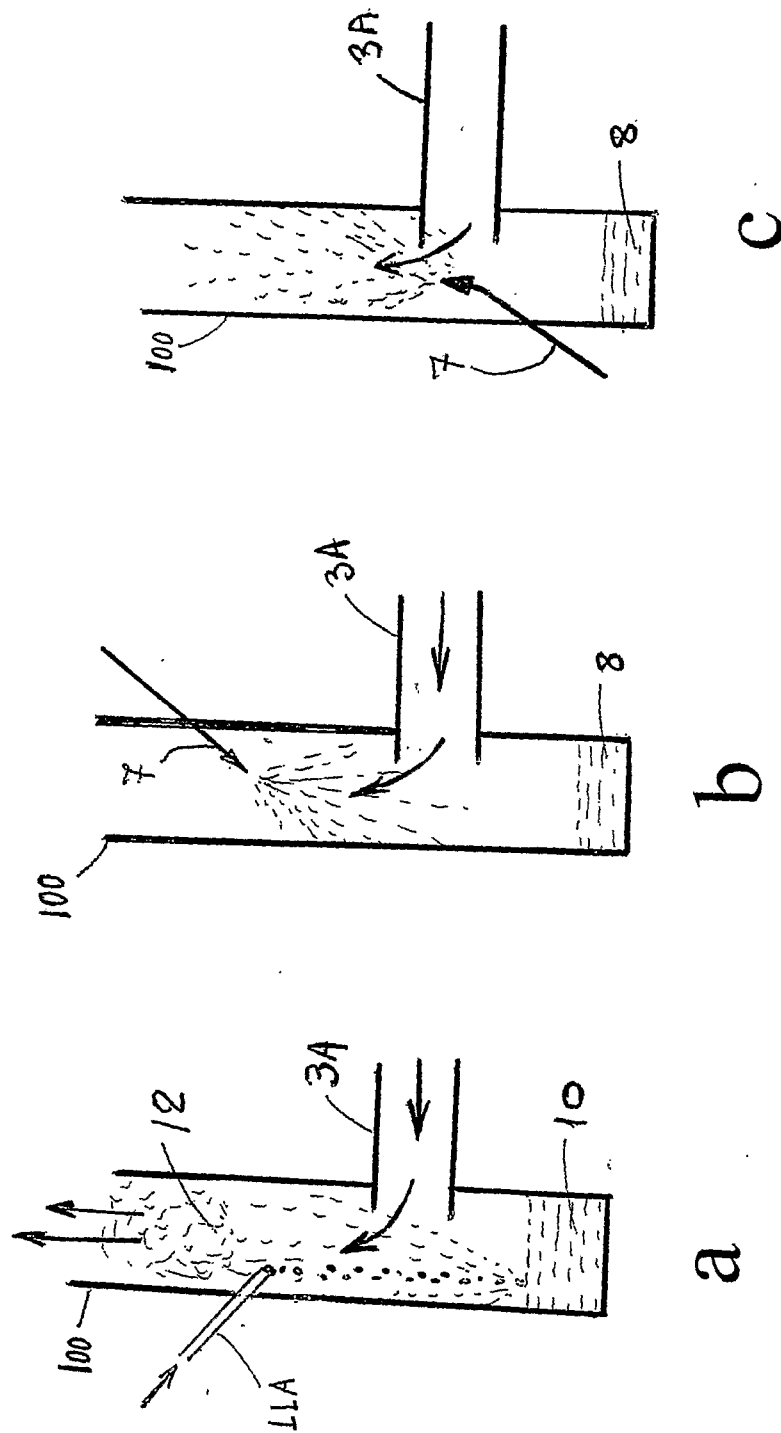


Figure 3



## Figure 4

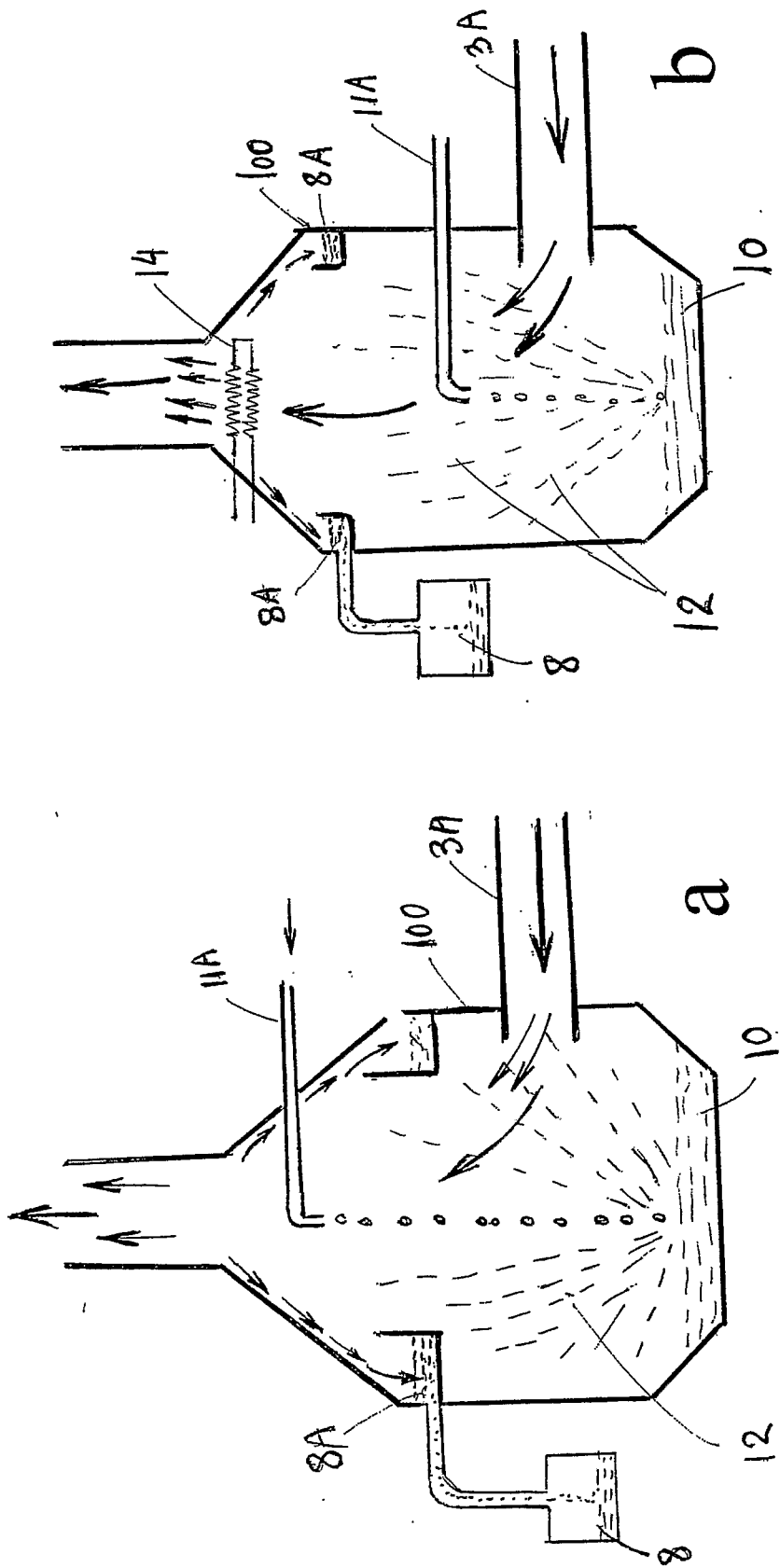


Figure 5

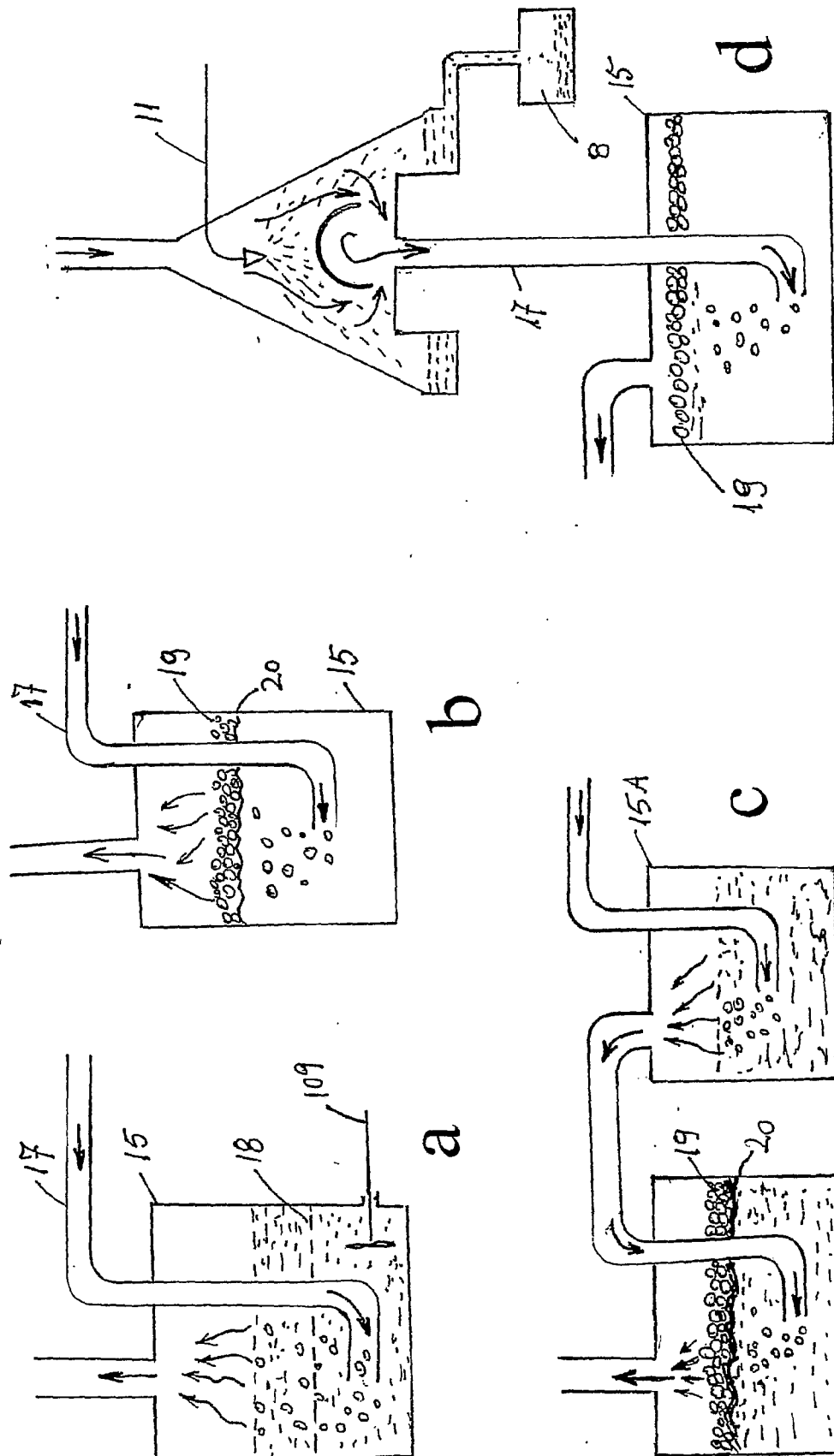


Figure 6

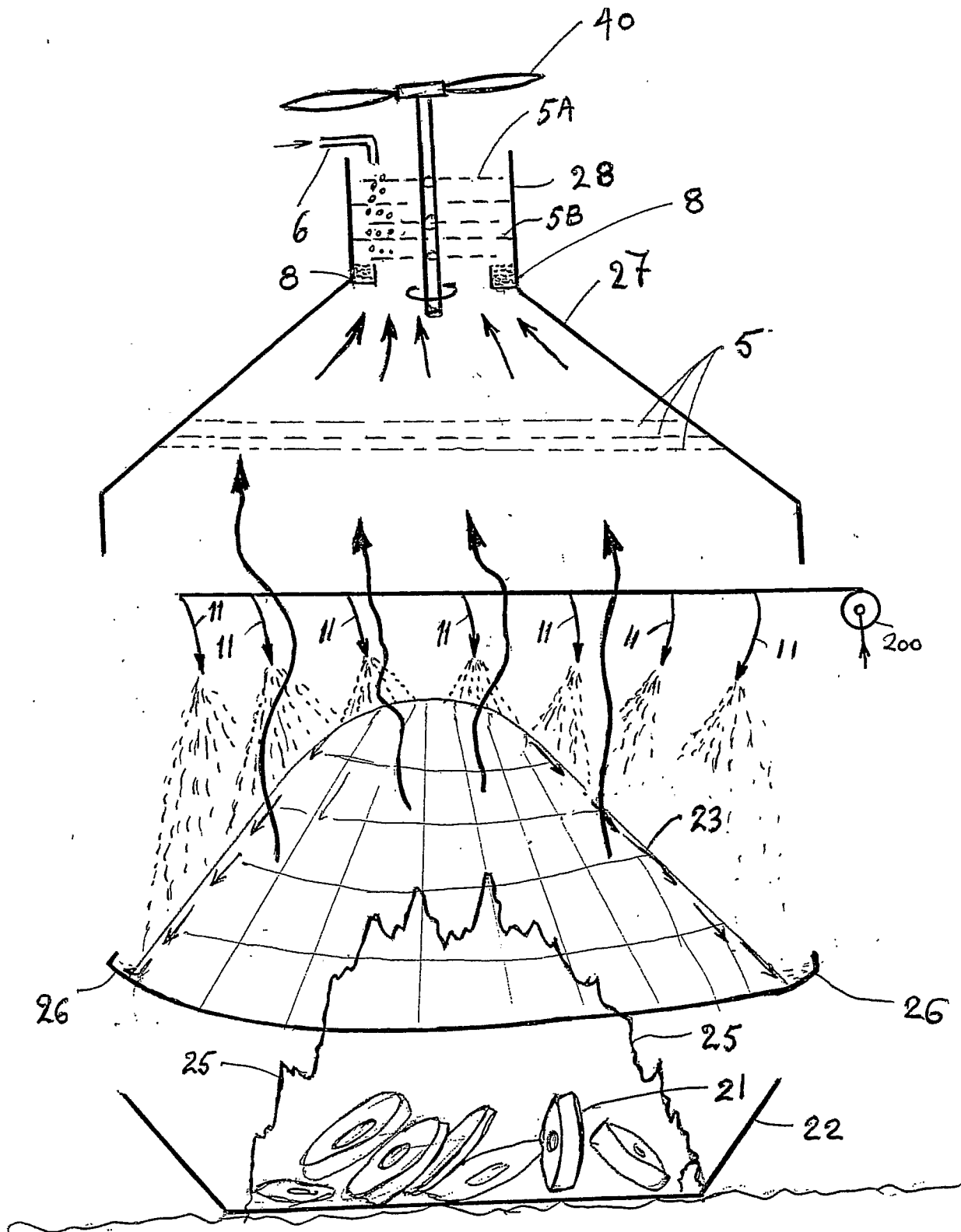


Figure 7

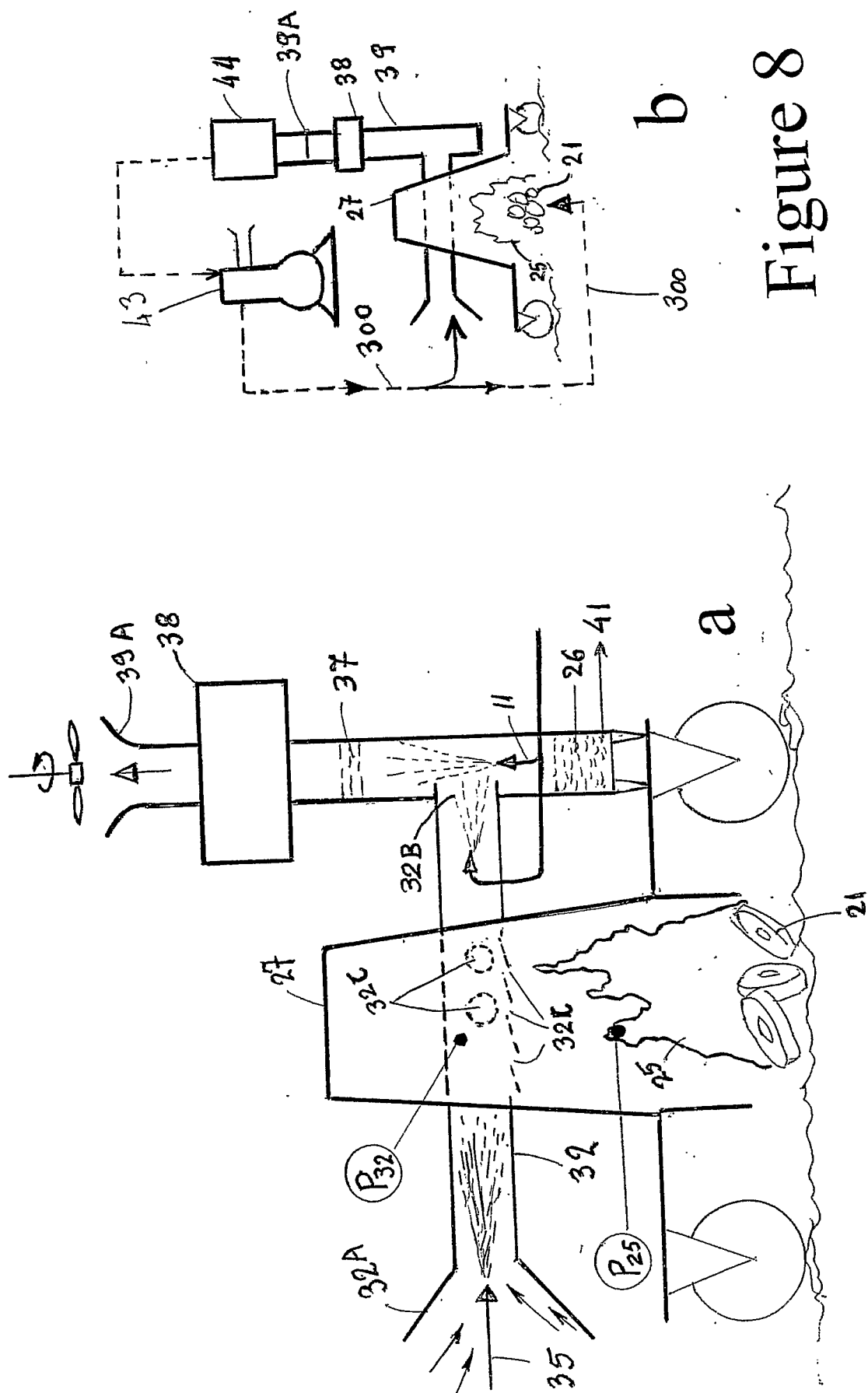


Figure 8

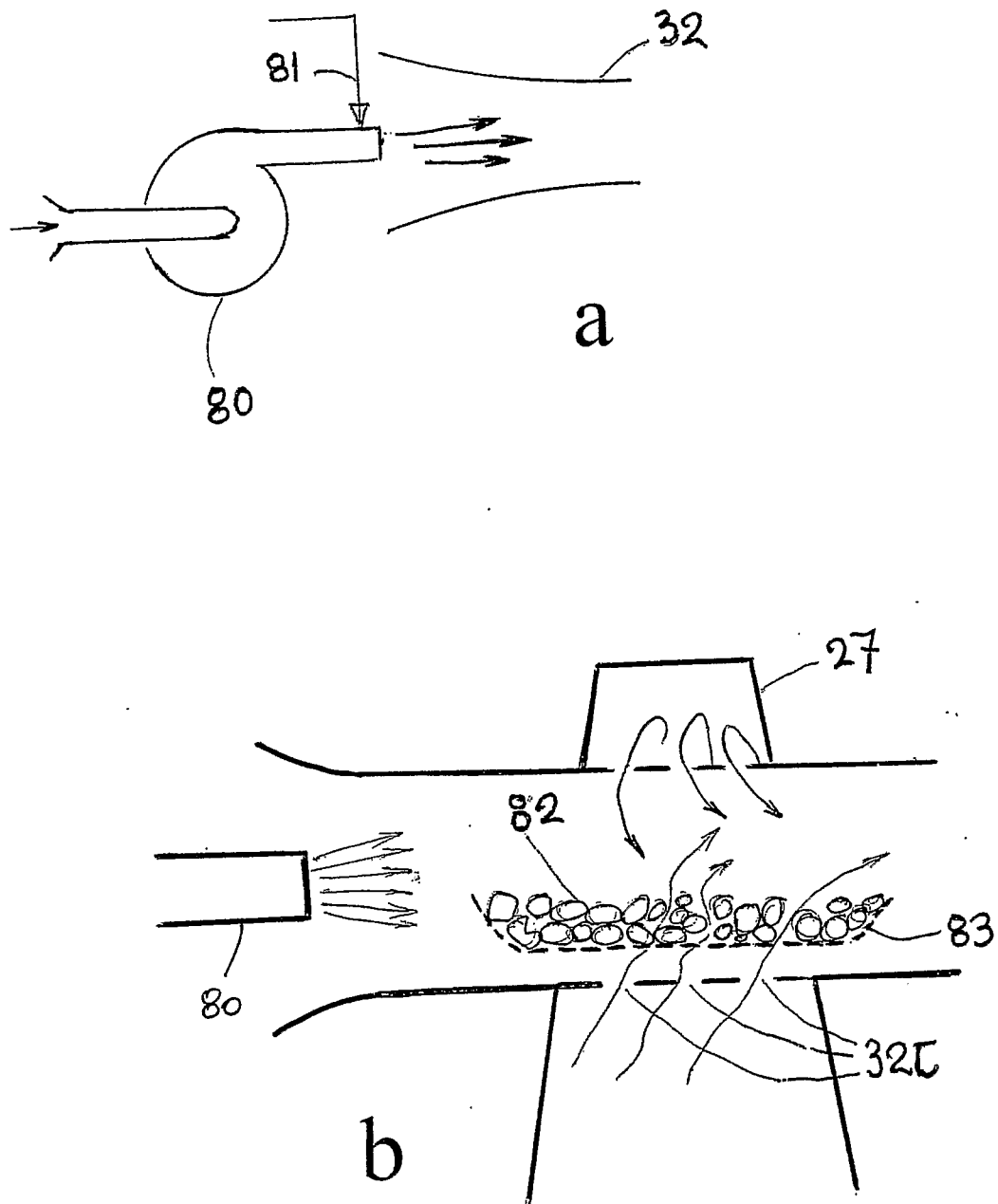


Figure 9

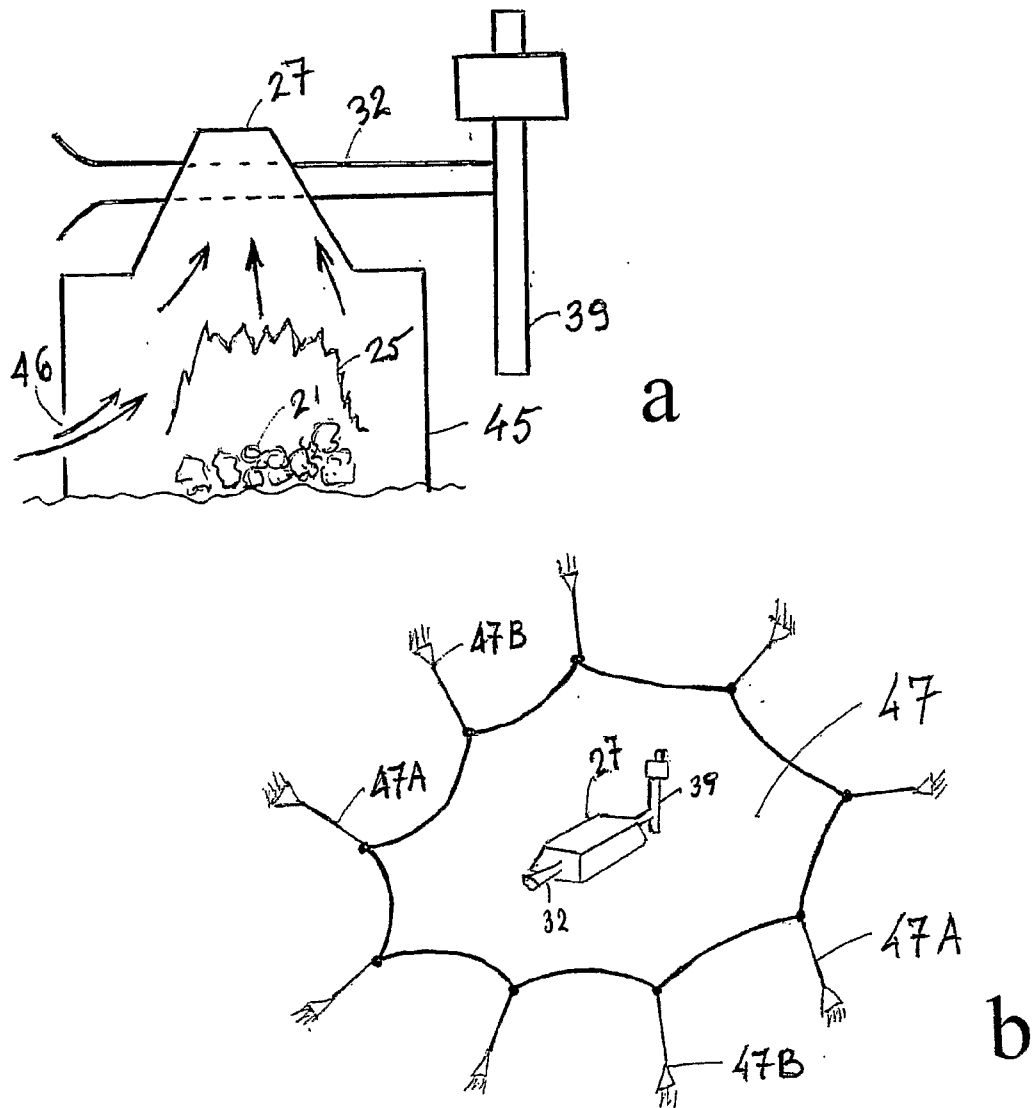
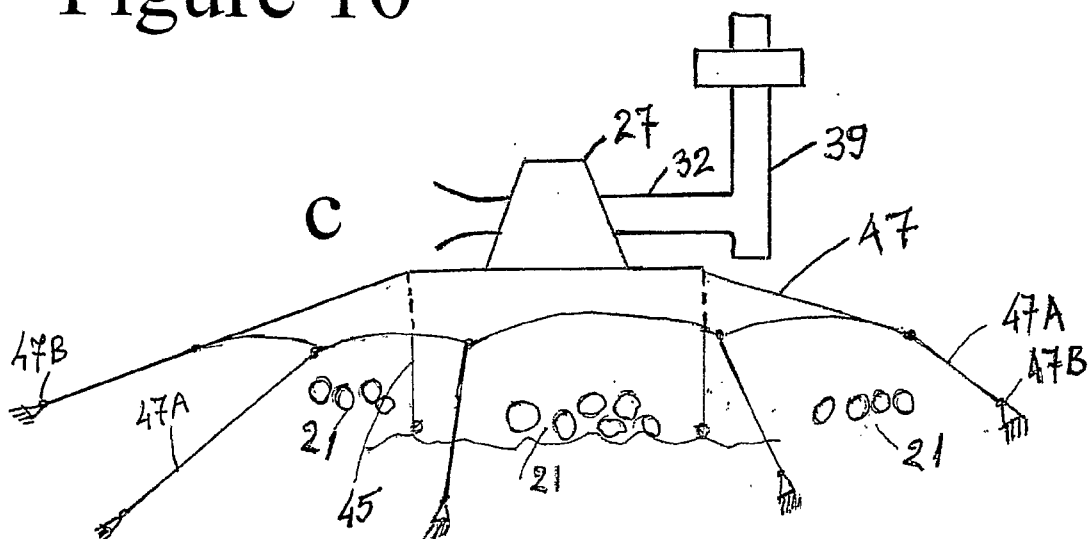


Figure 10



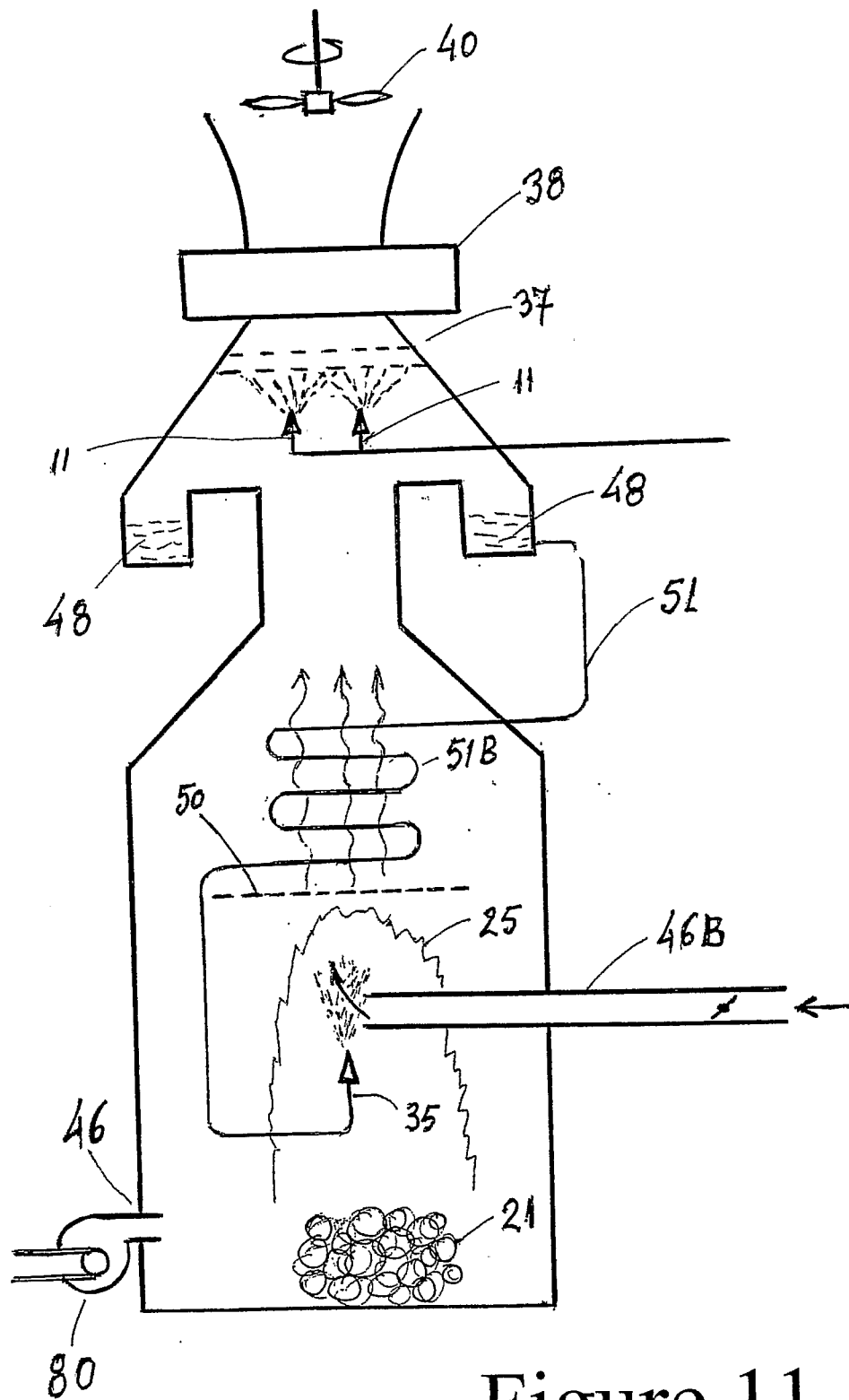


Figure 11

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/GR2007/000011

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. B01D53/14 B01D53/18

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)  
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 practical, 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.
X	WO 98/03247 A (DOW DEUTSCHLAND INC [DE]; WALLBAUM ULRICH [DE]; ZUNKER KURT [DE]) 29 January 1998 (1998-01-29) page 1, line 4 - page 3, line 5 page 8, line 17 - page 13, line 15; claims; examples	1,2, 13-17, 20,21
Y		19
X	DE 41 09 991 C1 (METALLWARENFABRIK STOCKACH GMBH, 7768 STOCKACH, DE) 25 June 1992 (1992-06-25) column 3, line 18 - column 4, line 68 column 5, line 66 - column 6, line 45 column 7, line 22 - column 8, line 28 column 10, line 38 - column 12, line 56; claims; figure	1,2,5-8, 10,13-18

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

\* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search

28 June 2007

Date of mailing of the international search report

11/07/2007

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Authorized officer

Eijkenboom, Thomas

## INTERNATIONAL SEARCH REPORT

International application No

PCT/GR2007/000011

## C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 101 49 179 A1 (BARNICKEL OTTO [DE]) 19 September 2002 (2002-09-19) the whole document -----	1-4, 9-14, 20
X	WO 95/27553 A (AUSTRIA METALL [AT]) 19 October 1995 (1995-10-19) the whole document -----	1, 5-8, 20, 21
X	US 4 844 721 A (COX JAMES P [US] ET AL) 4 July 1989 (1989-07-04) column 1, line 18 - column 5, line 47 claims; figure; tables -----	1, 8-12
Y	JP 10 249126 A (SHINTO DUST COLLECTOR KK) 22 September 1998 (1998-09-22) abstract; figure 1 -----	19

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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