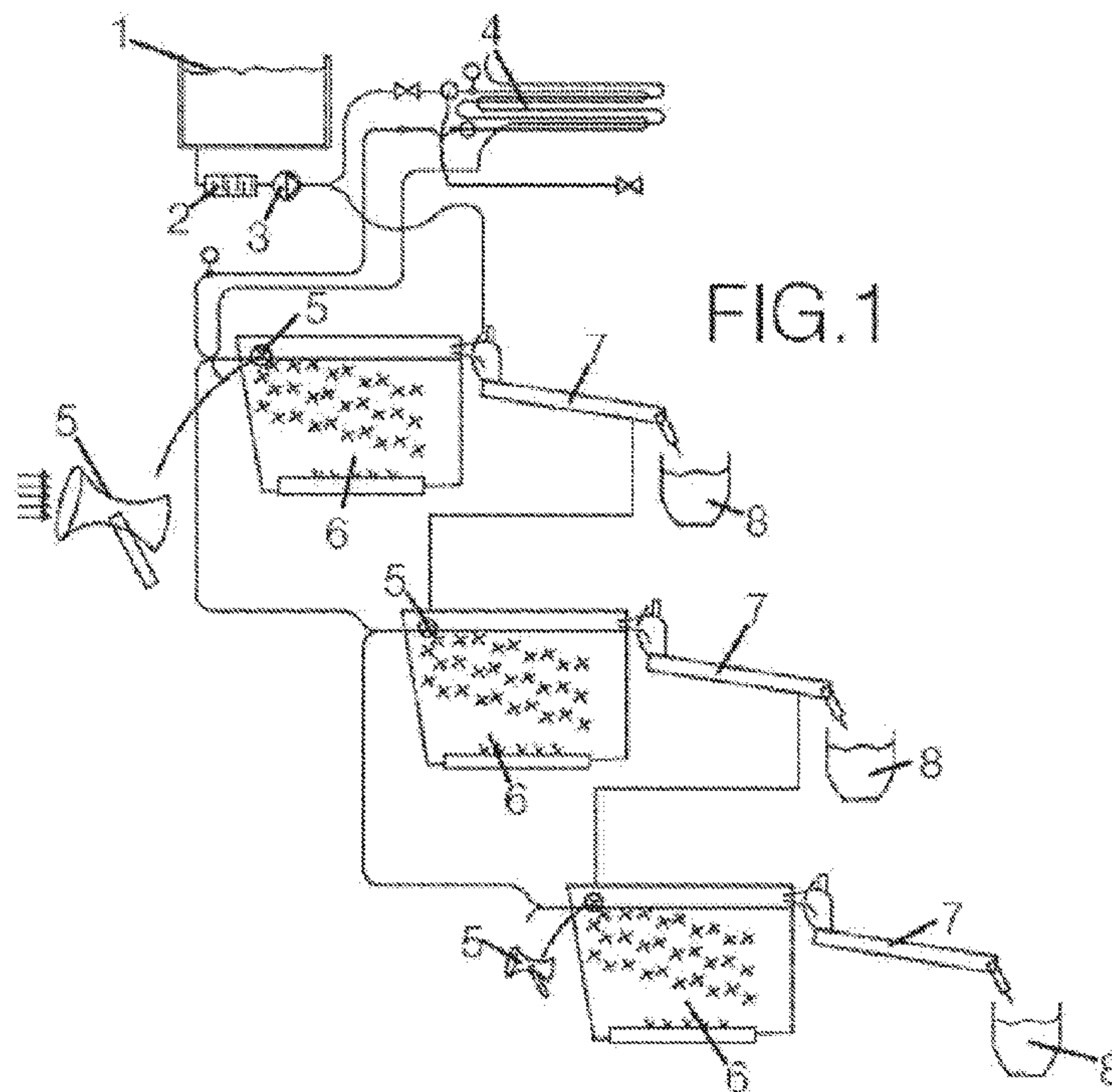




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(54) **Titre : INSTALLATION ET METHODE D'EPURATION DE FLUIDES PAR DISTILLATION**
(54) **Title: PLANT AND METHOD FOR FLUID PURIFICATION BY DISTILLATION**



(57) **Abrégé/Abstract:**

The invention relates to a method and installation for purifying fluids by distillation, comprising: a reservoir (1) containing a fluid with diluted solids and comprising at its outlet an impurity filter (2); a pump (3) connected to the outlet of the reservoir (1) and designed to raise the pressure and temperature of the solids-containing fluid; and a region (4) for heating the solids-containing fluid which comprises a plurality of pipes in contact with a heat-carrying fluid; and which further comprises a converging - diverging nozzle (5) connected to the outlet of the heating region (4) and designed to increase the velocity of the two-phase vapour - liquid fluid such that the solids diluted in the already heated fluid are precipitated in a solids reservoir (6) whilst the fluid passes to a condenser (7) and from there to a reservoir (8) for the purified fluid which is already in the liquid state.



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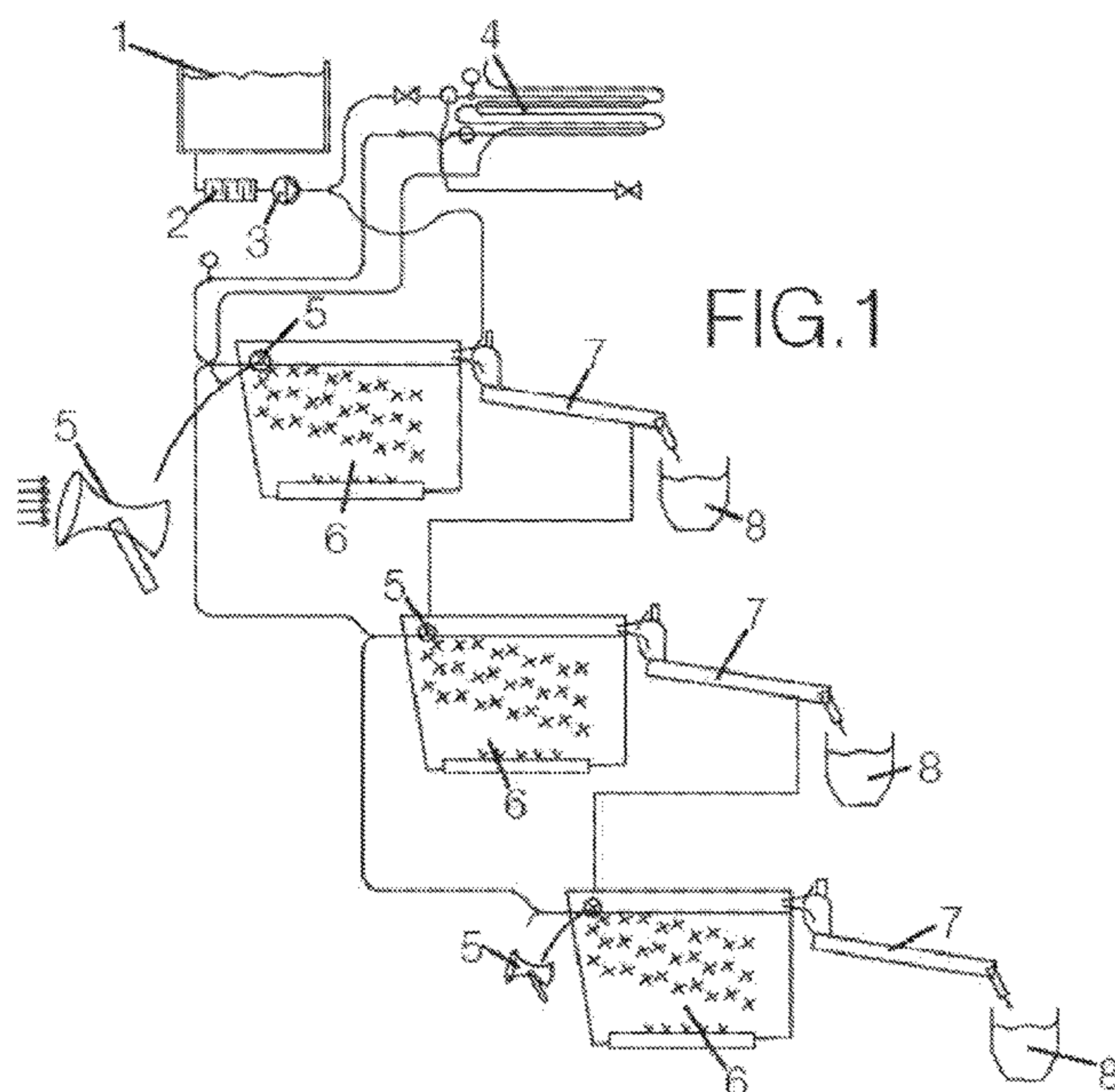
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(54) Title: INSTALLATION AND METHOD FOR PURIFYING FLUIDS BY DISTILLATION

(54) Título : PLANTA Y MÉTODO DE PURIFICACIÓN DE FLUIDOS POR DESTILACIÓN



(57) Abstract: The invention relates to a method and installation for purifying fluids by distillation, comprising: a reservoir (1) containing a fluid with diluted solids and comprising at its outlet an impurity filter (2); a pump (3) connected to the outlet of the reservoir (1) and designed to raise the pressure and temperature of the solids-containing fluid; and a region (4) for heating the solids-containing fluid which comprises a plurality of pipes in contact with a heat-carrying fluid; and which further comprises a converging - diverging nozzle (5) connected to the outlet of the heating region (4) and designed to increase the velocity of the two-phase vapour - liquid fluid such that the solids diluted in the already heated fluid are precipitated in a solids reservoir (6) whilst the fluid passes to a condenser (7) and from there to a reservoir (8) for the purified fluid which is already in the liquid state.

(57) Resumen: Método y planta de purificación de fluidos por destilación que comprende un depósito (1)

[Continúa en la página siguiente]

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con un fluido con sólidos diluidos que dispone en su salida de un filtro de impurezas (2); una bomba (3) conectada a la salida del depósito (1) y configurada para elevar la presión y temperatura del fluido con sólidos; y una zona de calentamiento (4) del fluido con sólidos que comprende una pluralidad de conductos en contacto con un fluido caloportador; y que además comprende una tobera (5) convergente – divergente conectada a la salida de la zona de calentamiento (4) y configurada para elevar la velocidad del fluido bifásico vapor – líquido de tal forma que los sólidos diluidos en el fluido ya calentado precipitan en un depósito de sólidos (6) mientras que el fluido pasa a un condensador (7) y de ahí a un depósito de fluido purificado (8) ya en estado líquido.

PLANT AND METHOD FOR FLUID PURIFICATION BY DISTILLATION

Object of the invention

The object of the present invention is a fluid purification system by distillation which separates solids diluted in the fluid by means of accelerating the fluid.

5 **State of the art**

Up to date the most common methods of purifying water are mechanical methods and filters, such as described, for example, in P201130239. Herein, as an example a device and method of water purification is provided that makes possible the water filtration, purification and distillation by a single device, using only sun energy (UV and IR radiation), also highlighting its portable and ergonomic characteristics, thus providing it with a capacity to be
 10 used anywhere and/or in any situation. Said device stands out mainly because it comprises a microporous bag containing a filtering material, such as activated charcoal, ultrathin resin or the like, for dirty water filtration, removing any microorganism, odor and color of such dirty water to obtain filtered water, and a container having on its surface an area provided with thermochromic paint adapted to indicate to the user the moment when the contained water is already purified through a change in color of said thermochromic paint once water has reached
 15 a certain temperature during sun exposure.

In contrast, methods involving the use of membranes and vapor condensation are also used, such as in ES 2388882, wherein described is a method for purification of a liquid by distillation by membrane comprising passing a stream of steamer retained liquid fraction heated through a retentive fraction channel along a porous hydrophobic membrane, whereby the liquid vapor flows through the pores of the membrane towards the other
 20 side of said membrane, and condensing said vapor on the other side of said membrane to produce a distillate stream in a channel of distillate, distillate created by passing the heat of the condensation (latent heat) towards a condenser surface, said surface forming a non-porous condenser separation between the liquid feeding stream of the liquid to be purified and said distillate stream, whereas the feeding stream is brought through a feeding channel in countercurrent with the retentive fraction stream and which feeding channel is connected hydraulically
 25 downstream with the retentive fraction stream, in which said feeding channel a spacer material is arranged, by which, at least a part of the latent heat is transferred via the condenser surface to the feeding stream, and whereby a positive differential pressure of the liquid is applied between the retentive fraction stream and the feeding stream at the respective points of the retentive fraction channel and the feeding channel, over a portion of each of the retentive fraction channel and the feeding channel.

30 **Description of the invention**

Such as it has been reported, the object of the present invention is a method and a fluid purification plant by distillation that takes advantage of the fact that a fluid with solid components in solution at high temperature and high pressure is passed through a nozzle until it reaches a speed approaching the speed of sound.

The pressure of fluid passing through the nozzle lowers, reaching a state of depression that enables it to reach its vapor pressure at that temperature, this time point being when the solid components of the fluid in gaseous state are separated. Thus obtaining the solid components separated from the clean vapor that continues its way towards the condensation phase, where it liquefies already purified.

Therefore, the present invention uses a distillation system to separate diluted solids by accelerating to fluid speeds approaching the speed of sound. This implies that the fluid in liquid state, for example sea water, is purified in a completely physic way without any kind of chemical treatments and without a high energy consumption that, can also be obtained through clean energies.

Throughout the description and claims, the word "comprise" and its variations are not intended to exclude other technical features, additives, components or steps. To those skilled in the art, other objects, advantages and features of the invention will arise partly from the description and partly from practice of the invention. The following examples and drawings are provided for illustrative purposes and they are not intended to restrict the present invention. Furthermore, the present invention embraces all possible combinations of particular and preferred embodiments set forth herein.

Brief description of drawings

In the following a series of drawings will be described very briefly that will help in better understanding the invention and which are expressly related to an embodiment of said invention presented as a non-limiting example thereof.

FIG.1 shows a block diagram of a purification plant according to one practical embodiment of the invention.

Explanation of a detailed embodiment of the invention

A preferred embodiment of the invention suggests obtaining drinking water from non usable waters non suitable for human use. Thus, it suggests a cleaning cycle based on the diluted solids separation by the kinetics of the biphasic mixture liquid-vapor. This will take into account the following:

- i. The temperature of the liquid has to be increased up to its boiling point under extreme conditions of pressure and temperature.
 - a. Obtaining the required energy from any ecological system present in nature surrounding the

place where the purification plant is to be installed, i.e., wind energy, sun energy or any other kind of renewable energy and/or its associated low costs; and

- b. Performing heat exchange with a primary thermal fluid arranged as heat transfer to the system cycle.

- 5 ii. Increasing the speed of the biphasic mixture vapor-liquid to speeds of around 450 m/s (Mach 0.85) to produce temperature variations up to 60 °C for a few milliseconds and instantly disintegrating the pure water from the salts therein.

The result of development gives rise to a process by which two products are obtained at the outlet:

- a) High purity clean water.
- 10 b) Solid wastes (for example, with sea water, common salt).

Figure 1 shows a purification plant object of the present invention embodiment. Thus, from a reservoir containing water not suitable for human use (1) the fluid goes through a first filter (2) for impurities and, by a pump (3) the fluid pressure and temperature are increased up to a temperature not higher than 253 °C. The fluid then passes to a heat area (4) where the fluid is heated through a heat transfer fluid which will be at a temperature not higher than 275 °C.

The heated fluid then passes to a convergent-divergent nozzle (5) accelerating the fluid to speeds approaching the speed of the sound (preferably, to about 450 m / s), performing an adiabatic compression - expansion of the biphasic liquid-vapor system.

Finally, in each of the solid reservoirs (6), the solids precipitate to the bottom, while the purified water is condensed in a condenser (7) to be stored in a purified fluid reservoir (8).

In the practical embodiment showed in figure 1 there several separation steps are set out (5, 6, 7) which are fed again with different thermal gradient (difference between the fluid inlet and the outlet temperatures).

Numerically, in the plant shown in Figure 1, for a mass flow rate of 30 l/min and a temperature gradient between the inlet and outlet of 32.3 °C with a fluid density 0.78 kg/dm³ as well as a specific heat of 2510 J/Kg, 3 l/min of purified water and 105 g of salt/min in case of sea water is obtained, yielding a thermal balance of 13.35 KW/l of obtained water.

CLAIMS

1. - Fluid purification method by distillation, comprising the steps of:

i) Providing a fluid with diluted solids from a reservoir (1);

5 ii) Filtering the provided fluid from the reservoir (1) through an impurities filter (2);

and **characterized in that** it comprises the steps of:

iii) Increasing the filtered and fluid pressure and temperature up to its boiling point by:

a. a pump (2); and

b. a heating area (4) with heat exchange with a heat transfer fluid;

10 iv) Passing the above fluid through a convergent-divergent nozzle (5) accelerating the fluid up to speeds approaching the speed of sound, whereby it is produced an adiabatic compression-expansion of the biphasic liquid-vapor system, wherein the suspending solids are settled in the bottom of the solids reservoir (6); and

v) Condensing the gas state fluid in the condenser (7).

15 2. - The method according to claim 1, wherein the temperature is increased by a heat transfer fluid which is at a temperature not higher than 275 °C.

3. - The method according any of the claims 1 to 2, wherein the pressure and the temperature are increased by a pump (3) up to a temperature not higher than 253 °C.

20 4. - The method according any of the claims 1 to 3, wherein the speed close to the speed of sound is of around 450 m/s.

5. - Fluid purification plant by distillation, comprising:

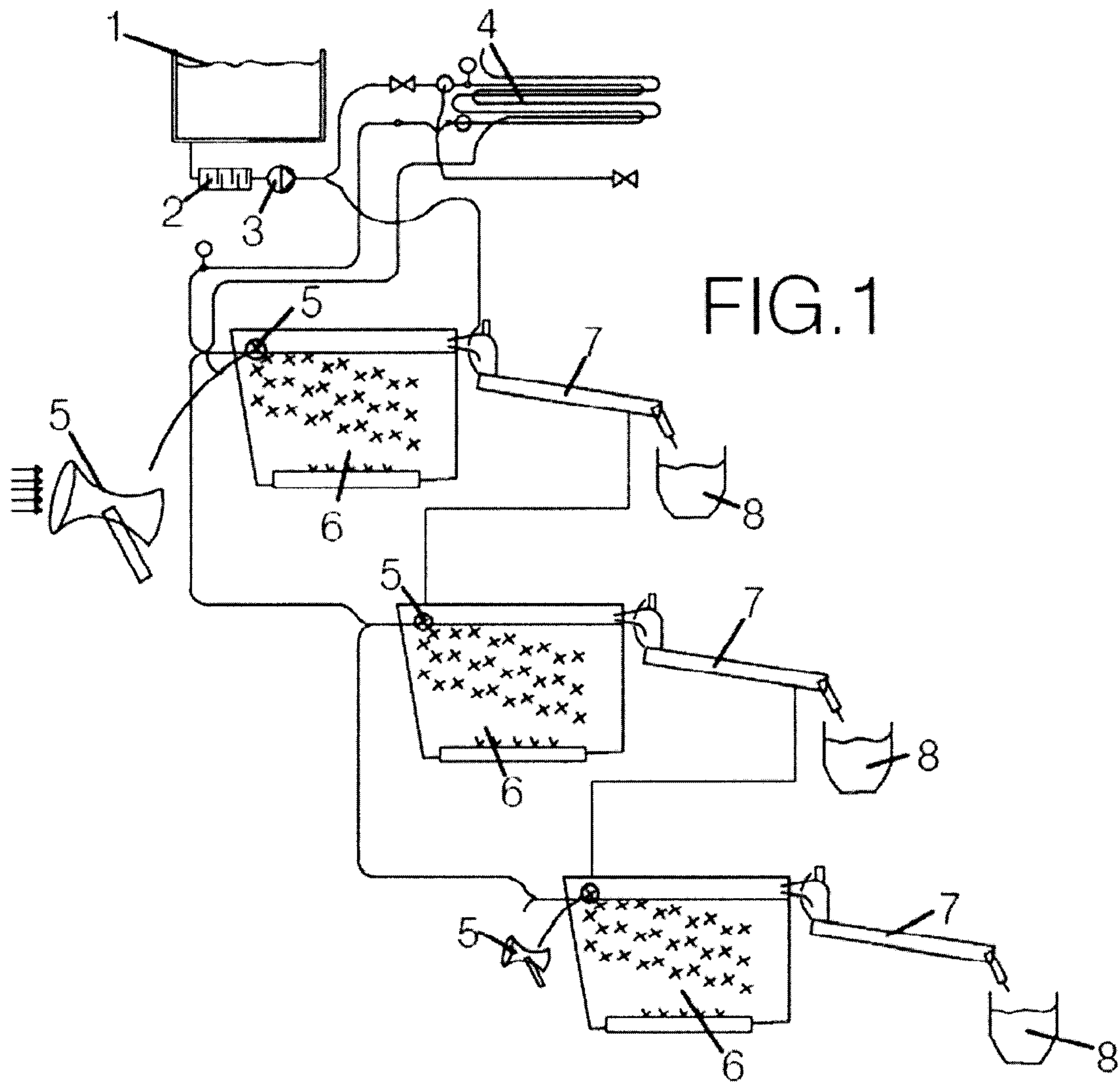
a) A reservoir (1) with a fluid and diluted solids therein, provided with an impurities filter at the outlet (2);

b) A pump (3) connected to the reservoir outlet (1) and set up to increase the pressure and the temperature of the fluid containing solids;

25 c) A heating area (4) for the fluid containing solids, comprising a plurality of ducts contacting with a heat transfer fluid; characterized in that it comprises a convergent-divergent nozzle (5) connected to the outlet

of the heat area (4) and set up to increase the speed of the biphasic liquid-vapor fluid so the diluted solids contained in the fluid already heated settle in a solids reservoir (6), whereas the fluid passes to a condenser (7) and then to a purified fluid reservoir (8) already in liquid state.

6. - The plant according to the claim 5, wherein the heat transfer fluid is at a temperature not higher than 275 °C.



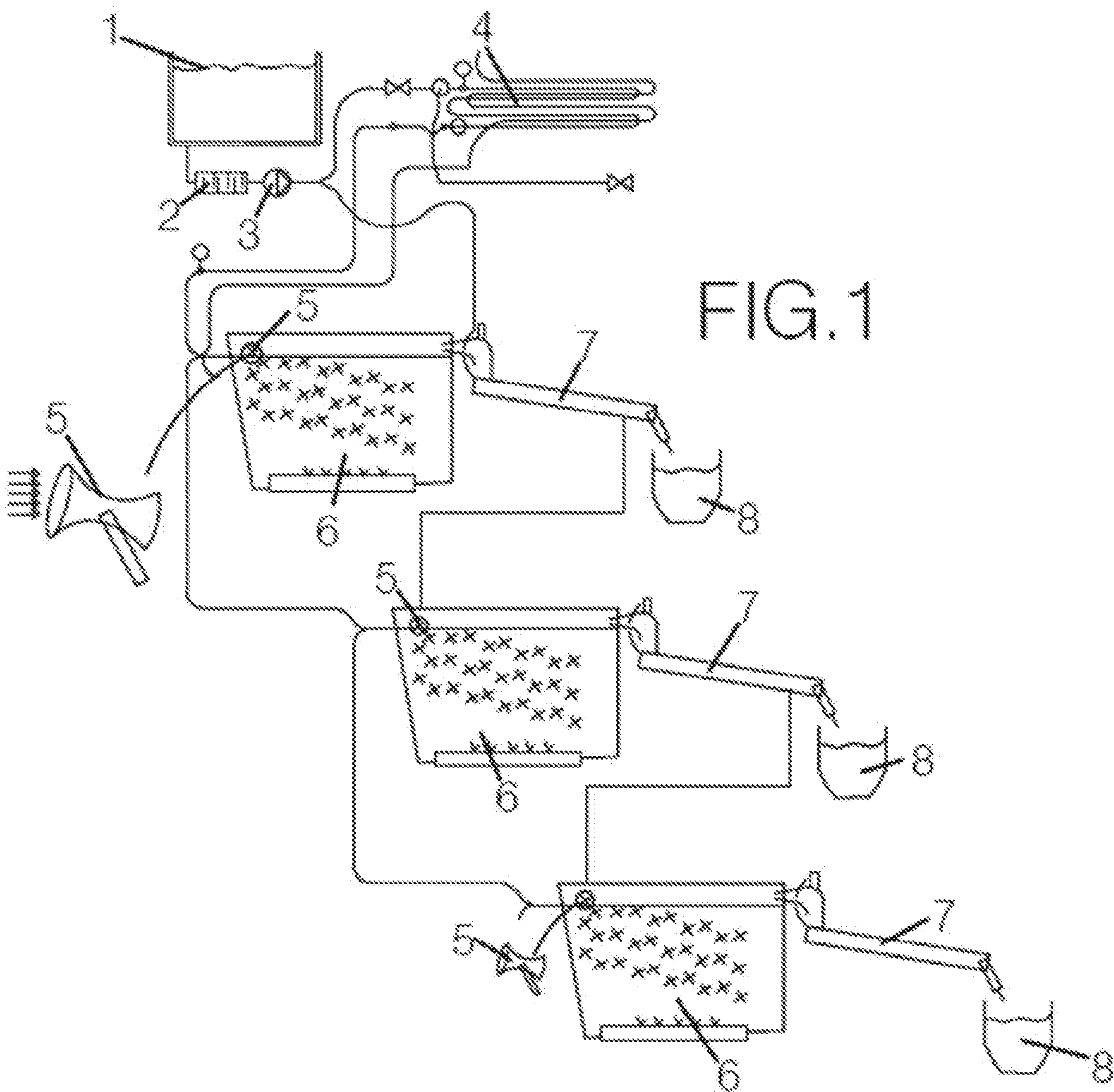


FIG. 1