HU000027374T2

(19) HU (11) Lajstromszám: E 027 374 (13) T2

MAGYARORSZÁG
Szellemi Tulajdon Nemzeti Hivatala

# EURÓPAI SZABADALOM
## SZÖVEGÉNEK FORDÍTÁSA

(21) Magyar ügyszám: **E 13 171615**
(22) A bejelentés napja: **2013. 06. 12.**

(51) Int. Cl.: ***B09C 1/00*** *(2006.01)*
***B09C 1/06*** *(2006.01)*

(96) Az európai bejelentés bejelentési száma:
**EP 20130171615**
(97) Az európai bejelentés közzétételi adatai:
**EP 2674230 A1 2013. 12. 18.**
(97) Az európai szabadalom megadásának meghirdetési adatai:
**EP 2674230 B1 2015. 10. 14.**

(30) Elsőbbségi adatok:
**1255504 2012. 06. 12. FR**

(72) Feltaláló(k):
**Gerland Emmanuel, 69520 Grigny (FR)**
**Bourdin, Christophe, 69580 Sathonay Village (FR)**

(73) Jogosult(ak):
**GRS Valtech, 69517 Vaulx-en-Velin Cedex (FR)**

(74) Képviselő:
**SBGK Szabadalmi Ügyvivői Iroda, Budapest**

(54) **Legalább egy extrahálandó szennyezőanyagot tartalmazó talaj kezelésére szolgáló eljárás és berendezés**

European application number: 12780117.3

European patent number:

This invention relates to a treatment method and installation for a soil containing at least one pollutant to be extracted.

In particular, the invention relates to a treatment method by which

- the soil is heated to a temperature adapted to produce vapours containing the soil pollutant in a gaseous state,

- the vapours are collected through a collection system comprising at least one extraction well pushed into the soil.

Such a treatment system, called SVTE (Soil Venting Thermal Extraction) implemented in situ to depollute the soil on a site in particular eliminates the need for excavation work and the resulting transport and storage problems. It can thus reduce nuisances for the environment, and possibly for persons living close to the treated site. It can also increase the rate at which the depollution treatment is done. In this sense, the SVTE method provides a perfect solution to constraints inherent to an application in an urban environment, for example for the treatment of organic pollution in a town centre, particularly for rehabilitation of a downgraded urban area, although it is not limited to such applications. Costs associated with such depollution treatment can also be reduced.

Soil treatment methods complying with the preamble to claim 1 and treatment installations complying with the preamble to claim 9 are known after being disclosed in documents US 6 543 539 and US 2004/228690.

The invention aims at improving the treatment method defined above and known in prior art.

According to a first aspect, the invention discloses a treatment method to achieve this purpose with the characteristics defined in the characterising part of claim 1.

The treatment method according to the invention uses one or several heating points to heat the soil. It thus exploits only the thermal conductivity of the soil. Since this parameter is approximately constant regardless of the nature of the ground, the treatment performance is not affected by soil heterogeneities, unlike other methods that may depend on other parameters such as the hydraulic conductivity of the soil. Furthermore, the type of heating point used provides better heat distribution over the entire length of the heating point. The result is better uniformity of the depollution treatment and a shorter treatment time.

In one embodiment, the treatment method may use a highly compacted powder of particles refractory to heat in the filling mass, to heat the soil.

Furthermore, the treatment method may use several heating points to heat the soil, arranged in a network consisting of at least two rows of heating points, each row including a plurality of heating points in line with each other and equidistant from each other, the heating rows being parallel to each other.

Furthermore, the pollutant to be treated may have a vapour pressure, and the treatment method may include increasing the temperature of each heating point to a temperature adapted to reach the vapour pressure of the pollutant in the soil, in particular by increasing the temperature to between 400°C and 1000°C.

The treatment method may include the installation of at least two extraction wells equidistant from each heating point, to collect the vapours.

The treatment method may collect the vapours by creating a negative pressure in the collection system by means of a suction system from the collection system connected to each extraction well.

The treatment method may also treat the vapours within the collection system, said treatment method particularly including at least one vapour treatment method chosen from among:

- recondensation of the vapours in a recondensation unit in the collection system;
- thermal oxidation of the pollutant including preheating followed by oxidation in a thermal catalysis unit in the collection system;
- photo-oxidation of the pollutant comprising a photolysis by ultra-violet radiation combined with oxidation in a photo-catalysis unit of the collection system;
- a filtration in a wet environment in a bio-filter of the collection system;
- a filtration on active charcoal in an active charcoal filter of the collection system.

The treatment method may also include recovery and treatment of water within the collection system, said treatment method particularly including at least one water treatment method chosen from among:

- separation by difference of densities in a reservoir of the collection system;

- extraction of pollutant dissolved in water by a fluid passing in counter-current through said water in a stripper of the collection system;

- filtration on active charcoal in an active charcoal filter of the collection system.

According to a second aspect, the invention describes a treatment installation for implementation of the treatment method defined above, said treatment installation including:

- an electric heating system adapted to heat the soil to a temperature adapted to generate vapours in the soil containing the pollutant in a gaseous state, said heating system comprising at least one electrical heating point and an electrical power supply device, each heating point comprising a hollow duct made of a heat conducting material, at least one electric heating element placed inside the duct and a filling mass made of an electrically insulating and heat conducting material, said filling mass filling the duct around the heating element, the duct of each heating point being designed to be pushed into the ground, the heating element of each heating point being designed to be connected to the power supply device;

- a collection system adapted to collect the vapours, said collection system comprising at least one extraction well that will be pushed into the ground, the collection system comprising at least one measurement sensor adapted to measure at least one collection parameter related to vapours in the collection system, such as a collection parameter chosen from among a vapour concentration, flow, pressure and temperature;

- a control unit connected to the measurement sensor and adapted to regulate the temperature of each heating point as a function of the collection parameter;

- the control unit being adapted to:

- memorise at least one set value gradient controlling a temperature increase at the heating point by a determined quantity at determined periods;

- control the temperature increase at the heating point following the set gradient as long as the collection parameter is within a first determined range of values;

- slow the increase in temperature of the heating point if the collection parameter is within a second determined range of values, distinct from the first range of values.

In one embodiment, the filling mass of each heating point may comprise a highly compacted powder of particles refractory to heat.

The collection system may include a suction device connected to each extraction well and adapted to create a negative pressure in the collection system.

The collection system may also be adapted to treat the vapours, said collection system including particularly at least one vapour treatment device among the following:

- a recondensation unit adapted to recondense vapours;
- a thermo-catalysis unit adapted to carry out a thermo-oxidation of the pollutant comprising preheating followed by oxidation;
- a photo-catalysis unit adapted to carry out a photo-oxidation of the pollutant comprising a photolysis by ultra-violet radiation combined with oxidation;
- a bio-filter adapted to carry out a filtration in a wet environment;
- an active charcoal filter adapted to carry out a filtration on active charcoal.

The collection system may also be adapted to recover and treat water, said collection system in particular comprising at least one water treatment device chosen from among:

- a reservoir adapted to make a separation by difference of densities;
- a stripper adapted to extract pollutant dissolved in the water by a fluid passing in counter-current through said water;
- an active charcoal filter adapted to carry out a filtration on active charcoal.

Other characteristics and advantages of this invention will become clear after reading the following description of a particular embodiment of the invention given as a non-limitative example, the description being made with reference to the appended drawings in which:

- figure 1 is a diagrammatic view of a treatment installation installed on a soil containing one or several pollutants, the treatment installation making use of a treatment method according to one embodiment of the invention to extract the pollutant(s) and to depollute the soil;

- figure 2 is a front view of an electric heating point used in the treatment installation in figure 1 to heat the soil so as to create vapours in the soil containing the pollutant in the gaseous state;

- figure 3 is a longitudinal sectional diagrammatic view of the heating point in figure 2;

- figure 4 is a diagrammatic view of a network of electrical heating points and extraction wells in a collection system for the treatment installation in figure 1, each extraction well being adapted to collect vapours produced in the soil;

- figure 5 is a perspective view of part of the network of heating points and extractions wells, illustrating heat dispersion along one of the heating points;

- figure 6 is a diagrammatic view of a recondensation unit in the collection system of the treatment installation in figure 1 adapted to recondense vapours;

- figure 7 is a diagrammatic view of a photo-catalysis unit of the collection system of the treatment installation in figure 1 adapted to carry out photo-oxidation of the pollutant including photolysis by ultra-violet radiation combined with oxidation;

- figure 8 is a diagrammatic view of a reactor of the photo-catalysis system in figure 7;

- figure 9 is a diagrammatic view of a bio-filter in the collection system of the treatment installation in figure 1 adapted for filtration in a wet environment;

- figure 10 is a diagrammatic view of an active charcoal filter in the collection system of the treatment installation in figure 1 adapted for filtration on active charcoal;

- figure 11 is a diagrammatic view of water treatment devices in the collection system of the treatment installation in figure 1.

The same references on the different figures refer to the same or similar elements.

Figure 1 shows a treatment installation 1 installed on a site 2 with a soil 3 that contains one or several pollutants. The treatment installation 1 is adapted to implement an SVTE (Soil Venting Thermal Extraction) method for in situ treatment of the soil 3 so as to extract pollutants from it and to depollute the soil 3 on the site 2.

The treatment installation 1 comprises:

- a heating system 5 adapted to heat the soil 3 so as to produce vapours containing pollutants to be extracted in a gaseous state, in the soil to be treated;

- a collection system 15 adapted to collect vapours produced in the soil 3.

The heating system 5 is electric and comprises one or several electrical heating points 6 and an electrical power supply device 7.

As shown in figures 2 and 3, each heating point comprises a hollow duct 8 made of a heat conducting material that will be pushed into the soil 3. In particular, the duct 8 may be formed from a cylindrical tube, particularly with a circular cross-section about a preferably straight axis A, made of metal such as steel. Inside the duct 8, the heating point 6 also comprises one to three electrical heating elements such as electrical resistances 9 arranged in the form of coils, and an infill mass 10 in which the electrical resistances 9 are embedded. The infill mass 10 may be composed of a highly compacted powder of particles refractory to heat, made of an electrically insulating material that is a good conductor of heat such as magnesium oxide or magnesia (MgO). Each electrical resistance 9 comprises an upper end 9a that will be placed adjacent to an external horizontal surface of the soil 3, connectors 11 arranged to make an electrical connection of the electrical resistance 9 to the power supply device 7. Each heating point 6 may also be equipped with a thermocouple 12 (visible in figure 6) with the objective of providing protection against overheating and also to regulate the temperature and therefore the energy supplied as will become clear from the remainder of the description.

The invention is not limited to the previously described structure of the heating point 6. As a variant, each heating point 6 could be composed of a single electrical resistance 9. Each electrical heating resistance 9 could also be inserted in an intermediate heat conducting tube that fits into the duct 8, the electrical resistance 9 being fixed in position inside the intermediate tube by an infill mass composed of an electrically conducting material that is a good conductor of heat identical to or different from the infill mass (if any) between the intermediate tube and the duct 8. Other forms of electrically insulating materials that are good conductors of heat could also be used.

Examples of heating points 6 that can be used in the heating system 5 in the treatment installation 1 according to the invention are described in patents US 2 767 288, US 3 305 820 and US 3 340 382. In particular, heating points 6 marketed by the WATLOW® company under the trade name MULTICELL® can be used.

The collection system 15 comprises one or several extraction wells 16, a suction device 17, one or several vapour treatment devices 18 and one or several water treatment devices 19.

Each extraction well 16 will be pushed into the soil 3. The extraction well 16 may consist of a cylindrical tube, particularly with a circular cross-section, along a preferably straight axis B, and made of metal such as steel. In particular, the tube may have a continuous wall over a determined length, for example 3 m, from a top end 16a that will be placed adjacent to the external horizontal surface of the soil 3. The tube wall may be perforated along its remaining length. A plug, for example made from bentonite or a similar material, may be formed on part of the continuous wall so as to make a perfect seal, for example at a distance of 2 m from the top end of the tube. An annular part on the perforated wall can be filled in with a filter element such as calibrated rolled filter gravel. Each extraction well 16 may be fitted with a wellhead on which branch connections are made so that samples of gas in the vapours and originating from the soil can be taken.

The collection system 15 also comprises one or several measurement sensors 20 each adapted to measure a collection parameter related to vapours produced in the soil, such as a vapour temperature, pressure, concentration or flow. Thermocouples 20a coupled to measurement sensors of the negative pressure control can thus be installed in the branch connections provided on each well head.

The treatment installation 1 also includes a control unit 25 connected to measurement sensors 20 and programmed to control operation of the treatment installation 1 as a function of data related to the soil 3 collected prior to treatment, and also to collection parameters measured during the treatment.

In figures 1 and 4, the duct 8 of each heating point 6 is pushed into the soil 3 to be treated to the required depth, defined based on geological, hydrogeological parameters and measured concentrations in an initial state. In particular, several heating points 6 are arranged in a network including several rows, for example four rows of heating points 6 in figure 4. Each row comprises a plurality of heating points 6 in line and separated from each other by a determined pitch. Each heating point 6 is then located equidistantly from adjacent heating points 6 in the same row. In figure 4, two adjacent rows are parallel to each other and are offset by half the pitch. The connectors 11 of the electrical resistances 9 are connected to the power supply device 7.

The network also comprises several extraction wells 16 pushed into the soil 3 to a variable depth, in the centre of the pollution concentration. At least two extraction wells 16, for example three in figure 4, are located equidistant from each heating point 6. Each extraction well 16 is connected to other extraction wells 16 in the network through a metal hose and a valve to isolate the extraction well 16 from the remainder of the network (gas isolation). All extraction wells 16 in the network and the all-metal hoses assure that full equipotentiality of the collection system 15 can be achieved. The network of extraction wells 16 is also connected to the suction device 17 such as an extraction fan, so that a negative pressure can be created in the collection system 15.

With the SVTE method, the soil 3 is heated in place adjacent to the contaminated zones up to a temperature at which a sufficient vapour pressure of the pollutants can be reached to facilitate their extraction be *venting*. Depending on the type of pollutant, the heating points 6 can output a power of 1.5 kW per meter and their temperature may be increased to between 400°C and 1000°C. Heat dispersion can then take place as shown in figure 5 until the minimum temperature is reached at the limit of the radius of action so that the required vapour pressure of the pollutants can be reached.

The power of the heating points 6 is regulated by switching power units. In particular, the control unit

25 can regulate the temperature of each heating point 6 as a function of one or several collection parameters. The temperature rise in the zone to be depolluted depends on the temperature of the heating points 6 and the response curve of the terrain. This temperature rise is controlled by increasing the temperature of the heating points 6 following a set gradient memorised in the control unit 25 and controlling an increase in the temperature of the heating point 6 by a determined quantity, for example 100°C, at determined periods, for example every week.

The control unit 25 controls the temperature increase of the heating point 6 following the control gradient as long as the collection parameters are within the first ranges of the corresponding determined values.

The temperature rise is preferably not accelerated. When the collection parameter(s) is (are) within the corresponding second determined ranges of values, distinct from the first ranges of values, in particular the temperature rise of each heating point 6 can be slowed particularly as a function of the extracted concentrations, the negative pressures and temperatures measured on the well heads, particularly when the collection parameter(s) go (goes) outside the corresponding first ranges of values.

Pollutants change to the gaseous state under the effect of heat, and are then collected by the extraction well 16 of the collection system 15 that is at negative pressure.

In the embodiment shown, the collection system 15 also comprises several vapour treatment devices 18.

Figure 6 shows a recondensation unit 30 that performs a preliminary treatment of the vapours that consists of recondensing vapours extracted by the extraction wells 16 by passing through a system of heat exchangers and droplet separators. The recondensation unit comprises a cooling unit 31, a cooling tower 32 and a "condensation skid - droplet separator exchanger" container 33 that cools the vapours to a temperature of 7°C. All liquids derived from this recondensation are transferred to water treatment devices 19, described below.

The entire collection system 15 is considered to be an ATEX 1 or 2 zone and is treated as such. A fan 34 maintains a negative pressure in the recondensation unit 30. The fan 34 and the part downstream from the recondensation unit 30 are declassified as a danger-free zone by regulating an explosivity value acting on a dilution valve. The regulation may for example be adjusted to a maximum of 25% of the L.E.L. (Lower Explosivity Limit) with a safety cutoff at 50%. These values can be calibrated and adjusted to the most restrictive gases.

The set of collection parameters including particularly the gas inlet and outlet temperatures, the vacuum on the upstream and downstream sides, and the explosivity can be measured by appropriate measurement sensors 20 and continuously recorded by the control unit 25. They can also be printed at any time, for example in the form of tables and/or graphs.

The collection system 15 may also include a thermo-catalysis (CATOX) unit. The principle of thermo-catalysis consists of violently oxidising organic pollutants so as to produce essentially $CO_2$ and water. This oxidation is produced by preheating the vapours and then directing them into a catalytic reactor. For example, preheating may be done using electrical resistances. Vapours are introduced into the catalytic reactor at a minimum temperature of 320°C, to guarantee good efficiency.

As a non-limitative example, a thermo-catalysis unit with the following characteristics could be used.

- treated air flow 1000 $m^3/h$,
- maximum input concentration: 15% L.E.L. (Hexane),
- dimensions: 6000 mm x 2500 mm x 2700 mm,
- mass: 5 tonnes,
- installed electrical power: 50 kW.

The reaction is strongly exothermic. Heat generated in the catalytic reactor supplies part of the heating of the incoming vapours (or all of it under auto-thermal conditions), through a heat exchanger. This temperature increase is also a technical limit for the maximum allowable concentrations in incoming vapours (maximum allowable temperature at the catalyser output = 480°C to 500°C). Consequently, in the above-mentioned example, vapours are introduced into the thermo-catalysis unit with an input flow limited to 11 $g/m^3$.

The thermo-catalysis unit may be installed in a container equipped with a control cabinet and a set of automatic controls and the necessary safety modules, such as a programmable logic controller with PID control to control preheating of vapours, automatic valves to close the network of the collection system

15 in the case of a problem, a dilution valve for use if incoming concentrations are too high (risk of temperature rise), checking and recording of flows and concentrations.

Figures 7 and 8 represent a photo-catalysis unit 35 of the collection system 15 of the treatment installation 1. The photo-catalysis unit 35 carries out photo-oxidation during which polluted vapours can be treated at low temperature. As a non-limitative example, photo-oxidation is of the catalysed ultraviolet (UV) type.

The photo-catalysis unit 35 comprises a photo-catalytic reactor 36 shown in figure 8 in which many reactions occur. Firstly, photolysis of the molecule denoted R-R (for example 1,2 dichloro-ethylene) is observed under the effect of UV radiation produced by the UV sources 37.

The photolysis reaction is written:

$R\text{-}R + h\nu \rightarrow R^{\circ} + R^{\circ}$ (wave length less than 250 nm)

The products of this photolysis then react with different oxidising agents produced at the same time in the photo-catalytic reactor 36 from oxygen in the air or humidity from the vapour flow. Dioxygen in the air is also photolysed resulting in the formation of ozone, according to the following reactions:

$O_2 + h\nu \rightarrow 2O^{\circ}$ (wave length less than 190 nm)

$O_2 + O^{\circ} \rightarrow O3$ (wave length less than 190 nm)

This reaction is reversible for a wavelength of less than 250 nm.

Moisture in the air flow can also produce the $OH^{\circ}$ radical that has a high oxidising power according to the following reaction:

$H_2O + hv \rightarrow H^{\circ} + OH^{\circ}$ (wave length less than 190 nm)

The photo-catalytic reactor 35 can advantageously make use of a TiO2 catalyser fixed onto a hybrid support 38 combining titanium dioxide and active charcoal. Adsorption of pollutants on an inert substrate with high porosity and their diffusion towards TiO2 particles can locally increase concentrations and therefore degradation rates. Furthermore, there is a strong possibility that reaction intermediaries will be reabsorbed on the support and once again become degraded. Therefore only small quantities are released into the atmosphere.

The photo-catalysis unit 35 can give excellent efficiency on chlorinated solvents and, to a lesser extent, BTEXs. However, its efficiency is limited on alkane hydrocarbons and ethanes (not more than 40%).

The final products of the photo-oxidation reaction are $CO_2$, water and hydrochloric acid HCl. Hydrochloric acid can be eliminated in a washing tower 39 in which washing is done using water to which soda NaOH has been added. The pH is regulated to 8 to give a good washing efficiency. Deconcentration is controlled by a conductivity measurement. Deconcentration water is sent to the water treatment system.

Each photo-catalysis unit 35 may be provided with an Hct measurement by photo-ionisation (PID) 41 to monitor its degradation efficiency and a fan 40 to assure a negative pressure inside the photo-catalytic reactor 36 and thus avoid any risk of an oxone leak. The photo-catalysis unit 35 may also be equipped with continuous flow, pressure and temperature measurement sensors 20 to monitor correct operation, and follower tables and graphs can be extracted from measurements made by the measurement sensors.

A treatment stage using a bio-filter 45 as shown in figure 9 can be added, since the photo-catalysis unit 35 cannot guarantee an efficiency of more than 40% to 90%. In particular, the bio-filter 45 can be optimised with a humidity management system, continuous spraying, water recovery and/or bio-stimulation.

For example, the bio-filter 45 may be made in the form of a swath equipped with membranes 46 on the top and bottom to assure leak tightness. Its main composition is based on compost that gives better diffusion than other coarser elements such as bark, etc. Active charcoal can also be integrated into its composition, thus smoothing out pollution peaks. The main parameter that assures high efficiency of the bio-filter during operation is its humidity content. The bio-filter may be continuously sprayed to maintain optimum humidity. Percolates are retrieved and pass through a bio-stimulation reactor 47, before being reinjected. The temperature of the bio-stimulation reactor 47 may be regulated, provided with an aeration system and a nutrient proportioning system. The efficiency of the bio-filter 45 may be checked by photo-ionisation VOC analysers (PID).

Figure 10 shows an air finishing treatment that can be done on active charcoal before it is released into the atmosphere to respect allowable release thresholds. This may be achieved by using an active charcoal filter 50 equipped with a fan 51 and downstream vacuum measurement probes and upstream pressure measurement probes to assure firstly that there are no leaks, and secondly that the charcoal is not clogged. Each active charcoal filter 50 may be equipped with a PID photo-ionisation VOC analyser that measures input and output sequencing of the filter to assure that it is functioning correctly and that releases are conforming. PID values and positive and negative pressures may be continuously recorded by the control unit.

All water and all types of liquid produced by the treatment of vapours can be recovered by different water treatment devices 19 in the collection system 15 shown in figure 11.

In particular, water may be sent to a buffer tank 42 (visible in figure 7) that makes it possible to manage flow fluctuations and to transfer a stable flow to water treatment devices 19.

In particular, the collection system 15 may include a reservoir 55 adapted to separate liquids as a result of their difference in densities. The reservoir 55 may be equipped with a first "deoiling" stage to recover supernatants and sinker fluids using a set of solenoid valves EV and a peristaltic pump 56 controlled by interface probes. The recovered supernatants and sinker fluids may be stored in a cubitainer on a retention 57.

The recovered water may also be treated on a stripper 60, for example of the column type, in which a fluid passing in counter-current through the water is used to dissolve the pollutants. The water can then be filtered on active charcoal in one or several active charcoal filters 65 before it is released into waste water.

The control unit 25 is connected to each vapour treatment device 18 and water treatment device 19 to control them and possibly to record data and collection parameters measured particularly by the measurement sensors 20 in the collection system 15.

The treatment performed by the treatment installation 1 described above can be checked by making a measurement of the quantity of pollutant present in extracted air, and calculating the quantity of pollutant in extracted air by integration with the flow. It would also be possible to weigh the pollutant volume extracted during the liquid phase when dispatched for elimination. Furthermore, extraction of vapours in each extraction well 16 can be adjusted by controlling PID concentrations and negative pressures using an electronic manometer during follow-up campaigns. Moreover, isolated monitoring, sampling operations, measurement campaigns and maintenance operations can also be carried out by specialised teams.

Depollution can be monitored mainly by monitoring extracted quantities and concentrations at each extraction well. These quantities and concentrations increase initially as the temperature of the heating system 5 rises. After the heating system 5 has reached its optimum temperature, they reduce following an exponential curve.

Although the treatments described above are described in combination with each other within the same treatment installation 1, they could be done independently of each other. Furthermore, only some of these treatments may be made. To achieve this, each device to implement the treatments could be used independently of the other devices, and only some of the devices to implement the treatments could be used. Furthermore, one or several of the previously described treatments, and even one or several of the devices described above could be used in applications other than a soil depollution treatment and particularly in an installation different from that described above. Therefore the treatments and the corresponding units may be different especially from the use of electrical heating points.

714368/DO

# LEGALÁBB EGY EXTRAHÁLANDÓ SZENNYEZŐANYAGOT TARTALMAZÓ TALAJ KEZELÉSÉRE SZOLGÁLÓ ELJÁRÁS ÉS BERENDEZÉS

## SZABADALMI IGÉNYPONTOK

1. Eljárás legalább egy extrahálandó szennyezőanyagot tartalmazó talaj (3) kezelésére, amely kezelési eljárás magában foglalja, hogy:

- felmelegítjük a talajt (3) olyan hőmérsékletre, amelyen a szennyezőanyagot gáz halmazállapotban tartalmazó gőzök hozhatók létre a talajban (3),

- leválasztjuk a gőzöket egy leválasztó rendszeren (15) keresztül, amely magában foglal legalább egy, a talajba (3) süllyesztett extrakciós kutat (16),

amely kezelési eljárás a talaj (3) melegítése céljából magában foglalja, hogy:

- alkalmazunk egy villamos melegítőrendszert (5), amely magában foglal legalább egy villamos fűtőtüskét (6) és egy villamosenergia-ellátó berendezést (7), valamennyi fűtőtüske (6) magában foglal egy hővezető anyagból készült üreges hüvelyt (8), legalább egy villamos fűtőelemet (9) a hüvelyben (8) elhelyezve, valamint egy villamosan szigetelő és hővezető anyagból készült kitöltőanyagot (10), amely kitöltőanyag (10) kitölti a hüvelyt (8) a fűtőelem (9) körül,

- besüllyesztjük valamennyi fűtőtüske (6) hüvelyét (8) a talajba (3),

- csatlakoztatjuk valamennyi fűtőtüske (6) fűtőelemét (9) az ellátó berendezéshez (7),

- mérünk a leválasztó rendszer (15) legalább egy mérési érzékelőjével (20) legalább egy, a leválasztó rendszerben (15) lévő gőzökre vonatkozó leválasztási paramétert, például egy, a gőzök koncentrációja, átfolyási sebessége, nyomása és hőmérséklete közül kiválasztott leválasztási paramétert,

- hőmérsékletszabályozást végzünk valamennyi fűtőtüskén (6) a leválasztási paraméter függvényében egy, a mérési érzékelőhöz (20) csatlakoztatott vezérlőegységgel (25),

amely kezelési eljárást az jellemzi, hogy az összes fűtőtüskén (6) alkalmazott hőmérséklet-szabályozás céljából magában foglalja, hogy:

- tárolunk legalább egy alapérték-felfutást, amely vezérléssel előidézi a fűtőtüske (6) hőmérsékletének meghatározott mennyiséggel való emelkedését meghatározott időtartamokban,

- irányítjuk a fűtőtüske (6) hőmérsékletének emelkedését az alapérték-felfutást követve, ameddig a leválasztási paraméter egy meghatározott első értéktartományban van,

- lelassítjuk a fűtőtüske (6) hőmérsékletének emelkedését, ha a leválasztási paraméter egy, az első értéktartománytól különböző, meghatározott második értéktartományban van.

2. Az 1. igénypont szerinti kezelési eljárás, amely a talaj (3) melegítése céljából magában foglalja, hogy egy hőálló szemcsékből álló, erősen tömörített port alkalmazunk a kitöltőanyagban (10).

3. Az 1. vagy a 2. igénypont szerinti kezelési eljárás, amely a talaj (3) melegítése céljából magában foglalja, hogy hálózatba rendezünk több fűtőtüskét (6), amely hálózat legalább két sor fűtőtüskéből (6) áll, és valamennyi sor több, egy vonalba állított és egymástól egyenlő távolságra lévő fűtőtüskéből (6) áll, a fűtőtüskék (6) sorai pedig egymással párhuzamosak.

4. Az 1-3. igénypontok bármelyike szerinti kezelési eljárás, amelyben a szennyezőanyagnak van egy gőznyomása, és a kezelési eljárás a talaj (3) melegítése céljából magában foglalja, hogy valamennyi fűtőtüskét (6) olyan hőmérsékletre hozzuk, amelyen elérhető a talajban (3) lévő szennyezőanyag gőznyomása, különösen 400 °C és 1000 °C közötti hőmérsékletre hozzuk.

5. Az 1-4. igénypontok bármelyike szerinti kezelési eljárás, amely a gőzök leválasztása céljából magában foglalja, hogy valamennyi fűtőtüskétől (6) egyenlő távolságra elhelyezünk legalább két extrakciós kutat (16).

6. Az 1-5. igénypontok bármelyike szerinti kezelési eljárás, amely a gőzök leválasztása céljából magában foglalja, hogy a leválasztó rendszert (15) nyomáscsökkentésnek vetjük alá a leválasztó rendszernek (15) egy, az összes extrakciós kúthoz (16) csatlakoztatott szívókészülékén (17) keresztül.

7. Az 1-6. igénypontok bármelyike szerinti kezelési eljárás, amely magában foglalja azonkívül, hogy a leválasztó rendszeren (15) keresztül kezeljük a gőzöket, amely kezelési eljárás különösen magában foglalja, hogy végrehajtjuk a gőzöknek legalább egy, az alábbiak közül kiválasztott kezelését:

- a gőzök újrakondenzálása a leválasztó rendszer (15) egy kondenzációs egységében (30),

- a szennyezőanyag termikus oxidálása, amely magában foglal egy előmelegítést, amelyet oxidáció követ a leválasztó rendszer (15) egy termikus katalízises egységében,

- a szennyezőanyag fotooxidációs kezelése oxidálással kombinált ultraibolya sugárzásos fotolízissel a leválasztó rendszer (15) egy fotokatalízises egységében (35),

- szűrés nedves környezetben a leválasztó rendszer (15) egy bioszűrőjén (45),

- szűrés aktív szénen a leválasztó rendszer (15) egy aktívszén-szűrőjén (50).

8. Az 1-7. igénypontok bármelyike szerinti kezelési eljárás, amely magában foglalja azonkívül, hogy a leválasztó rendszeren (15) keresztül visszanyerjük és kezeljük

a vizet, amely kezelési eljárás különösen magában foglalja, hogy végrehajtjuk a víznek legalább egy, az alábbiak közül kiválasztott kezelését:

- szétválasztás a sűrűség-különbség szerint a leválasztó rendszer (15) egy tartályában (55),

- a vízben oldott szennyezőanyag extrahálása a vízen ellenáramban átáramoltatott folyadékkal a leválasztó rendszer (15) egy sztrippelő készülékében (60),

- szűrés aktív szénen a leválasztó rendszer (15) egy aktívszén-szűrőjén (65).

9. Kezelési berendezés (1) az 1-8. igénypontok bármelyike szerinti kezelési eljárás kivitelezésére, amely kezelési berendezés magában foglal:

- egy villamos melegítőrendszert (5), amellyel felmelegíthető a talaj (3) olyan hőmérsékletre, amelyen a szennyezőanyagot gáz halmazállapotban tartalmazó gőzök hozhatók létre a talajban (3), amely melegítőrendszer (5) magában foglal legalább egy villamos fűtőtüskét (6) és egy villamosenergia-ellátó berendezést (7), valamennyi fűtőtüske (6) magában foglal egy hővezető anyagból készült üreges hüvelyt (8), legalább egy villamos fűtőelemet (9) a hüvelyben (8) elhelyezve, valamint egy villamosan szigetelő és hővezető anyagból készült kitöltőanyagot (10), amely kitöltőanyag (10) kitölti a hüvelyt (8) a fűtőelem (9) körül, valamennyi fűtőtüske (6) hüvelyének (8) rendeltetése, hogy be legyen süllyesztve a talajba (3), valamennyi fűtőtüske (6) fűtőelemének (9) rendeltetése, hogy csatlakoztatva legyen az ellátó berendezéshez (7),

- egy leválasztó rendszert (15), amellyel leválaszthatók a gőzök, amely leválasztó rendszer (15) magában foglal legalább egy extrakciós kutat (16), amelynek rendeltetése, hogy be legyen süllyesztve a talajba (3), a leválasztó rendszer (15) magában foglal legalább egy mérési érzékelőt (20), amellyel mérhető legalább egy, a leválasztó rendszerben (15) lévő gőzökre vonatkozó leválasztási paraméter, például egy, a gőzök koncentrációja, átfolyási sebessége, nyomása és hőmérséklete közül kiválasztott leválasztási paraméter,

- egy vezérlőegységet (25) a mérési érzékelőhöz (20) csatlakoztatva, amellyel hőmérsékletszabályozás végezhető valamennyi fűtőtüskén (6) a leválasztási paraméter függvényében, amely vezérlőegységet (25) az jellemzi, hogy alkalmas:

- tárolni legalább egy alapérték-felfutást, amely vezérléssel előidézi a fűtőtüske (6) hőmérsékletének meghatározott mennyiséggel való emelkedését meghatározott időtartamokban,

- irányítani a fűtőtüske (6) hőmérsékletének emelkedését az alapérték-felfutást követve, ameddig a leválasztási paraméter egy meghatározott első értéktartományban van,

- lelassítani a fűtőtüske (6) hőmérsékletének emelkedését, ha a leválasztási paraméter egy, az első értéktartománytól különböző, meghatározott második értéktartományban van.

10. A 9. igénypont szerinti kezelési berendezés (1), amelyben valamennyi fűtőtüske (6) kitöltőanyaga (10) magában foglal egy hőálló szemcsékből álló, erősen tömörített port.

11. A 9. vagy a 10. igénypont szerinti kezelési berendezés (1), amelyben a leválasztó rendszer (15) magában foglal egy szívókészüléket (17) az összes extrakciós kúthoz (16) csatlakoztatva, amellyel a leválasztó rendszer (15) nyomáscsökkentésnek vethető alá.

12. A 9-11. igénypontok bármelyike szerinti kezelési berendezés (1), amelyben a leválasztó rendszerrel (15) azonkívül kezelhetők a gőzök, amely leválasztó rendszer (15) magában foglal különösen legalább egy, az alábbiak közül kiválasztott, a gőzök (18) kezelésére szolgáló készüléket:

- egy kondenzációs egységet (30), amellyel végrehajtható a gőzök újrakondenzálása,
- egy termikus katalízises egységet, amellyel végrehajtható a szennyezőanyag termikus oxidálása, amely magában foglal egy előmelegítést, amelyet oxidáció követ,
- egy fotokatalízises egységet, amellyel végrehajtható a szennyezőanyag fotooxidációs kezelése, amely magában foglal egy oxidálással kombinált ultraibolya sugárzásos fotolízist,
- egy bioszűrőt (45), amellyel nedves környezetben szűrés hajtható végre,
- egy aktívszén-szűrőt (50), amellyel aktív szénen szűrés hajtható végre.

13. A 9-12. igénypontok bármelyike szerinti kezelési berendezés (1), amelyben a leválasztó rendszerrel (15) azonkívül visszanyerhető és kezelhető a víz, amely leválasztó rendszer (15) magában foglal különösen legalább egy, az alábbiak közül kiválasztott, a víz (19) kezelésére szolgáló készüléket:

- egy tartályt (55), amellyel a sűrűség-különbség szerint szétválasztás hajtható végre,
- egy sztrippelő készüléket (60), amellyel végrehajtható a vízben oldott szennyezőanyag extrahálása a vízen ellenáramban átáramoltatott folyadékkal,
- egy aktívszén-szűrőt (65), amellyel aktív szénen szűrés hajtható végre.

(A meghatalmazott)

Mészárosné Dónusz Katalin
szabadalmi ügyvivő
SBGK Szabadalmi Ügyvivői Iroda
H-1062 Budapest, Andrássy út 113.
Telefon: 461-1000 Fax: 461-1099

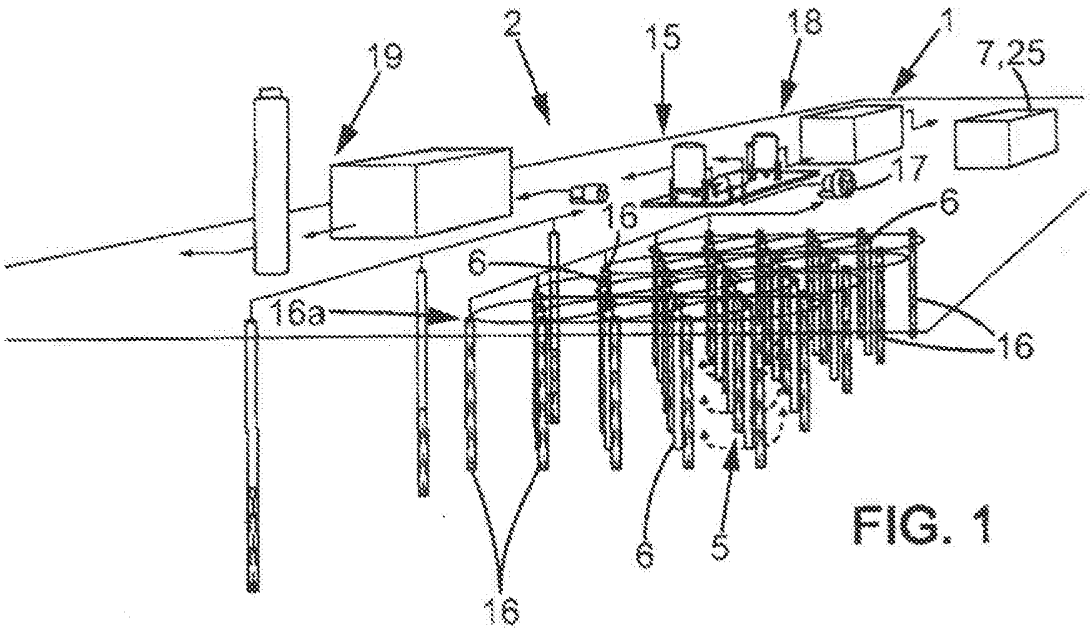


FIG. 1

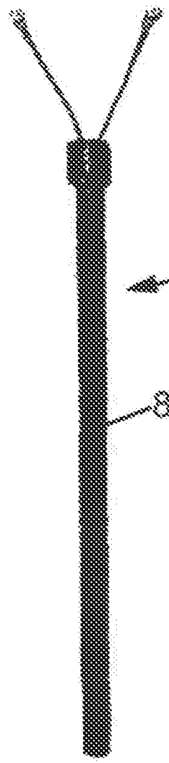


FIG. 2

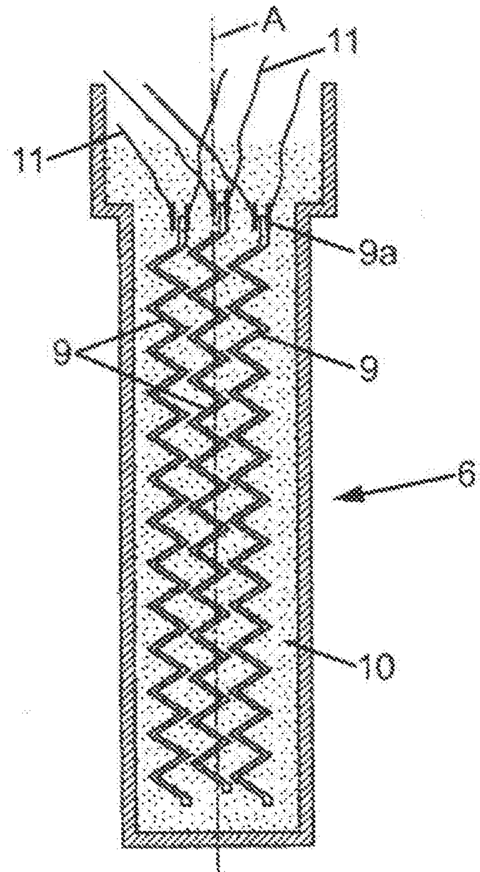


FIG. 3

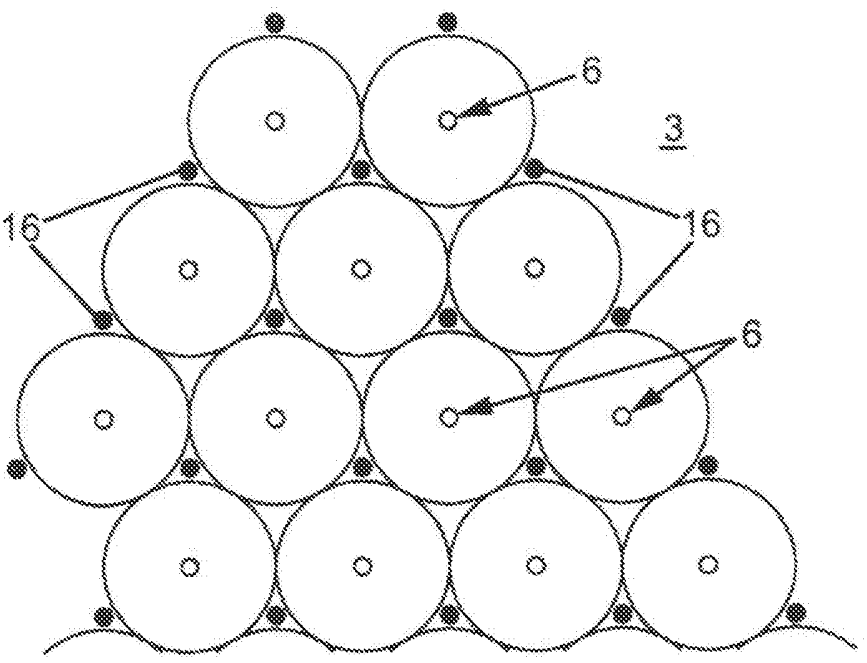


FIG. 4

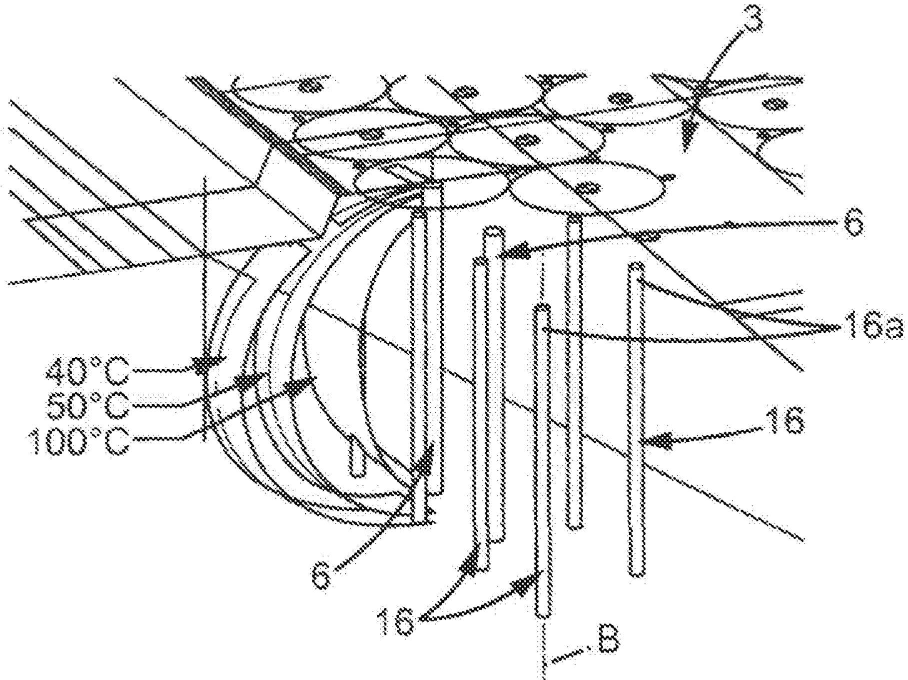


FIG. 5

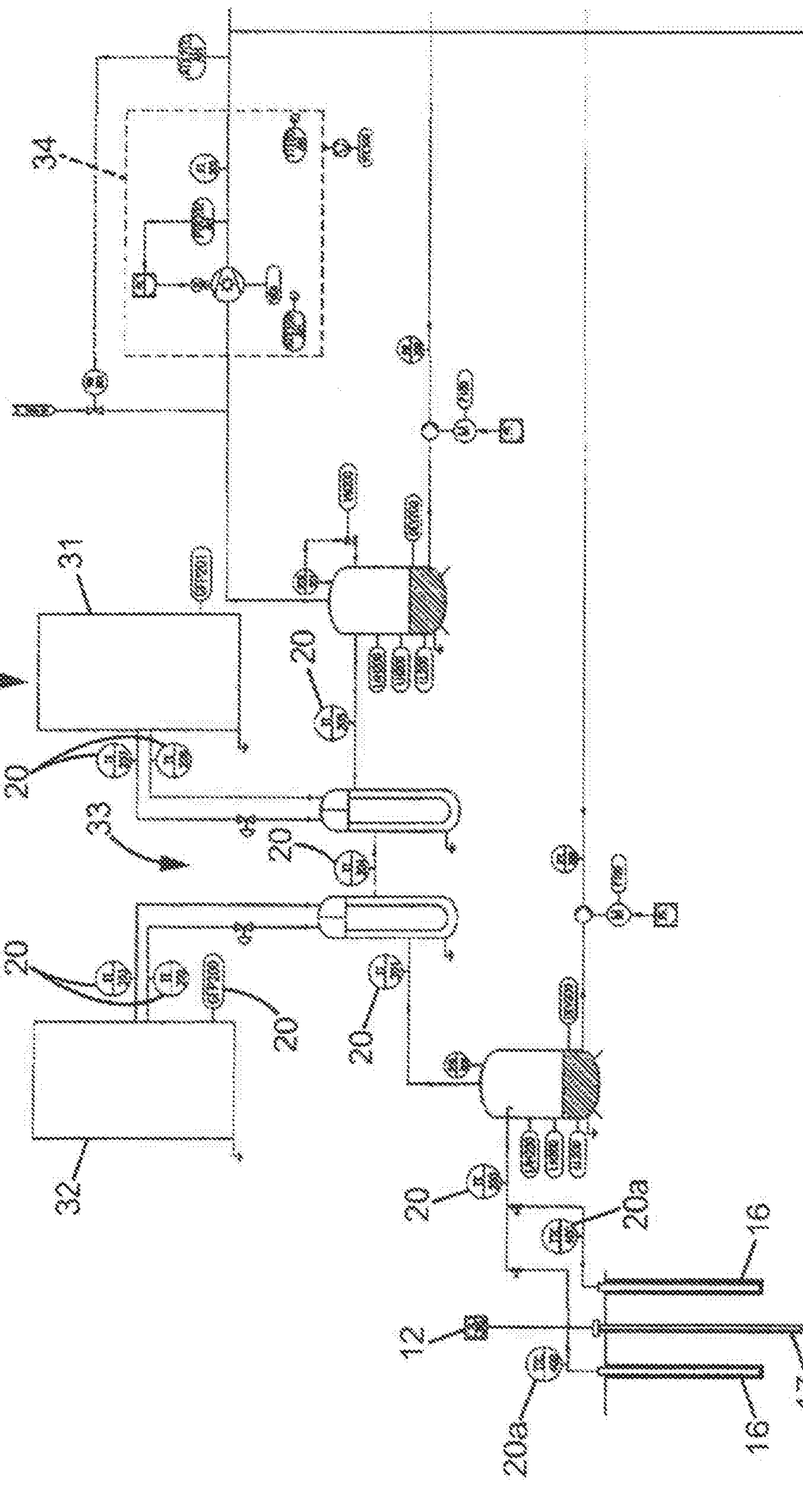


FIG. 6

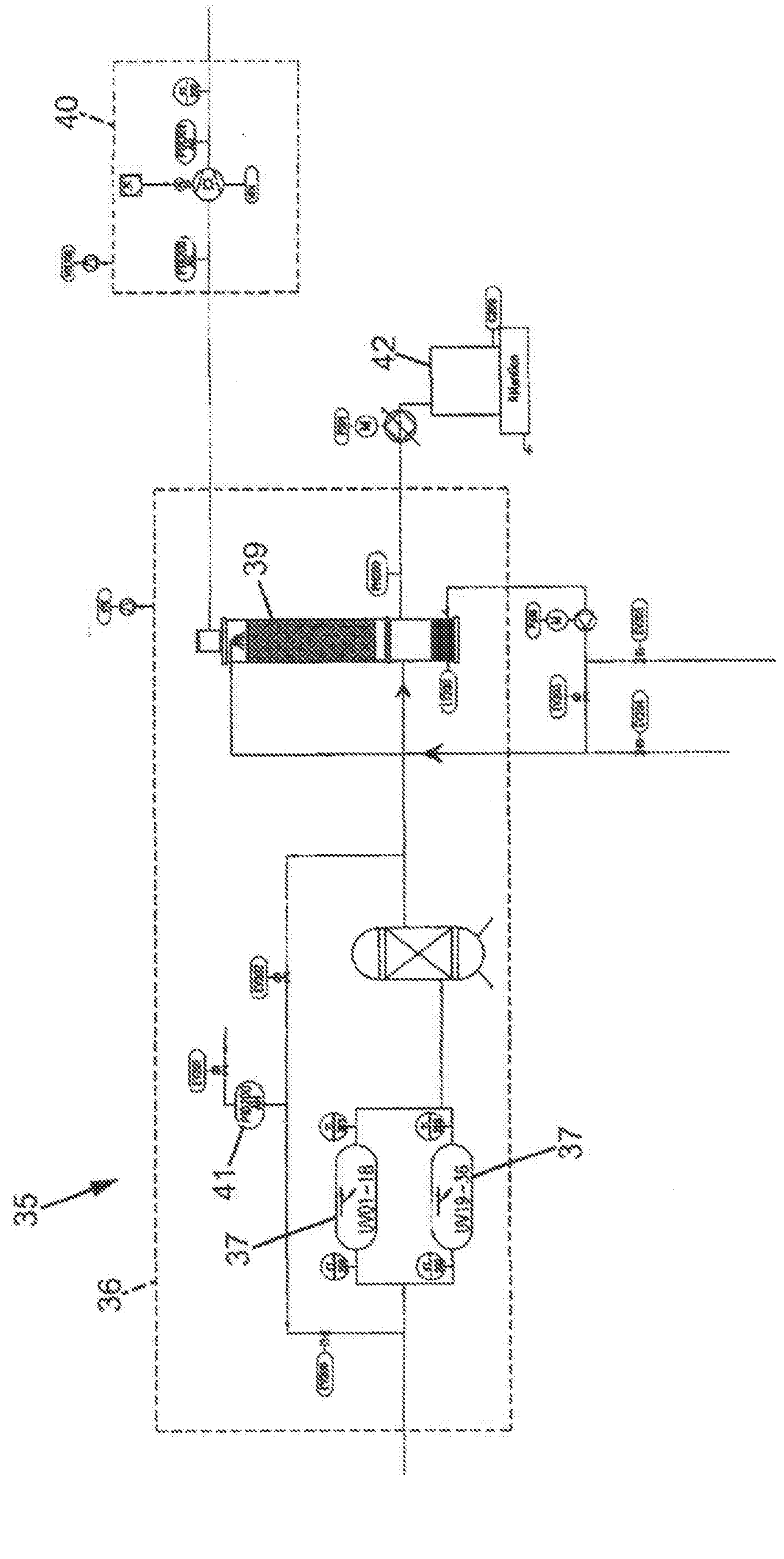


FIG. 7

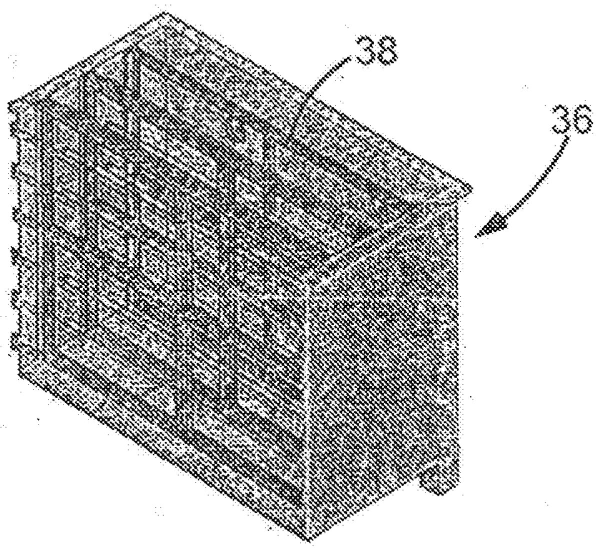


FIG. 8

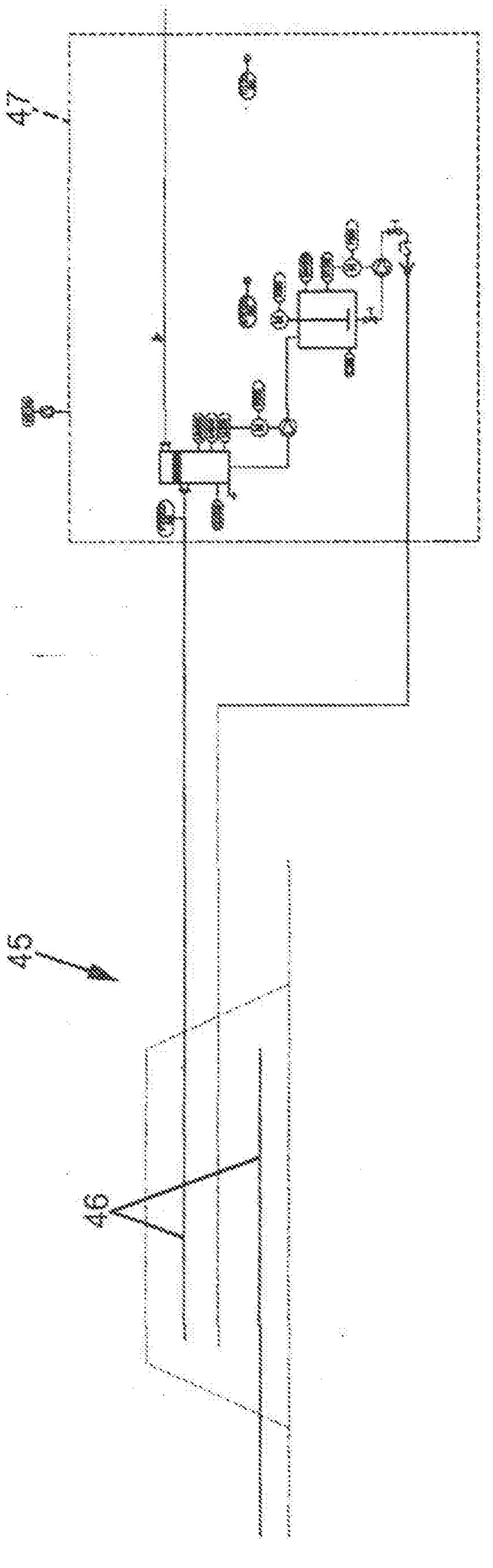


FIG. 9

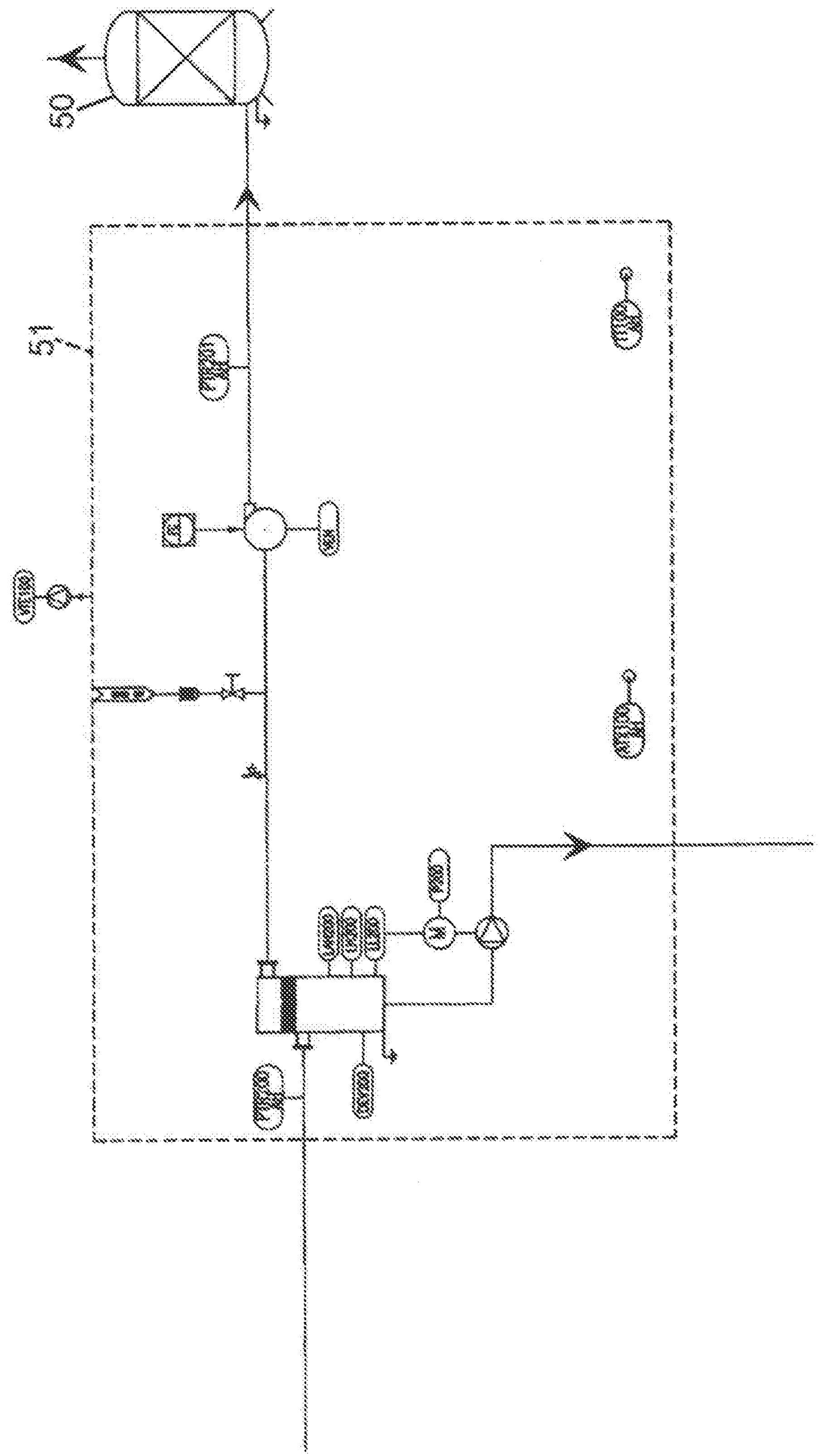


FIG. 10

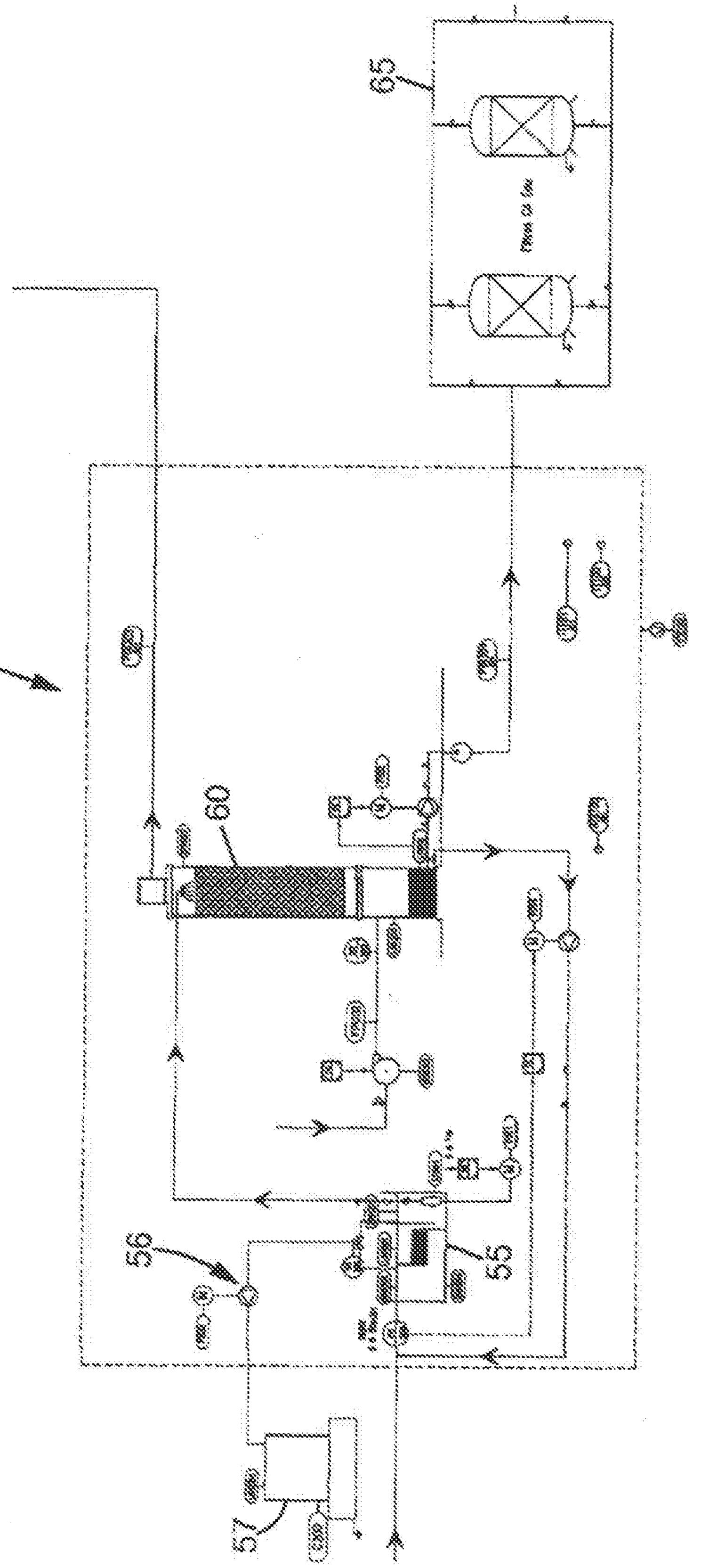


FIG. 11