



(86) Date de dépôt PCT/PCT Filing Date: 2005/02/22

(87) Date publication PCT/PCT Publication Date: 2005/09/09

(45) Date de délivrance/Issue Date: 2014/05/20

(85) Entrée phase nationale/National Entry: 2006/08/22

(86) N° demande PCT/PCT Application No.: EP 2005/001799

(87) N° publication PCT/PCT Publication No.: 2005/083386

(30) Priorité/Priority: 2004/02/27 (DE10 2004 010 217.1)

(51) Cl.Int./Int.Cl. *G01N 1/00* (2006.01),  
*A01C 23/00* (2006.01), *G01N 1/14* (2006.01),  
*G01N 21/31* (2006.01), *G01N 33/487* (2006.01)

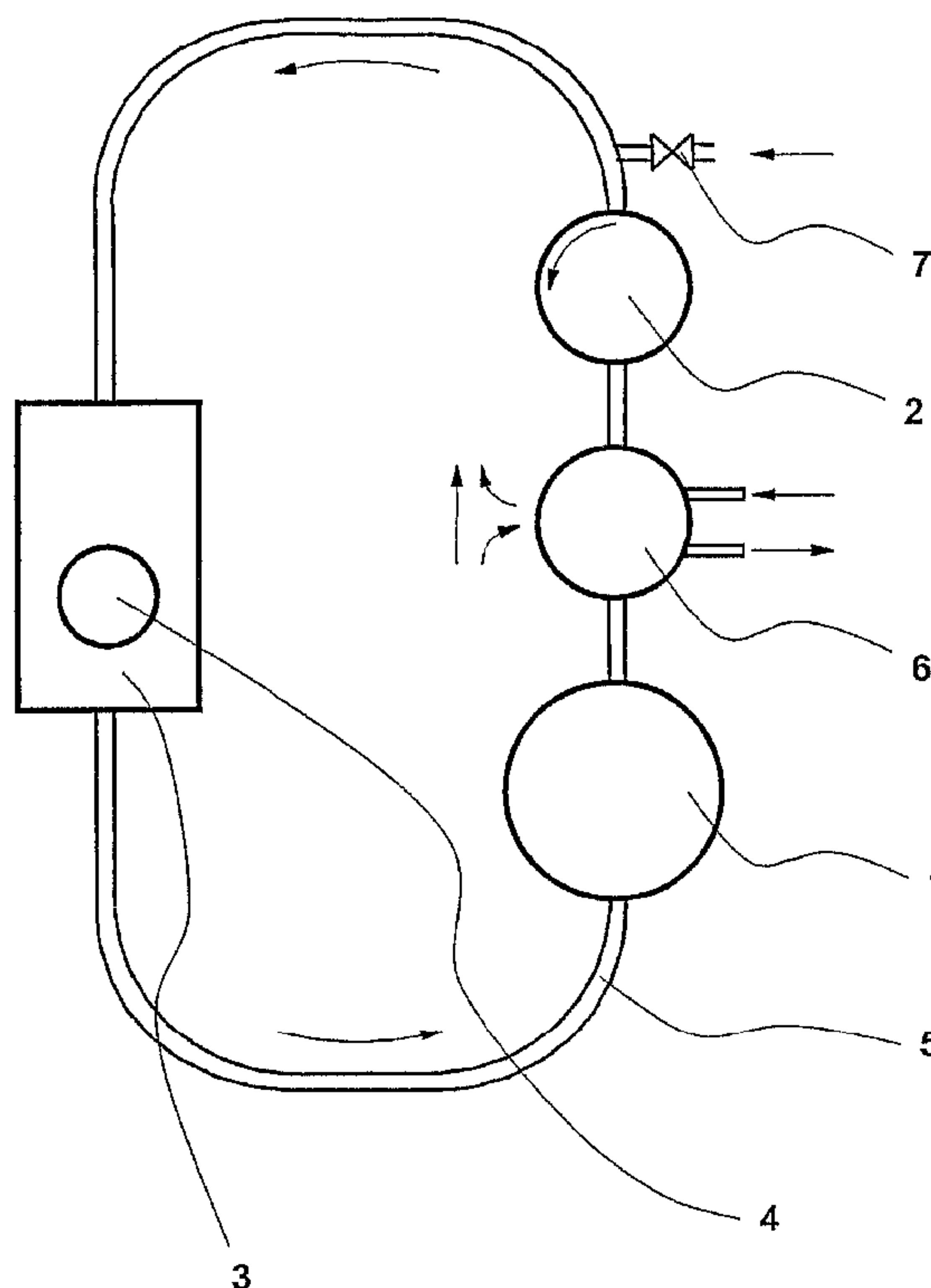
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(54) Titre : ENSEMBLE ET PROCEDE DE DETERMINATION SPECTROSCOPIQUE DES CONSTITUANTS ET DES  
CONCENTRATIONS DE COMPOSES ORGANIQUES APTES AU POMPAGE

(54) Title: SYSTEM AND METHOD FOR THE SPECTROSCOPIC DETERMINATION OF THE COMPONENTS AND  
CONCENTRATIONS OF PUMPABLE ORGANIC COMPOUNDS



(57) Abrégé/Abstract:

The invention relates to a fast and nondestructive measuring method for determining the components of solid, liquid and/or suspended flowing organic compounds. The inventive system comprises a sample container (1), a pump (2) and a measuring cell



**(57) Abrégé(suite)/Abstract(continued):**

(3) which forms an integrity with a spectroscopic measuring head (4). The measuring cell (3) is linked with the pump (2), which can be adjusted to vary the flow rate, and the sample container (1) via a pipe (5). The spectroscopic measuring head (4) and the adjustable pump (2) are electrically connected to a control and evaluation unit. The system works on the principle of transflexion and, due to its compact design, is especially suitable for mobile use, for example for determining the components of manure during its application. In principle, the inventive system and method can be used for any applications that involve suspensions or pumpable, homogeneous and inhomogeneous materials.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES  
PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG(19) Weltorganisation für geistiges Eigentum  
Internationales Büro(43) Internationales Veröffentlichungsdatum  
9. September 2005 (09.09.2005)

PCT

(10) Internationale Veröffentlichungsnummer  
**WO 2005/083386 A1**(51) Internationale Patentklassifikation<sup>7</sup>: **G01N 1/00**,  
33/487, 1/14, 21/31, A01C 23/00

(21) Internationales Aktenzeichen: PCT/EP2005/001799

(22) Internationales Anmeldedatum:  
22. Februar 2005 (22.02.2005)

(25) Einreichungssprache: Deutsch

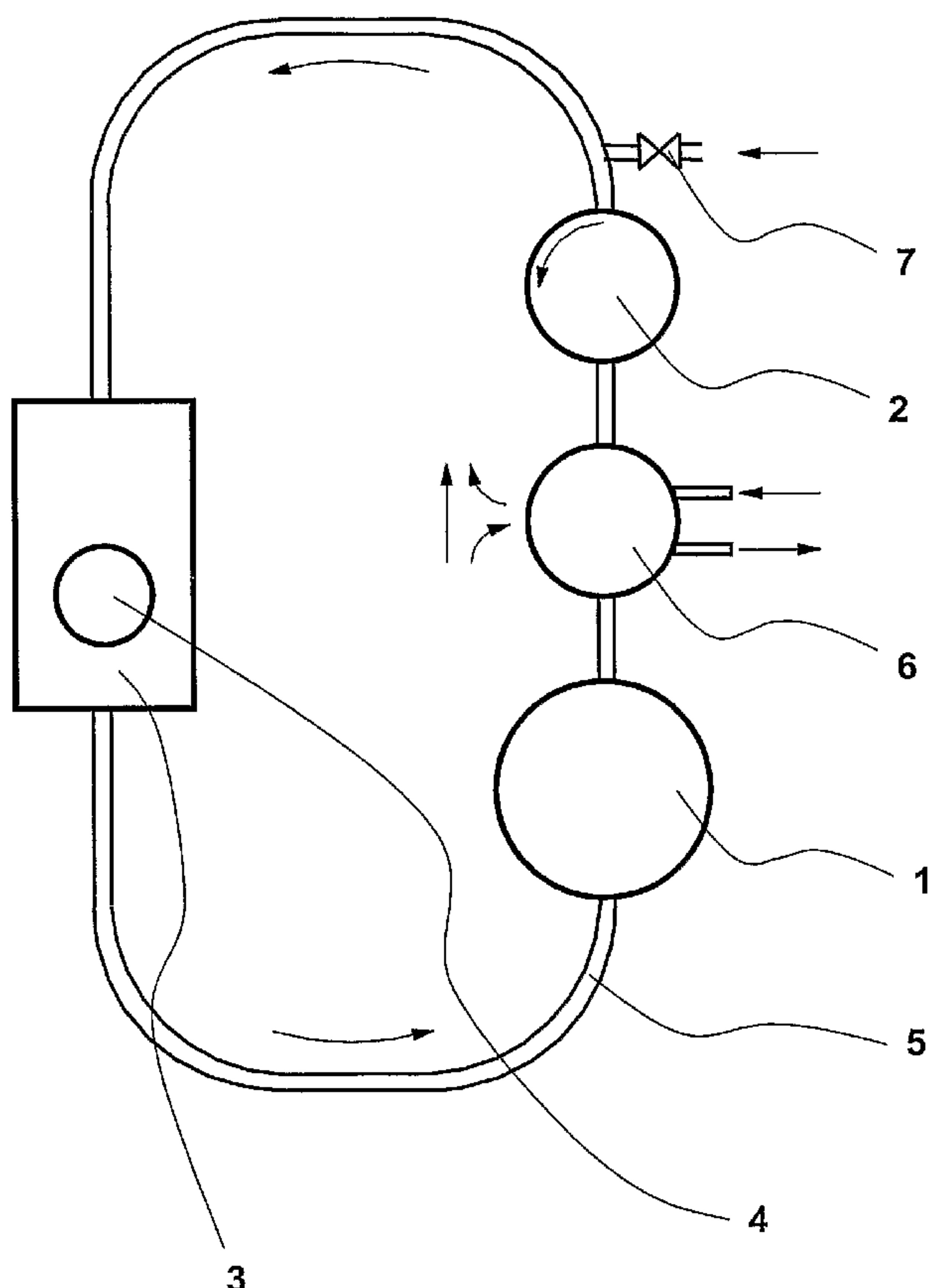
(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:  
10 2004 010 217.1  
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[Fortsetzung auf der nächsten Seite]

(54) Title: SYSTEM AND METHOD FOR THE SPECTROSCOPIC DETERMINATION OF THE COMPONENTS AND CON-  
CENTRATIONS OF PUMPABLE ORGANIC COMPOUNDS(54) Bezeichnung: ANORDNUNG UND VERFAHREN ZUR SPEKTROSKOPISCHEN BESTIMMUNG DER BESTANDTEILE  
UND KONZENTRATIONEN PUMPFÄHIGER ORGANISCHER VERBINDUNGEN(57) Abstract: The invention relates to a fast and nonde-  
structive measuring method for determining the compo-  
nents of solid, liquid and/or suspended flowing organic  
compounds. The inventive system comprises a sample  
container (1), a pump (2) and a measuring cell (3) which  
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tem works on the principle of transflexion and, due to  
its compact design, is especially suitable for mobile use,  
for example for determining the components of manure  
during its application. In principle, the inventive system  
and method can be used for any applications that involve  
suspensions or pumpable, homogeneous and inhomoge-  
neous materials.(57) Zusammenfassung: Die vorliegende Erfindung  
betrifft ein schnelles und zerstörungsfreies Mess-  
verfahren zur Bestimmung der Inhaltstoffe fester,  
flüssiger und/oder suspensiver organischer im Fluss  
befindlicher Verbindungen. Die erfindungsgemäße  
Anordnung besteht aus einem Probenbehälter (1),  
einer Pumpe (2) und einer Messzelle (3), die mit einem  
spektroskopischen Messkopf (4) eine Einheit bildet,  
wobei die Messzelle (3) mit der Pumpe (2), die zur  
Variation der Fließgeschwindigkeit regelbar ist, und dem

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(81) **Bestimmungsstaaten** (soweit nicht anders angegeben, für jede verfügbare nationale Schutzrechtsart): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) **Bestimmungsstaaten** (soweit nicht anders angegeben, für jede verfügbare regionale Schutzrechtsart): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG,

ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Veröffentlicht:**

— mit internationalem Recherchenbericht

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

Probenbehälter (1) über eine Rohrleitung (5) verbunden sind und bei der der spektroskopische Messkopf (4) und die regelbare Pumpe (2) zu einer Steuer- und Auswerteeinheit elektrische Verbindungen aufweisen. Die nach dem Transflexionsprinzip arbeitende Lösung ist durch den kompakten Aufbau insbesondere auch für den mobilen Einsatz geeignet, beispielsweise zur Bestimmung der Inhaltsstoffe von Gülle während des Ausbringens. Prinzipiell lässt sich die Lösung auf beliebige Anwendungen mit Suspensionen bzw. pumpfähige, homogene und inhomogene Materialien übertragen.



## SYSTEM AND METHOD FOR THE SPECTROSCOPIC DETERMINATION OF THE COMPONENTS AND CONCENTRATIONS OF PUMPABLE ORGANIC COMPOUNDS

[0001] The present invention is directed to a fast, nondestructive measurement method for determining the substances contained in solid, liquid and/or suspended flowing organic compounds. The proposed solution is suitable for calibration to a large number of relevant parameters and can be used in all fields, particularly also in a mobile manner.

[0002] The through-flow measurement cuvette described in DE 100 16 023 C2 is suitable for the combined use of spectroscopy and polarimetry for the simultaneous determination of a plurality of measured quantities in physical-chemical and bio-technical processes. In particular, substances dissolved in flowing media can be detected continuously and without a delay in time and can be quantitatively determined. Wavelengths in the UV region to the NIR region can be used for spectroscopic measurement. The measurement path is located between two rods of glass, or the like, projecting into the measurement cuvette transverse to the flow direction. Depending on the substance to be investigated, the measurement path must be varied by displacing the rods because measurements can only be carried out by transmission. However, this makes it more difficult or impossible to use the through-flow measurement cuvettes for automated, mobile use.

[0003] The determination of the contents of liquid manure, for example, with a view to the precise use thereof as organic fertilizer, is particularly important. Heretofore, the applicable guidelines in this case with regard to the maximum amount to be dispensed could be adhered to only with difficulty because an exact determination of the components and concentrations at the moment of dispensing was impossible. It was only possible to monitor adherence to guidelines through soil analyses before or after dispensing.

[0004] According to the known prior art, the determination of the contained substances is carried out after taking samples by subsequent wet chemical measurements in the laboratory. This method is time-consuming and requires extensive preparation of samples. The quantity of samples is limited, and the analysis data can be used for controlling and/or regulating processes in a timely manner only to a limited extent if at all. When the measurement is

carried out in through-flow cells with conventional sensors, only the contents that are measurable selectively by the respective sensors can be detected.

[0005] A project ("Analysis of Nutrients in Hog Manure by Field-portable Near-infrared Spectroscopy", July 2001) conducted by PDK Projects, Inc., documents the use of NIR spectroscopy for determining components and concentrations of organic waste. However, the results of this project relate only to the use of spectroscopic measuring instruments under laboratory use. The samples to be determined were placed on the spectroscopic measurement head for this purpose. A compact solution for a possible mobile use on a vehicle for dispensing liquid manure was not the aim of the project.

[0006] It is the object of the present invention to develop a fast, nondestructive measurement method and a corresponding arrangement for determining the components of solid, liquid and/or suspended organic waste. The solution is suitable for mobile use, and a high, continuous measurement data density can be realized.

[0006a] A preferred embodiment of the invention of the invention relates to an arrangement for the spectroscopic determination of the components and concentrations of a pumpable material, comprising a sample vessel, a pump, and a measurement cell with a spectroscopic measurement head, wherein the measurement cell is connected to the sample vessel by a pipe, and wherein the spectroscopic measurement head has electrical connections to a controlling and evaluating unit, the controlling and evaluating unit being set up to determine components and concentrations of substances contained in a sample and to regulate a mass flow of an outlet valve provided in an outlet line of a vessel based on the determined components and concentrations of substances contained in the sample.

[0007] Another preferred embodiment of the invention relates to an arrangement for the spectroscopic determination of the components and concentrations of pumpable material, comprising a sample vessel, a regulable pump, and a measurement cell with a spectroscopic measurement head, wherein the measurement cell is connected to the regulable pump, which can be



regulated to vary the flow rate, and to the sample vessel by a pipe, and wherein the spectroscopic measurement head and the regulable pump have electrical connections to a controlling and evaluating unit, the controlling and evaluating unit being set up to determine components and concentrations of substances contained in a sample and to regulate a mass flow of an outlet valve provided in an outlet line of a vessel based on the determined components and concentrations of substances contained in the sample. More preferably, the pumpable material maybe an organic waste.

[0008] Another preferred embodiment of the invention relates to an arrangement as defined hereinbefore, wherein the measurement cell is constructed in such a way that the sample flows between two oppositely located windows which are integrated in the measurement cell perpendicular to a direction of flow.

[0009] Another preferred embodiment of the invention relates to an arrangement as defined hereinbefore, wherein a multi-port valve is arranged in the pipe to produce connections to at least one of a water vessel and a cleaning liquid vessel.

[0010] Another preferred embodiment of the invention relates to an arrangement as defined hereinbefore, wherein the multi-port valve arranged in the pipe further produce connections to one or more vessels with test liquids for self calibration.

[0011] Another preferred embodiment of the invention relates to an arrangement as defined hereinbefore, wherein the multi-port valve has an actuating drive which is connected to the controlling and evaluating unit.

[0012] Another preferred embodiment of the invention relates to an arrangement as defined hereinbefore, wherein a device is further provided for drying the measurement cell and is connected to the controlling and evaluating unit.

[0013] Another preferred embodiment of the invention relates to an arrangement as defined hereinbefore, wherein a device is further provided for

regulating the temperature of the sample and is connected to the controlling and evaluating unit.

[0014] Another preferred embodiment of the invention relates to an arrangement as defined hereinbefore, wherein the arrangement is connected to the outlet line of the vessel by two three-way directional valves, said outlet line of the vessel being arranged on a vehicle.

[0015] Another preferred embodiment of the invention relates to an arrangement as defined hereinbefore, wherein the arrangement is mounted in its entirety on a vehicle for dispensing the pumpable material.

[0015a] Another embodiment of the invention relates to a method for the spectroscopic determination of the components and concentrations of a pumpable material, wherein a sample contained in a sample vessel is pumped by a pump through a measurement cell with a spectroscopic measurement head, the measurement head carries out a spectroscopic measurement of the sample flowing through the measurement cell using the principle of transmission and/or reflection, and the measurement results are conveyed for further processing to a controlling and evaluating unit which determines components and concentrations of substances contained in the sample based on stored specific calibrations, and a mass flow of an outlet valve provided in an outlet line of a vessel is regulated based on the determined components and concentrations of substances contained in the sample.

[0016] Another preferred embodiment of the invention relates to a method for the spectroscopic determination of the components and concentrations of a pumpable material, wherein a sample contained in a sample vessel is pumped by a pump through a measurement cell with a spectroscopic measurement head, the measurement head carries out a spectroscopic measurement of the sample flowing through the measurement cell using the principle of transflection, and the measurement results are conveyed for further processing to a controlling and evaluating unit which determines components and concentrations of substances contained in the sample based on stored specific calibrations, and a mass flow of an outlet valve provided in an outlet line of a vessel is regulated based on the



determined components and concentrations of substances contained in the sample. More preferably, the pumpable material may be an organic waste.

[0017] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein the pump can be regulated to ensure a flow rate of the sample required for the spectroscopic measurement.

[0018] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein an existing water vessel is connected to the measurement cell by a multi-port valve in order to remove residues of the measured sample from the measurement cell and prepare the measurement cell for a next sample.

[0019] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein an existing water vessel and a vessel with cleaning liquid are connected successively to the measurement cell by a multi-port valve in order to clean out residues of the measured sample from the measurement cell, rinse the measurement cell, and prepare the measurement cell for a next sample.

[0020] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein residual moisture is removed from the measurement cell by a device for drying after the measurement cell has been cleaned.

[0021] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein one or more vessels with test liquids for self-calibration of an arrangement as defined above can be connected to the measurement cell by a multi-port valve.

[0022] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein at least one of a cleaning and drying of the measurement cell and optionally a temperature regulation of the sample are/is controlled by the controlling and evaluating unit.

## 5a

[0023] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein the sample can be temperature-controlled by a device to prevent the influence of temperature on the measurement results.

[0024] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein the measurement head carries out a spectroscopic measurement of the measurement cell without the sample in order to determine a degree of contamination of the measurement cell.

[0025] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein the sample to be measured is taken from an outlet line of the sample vessel, said outlet line of the sample vessel being arranged on a vehicle, by a first three-way directional valve arranged in a pipe and is conveyed back into the outlet line by a second three-way directional valve arranged in the pipe after being measured.

[0026] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein an additional control signal is generated by the controlling and evaluating unit based on the determined components and concentrations of substances contained in the sample for regulating the flow through the outlet valve when dispensing the pumpable material.

[0027] Another preferred embodiment of the invention relates to a method as defined hereinbefore, wherein previously determined soil values and the instantaneous speed of the vehicle are taken into account by the controlling and evaluating unit in addition to the determined components and concentrations of substances contained in the sample in order to generate a control signal for regulating the flow through the outlet valve while dispensing the pumpable material.



[0028] The proposed technical solution delivers representative measurement values of the components of inhomogeneous material using the through-flow method, wherein direct measurement is carried out by light absorption or light transmission. Using the principle of transflection, it is possible to carry out measurements on highly absorbent samples as well as transmissive samples, i.e., also turbid suspensions, and to detect liquid components as well as solid components of the sample.

[0029] Due to the compact construction, the solution is also particularly suitable for mobile use for determining the components of solid, liquid and/or  
10 suspended organic compounds.

[0030] For example, the solution can be used to determine the components of liquid manure and organic fertilizers. By determining the components of the fertilizer in situ, particularly also while it is being dispensed, the fertilizer can be metered in a purposeful manner depending on the directly determined components.

[0031] In principle, the proposed technical solution can be transferred to any applications with suspensions or pumpable, homogeneous and inhomogeneous materials. In particular, the invention can conceivably be applied in the foodstuffs industry, sewage control, and process monitoring, e.g., in meat processing and in the production of biogas.

20 [0032] The invention will be described more fully in the following with reference to an embodiment example.

[0033] Figure 1 shows a schematic diagram of the arrangement according to the invention for use in the laboratory; and

[0034] Figure 2 shows an arrangement which is adapted for mobile use in a vehicle.

[0035] Figure 1 shows the arrangement according to the invention for spectroscopic determination of the components and concentrations of pumpable organic compounds. The arrangement comprises a sample vessel 1, a pump 2, and a measurement cell 3 which, together with a spectroscopic measurement head 4,



form a unit. The measurement cell 3 is connected to the pump 2, which can be regulated to vary the flow rate, and to the sample vessel 1 by a pipe 5. The spectroscopic measurement head 4 and the regulatable pump 2 have electrical connections to a controlling and evaluating unit (not shown).

[0036] The measurement cell 3 is preferably constructed in such a way that the sample flows between two windows which are integrated in the measurement cell opposite one another and perpendicular to the direction of flow. As the sample flows through the measurement cell 3, it must be ensured that no sedimentation, foaming or clogging occurs. The optimal flow rate varies depending on the type of sample as a function of solids content, particle size, particle structure, and thixotropy.

[0037] In order to clean the measurement cell 3 of residues from the measured sample and prepare it for the next sample, a multi-port valve 6 is provided which produces connections to a water vessel and/or a vessel with cleaning liquid. The multi-port valve 6 has an actuating drive which is connected to the controlling and evaluating unit. By means of this multi-port valve 6, the measurement cell can be additionally connected to vessels containing test liquids for self-calibration of the measurement arrangement.

[0038] The cleaning liquid and rinsing water can be expelled via the multi-port valve 6 after rinsing the measurement cell 3. A repeated rinsing of the measurement cell 3 is advantageous.

[0039] The degree of contamination and any cleaning of the measurement cell 3 that may be necessary can be determined by a spectroscopic measurement of the measurement cell 3 without the sample.

[0040] Further, the arrangement can have a device for drying the measurement cell 3, which device is likewise connected to the controlling and evaluating unit. Drying is carried out, for example, by aeration in that air is pressed through the measurement cell 3 by means of a valve 7. The air can also be expelled via the multi-port valve 6 after flowing through the measurement cell 3.

[0041] Since it must be assumed that the measurement results are affected by temperature, a device for maintaining the temperature of the sample is provided, preferably in or in front of the measurement cell 3.

[0042] In an advantageous development, the arrangement is mounted on a vehicle particularly for dispensing pumpable organic waste.

[0043] Figure 2 shows an arrangement which is adapted for this purpose for mobile use on a vehicle. To this end, two additional three-way directional valves 8 and 9 are arranged in the pipe 5. In order to determine the components and concentrations while dispensing, a sample is taken from the outlet line of the tank by means of the three-way directional valve 8, pumped through the measurement cell 3, and guided back into the outlet line of the tank by the three-way directional valves 9. The three-way directional valves 8 and 9 preferably likewise have actuating drives which are connected to the controlling and evaluating unit. The sample vessel 1 can remain in the arrangement during this period so that a closed circuit is provided for the rinsing and/or drying process.

[0044] The flow volume of an output valve provided at the tank can be regulated by the controlling and evaluating unit by evaluating the determined components and concentrations of the pumpable organic waste. In addition to the determined components and concentrations of substances contained in the sample, previously determined soil values and the instantaneous speed of the vehicle can also be taken into account by the controlling and evaluating unit to generate a suitable control signal for regulating the flow through an outlet valve while dispensing pumpable organic waste. In this way, fertilization can be carried out corresponding to the requirements of the soil.

[0045] Since the particle size of organic waste varies sharply and in some cases can lead to clogging, a cutting mechanism and/or sieve are/is advisably arranged in front of the pump 2. Particles which are too large can be made smaller in this way without changing the composition of the sample.



[0046] Determining the components of liquid manure is particularly important, for example, with a view to a precise use as organic fertilizer. In order to adhere to the applicable guidelines, it is useful to document the output amount of organic waste with respect to the components and concentrations of individual ingredients. In this way, it is easy to verify the amount of organic waste that has been dispensed.

[0047] In the method according to the invention for the spectroscopic determination of the components and concentrations of pumpable organic waste, the sample contained in a sample vessel 1 is pumped by a pump 2 through a measurement cell 3 which forms a unit with the spectroscopic measurement head 4. The measurement head 4 carries out a spectroscopic measurement of the sample flowing through the measurement cell 3 by transmission and/or reflection and conveys the measurement results for further processing to a controlling and evaluating unit. This controlling and evaluating unit determines components and concentrations of substances contained in the sample based on stored specific calibrations. Temperature-dependent, flow-dependent and sample-dependent specific calibrations are required for this purpose.

[0048] The measurement cell 3 is preferably constructed in such a way that the sample flows between two windows which are integrated opposite one another in the measurement cell perpendicular to the flow direction. The pump 2 can be regulated for adjusting the flow rate of the sample required for the spectroscopic measurement. In this way, it can be ensured that no sedimentation, foaming or clogging occurs as the sample passes through the measurement cell 3. The optimal flow rate varies depending on the type of sample as a function of solids content, particle size, particle structure, and thixotropy.

[0049] To prevent corruption of measurement values, the measurement cell 3 is cleaned after measuring a sample. For this purpose, an existing water vessel is connected to the measurement cell 3 by a multi-port valve 6 in order to remove residues of the measured sample. However, it is also possible to provide an



additional vessel with cleaning liquid which is connected to the measurement cell 3 by the multi-port valve 6. After cleaning, the measurement cell 3 is rinsed with water. In some cases, drying of the measurement cell 3 is required after cleaning and rinsing. The drying is carried out by aeration in that air is pressed through the measurement cell 3 by means of a valve 7.

[0050] To prevent the influence of temperature on the measurement results, the samples can be temperature-controlled prior to the measurement process by means of a device. This should preferably be carried out in or in front of the measurement cell 3.

10 [0051] In an advantageous construction, the described method can be applied to a vehicle, particularly for dispensing pumpable organic waste. Based on the determined components and concentrations of substances contained in the sample, an additional signal is generated by the controlling and evaluating unit for regulating the flow through an outlet valve while dispensing pumpable organic waste.

[0052] In a particularly advantageous solution, previously determined soil values and the instantaneous speed of the vehicle are taken into account by the controlling and evaluating unit in addition to the determined components and concentrations of substances contained in the sample in order to generate a control  
20 signal for regulating the flow through an outlet valve when dispensing pumpable organic waste.

[0053] In this way, liquid manure can be dispensed as organic fertilizer in an even more purposeful manner. Purposeful metering is made possible by means of the previously determined soil values particularly while dispensing.

[0054] The special advantage of the proposed technical solution consists in that it is possible to carry out determinations of components and concentrations of substances contained in the sample in a stationary manner (at-line from sample vessels) or in a mobile manner (in-line while dispensing organic waste).

[0055] Further, spectroscopic measurement according to the principle of transflection is particularly advantageous. In this way, it is possible to carry out a direct measurement of the sample through light absorption and/or light transmission without having to change the measurement construction. Depending on the sample to be measured, specifically the solid, liquid and/or suspended organic waste contained therein, the measurement delivers transmission and/or reflection measurement results.

[0056] The process of cleaning, rinsing and drying the measurement cell in order to prepare it for the measurement of other samples can be automated and regulated and monitored by the controlling and evaluating unit. The process of  
10 cleaning, rinsing and drying can be monitored by spectroscopy. With reference to existing reference standards, the degree of contamination and the relative humidity of the measurement cell can be determined by the measurement head in connection with the controlling and evaluating unit.

[0057] When the "cell dry" state is detected, referencing is carried out through automatic white/black calibration of the spectrometer by means of conventional known reference standards. Referencing of this kind can be carried out periodically or as needed. The degree of contamination of the measurement cell can also be monitored by the system itself.

20 [0058] The solution according to the invention also offers the possibility of self-calibration. After the process of cleaning, rinsing and drying has been regulated and monitored by the controlling and evaluating unit, one or more test liquids of defined composition and known absorption or transmission can also be introduced into the measurement cell by means of the multi-port valve. The spectroscopic signal can be calibrated and adjusted on the basis of this calibration liquid. A consistently high measurement accuracy of the system can be achieved in this way. Also, the test liquids used in this case can be expelled via the multi-port valve 6 after the measurement cell 3 is rinsed out.

[0059] Complete partial samples or complete batches can be measured continuously with the solution according to the invention without requiring preprocessing of the samples. The samples are not changed by the measurement process. The solution can be calibrated to a large number of relevant parameters and delivers a fast analysis with high measurement data density. Due to the very compact and robust construction, the solution is particularly suited to mobile use.

[0060] The solution is suitable for both in-line and at-line determination of the components of solid, liquid and/or suspended organic waste due to the fast and continuous detection of measurement values.



**WHAT IS CLAIMED IS:**

1. Arrangement for the spectroscopic determination of the components and concentrations of a pumpable material, comprising a sample vessel (1), a pump (2), and a measurement cell (3) with a spectroscopic measurement head (4), wherein the measurement cell (3) is connected to the sample vessel (1) by a pipe (5), and wherein the spectroscopic measurement head (4) has electrical connections to a controlling and evaluating unit, the controlling and evaluating unit being set up to determine components and concentrations of substances contained in a sample and to regulate a mass flow of an outlet valve provided in an outlet line of a vessel  
10 based on the determined components and concentrations of substances contained in the sample.
2. Arrangement according to claim 1, wherein the measurement cell (3) is constructed in such a way that the sample flows between two oppositely located windows which are integrated in the measurement cell (3) perpendicular to a direction of flow.
3. Arrangement according to any one of claims 1 to 2, wherein a multi-port valve (6) is arranged in the pipe (5) to produce connections to at least one of a water vessel and a cleaning liquid vessel.
4. Arrangement according to claim 3, wherein the multi-port valve (6) arranged  
20 in the pipe (5) further produce connections to one or more vessels with test liquids for self-calibration.
5. Arrangement according to anyone of claims 3 to 4, wherein the multi-port valve (6) has an actuating drive which is connected to the controlling and evaluating unit.

6. Arrangement according to any one of claims 1 to 5, wherein a device is further provided for drying the measurement cell (3) and is connected to the controlling and evaluating unit.
7. Arrangement according to any one of claims 1 to 6, wherein a device is further provided for regulating the temperature of the sample and is connected to the controlling and evaluating unit.
8. Arrangement according to anyone of claims 1 to 7, wherein the arrangement is connected to the outlet line of the vessel by two three-way directional valves (8, 9), said outlet line of the vessel being arranged on a vehicle.
- 10 9. Arrangement according to anyone of claims 1 to 8, wherein the arrangement is mounted in its entirety on a vehicle for dispensing the pumpable material.
10. Method for the spectroscopic determination of the components and concentrations of a pumpable material, wherein a sample contained in a sample vessel is pumped by a pump (2) through a measurement cell (3) with a spectroscopic measurement head (4), the measurement head (4) carries out a spectroscopic measurement of the sample flowing through the measurement cell using the principle of transmission and/or reflection, and the measurement results are conveyed for further processing to a controlling and evaluating unit which determines components and concentrations of substances contained in the sample  
20 based on stored specific calibrations, and a mass flow of an outlet valve provided in an outlet line of a vessel is regulated based on the determined components and concentrations of substances contained in the sample.
11. Method according to claim 10, wherein the pump (2) can be regulated to ensure a flow rate of the sample required for the spectroscopic measurement.

12. Method according to any one of claims 10 to 11, wherein an existing water vessel is connected to the measurement cell (3) by a multi-port valve (6) in order to remove residues of the measured sample from the measurement cell (3) and prepare the measurement cell (3) for a next sample.

13. Method according to any one of claims 10 to 11, wherein an existing water vessel and a vessel with cleaning liquid are connected successively to the measurement cell (3) by a multi-port valve (6) in order to clean out residues of the measured sample from the measurement cell (3), rinse the measurement cell (3), and prepare the measurement cell (3) for a next sample.

10 14. Method according to any one of claims 10 to 13, wherein residual moisture is further removed from the measurement cell (3) by a device for drying after the measurement cell (3) has been cleaned.

15. Method according to any one of claims 10 to 14, wherein one or more vessels with test liquids for self-calibration of an arrangement as defined in any one of claims 1 to 9 can be connected to the measurement cell (3) by a multi-port valve (6).

16. Method according to any one of claims 10 to 15, wherein at least one of a cleaning and drying of the measurement cell (3) are/is controlled by the controlling and evaluating unit.

20 17. Method according to any one of claims 10 to 15, wherein at least one of a cleaning and drying of the measurement cell (3) and a temperature regulation of the sample are/is controlled by the controlling and evaluating unit.

18. Method according to any one of claims 10 to 15, wherein the sample is further temperature-controlled by a device to prevent the influence of temperature on the measurement results.



19. Method according to any one of claims 10 to 18, wherein the measurement head (4) carries out a spectroscopic measurement of the measurement cell without the sample in order to determine a degree of contamination of the measurement cell (3).

20. Method according to any one of claims 10 to 19, wherein the sample to be measured is taken from an outlet line of the sample vessel, said outlet line of the sample vessel being arranged on a vehicle, by a first three-way directional valve (8) arranged in a pipe (5) and is conveyed back into the outlet line by a second three-way directional valve (9) arranged in the pipe (5) after being measured.

10 21. Method according to claim 20, wherein an additional control signal is generated by the controlling and evaluating unit based on the determined components and concentrations of substances contained in the sample for regulating the flow through the outlet valve when dispensing the pumpable material.

22. Method according to any one of claims 20 to 21, wherein previously determined soil values and the instantaneous speed of the vehicle are taken into account by the controlling and evaluating unit in addition to the determined components and concentrations of substances contained in the sample in order to generate a control signal for regulating the flow through the outlet valve while dispensing the pumpable material.

20 23. Method according to any one of claims 10 to 22, wherein the pumpable material is a pumpable organic waste.

24. Method for the spectroscopic determination of the components and concentrations of a pumpable material, wherein a sample contained in a sample vessel is pumped by a pump (2) through a measurement cell (3) with a spectroscopic measurement head (4), the measurement head (4) carries out a spectroscopic measurement of the sample flowing through the measurement cell

using the principle of transmission and/or reflection, and the measurement results are conveyed for further processing to a controlling and evaluating unit which determines components and concentrations of substances contained in the sample based on stored specific calibrations, and a mass flow of an outlet valve provided in an outlet line of a vessel is regulated based on the determined components and concentrations of substances contained in the sample and wherein the sample to be measured is taken from an outlet line of the sample vessel, said outlet line of the sample vessel being arranged on a vehicle, by a first three-way directional valve (8) arranged in a pipe (5) and is conveyed back into the outlet line by a second three-way directional valve (9) arranged in the pipe (5) after being measured.

25. Method according to claim 24, wherein the pump (2) can be regulated to ensure a flow rate of the sample required for the spectroscopic measurement.

26. Method according to any one of claims 24 to 25, wherein an existing water vessel is connected to the measurement cell (3) by a multi-port valve (6) in order to remove residues of the measured sample from the measurement cell (3) and prepare the measurement cell (3) for a next sample.

27. Method according to any one of claims 24 to 25, wherein an existing water vessel and a vessel with cleaning liquid are connected successively to the measurement cell (3) by a multi-port valve (6) in order to clean out residues of the measured sample from the measurement cell (3), rinse the measurement cell (3), and prepare the measurement cell (3) for a next sample.

28. Method according to any one of claims 24 to 27, wherein residual moisture is further removed from the measurement cell (3) by a device for drying after the measurement cell (3) has been cleaned.

29. Method according to any one of claims 24 to 28, wherein one or more vessels with test liquids for self-calibration of an arrangement as defined in any one



of claims 1 to 9 can be connected to the measurement cell (3) by a multi-port valve (6).

30. Method according to any one of claims 24 to 29, wherein at least one of a cleaning and drying of the measurement cell (3) are/is controlled by the controlling and evaluating unit.

31. Method according to any one of claims 24 to 30, wherein at least one of a cleaning and drying of the measurement cell (3) and a temperature regulation of the sample are/is controlled by the controlling and evaluating unit.

10 32. Method according to any one of claims 24 to 31, wherein the sample is further temperature-controlled by a device to prevent the influence of temperature on the measurement results.

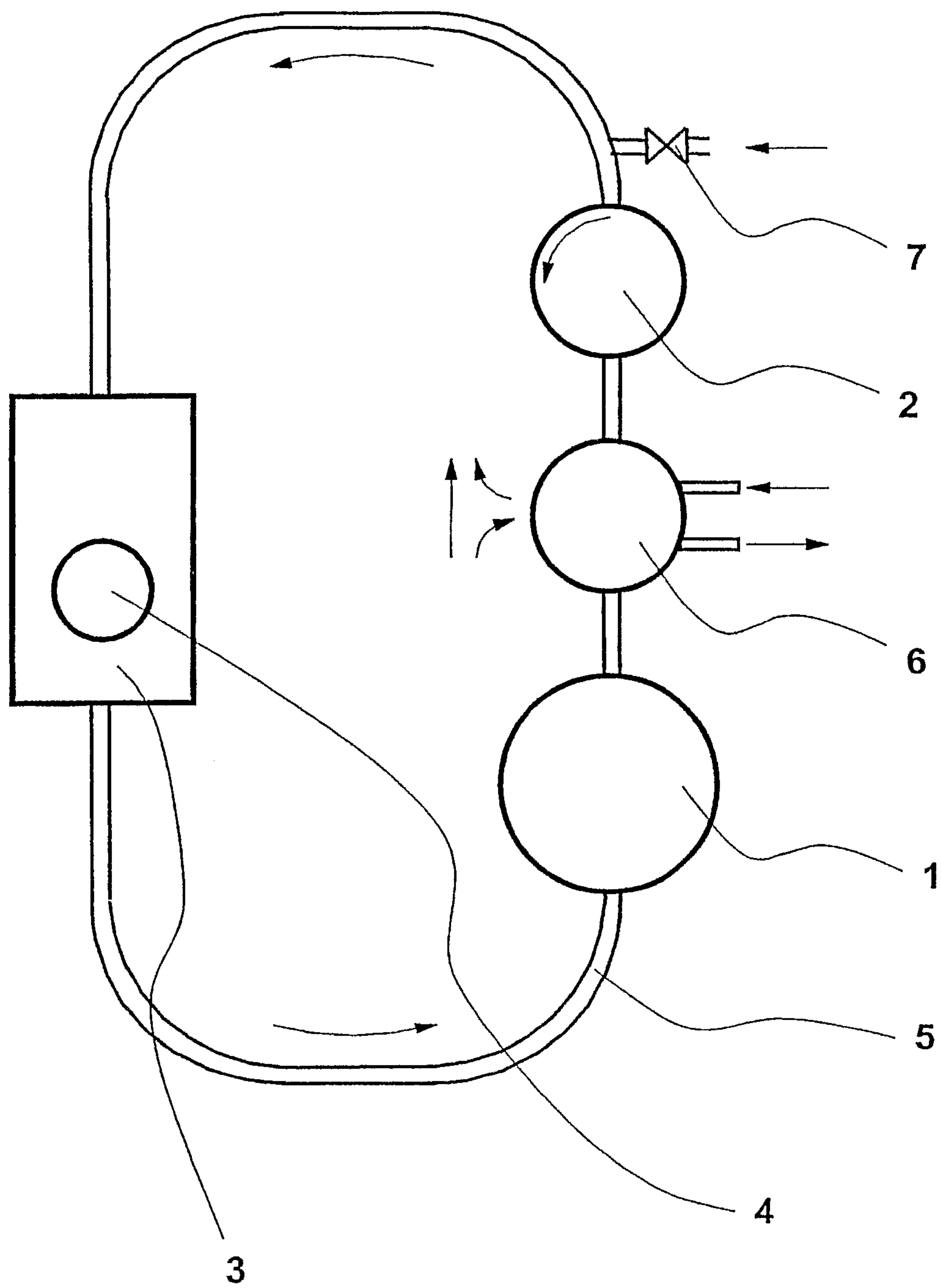
33. Method according to any one of claims 24 to 32, wherein the measurement head (4) carries out a spectroscopic measurement of the measurement cell without the sample in order to determine a degree of contamination of the measurement cell (3).

34. Method according to claim 24, wherein an additional control signal is generated by the controlling and evaluating unit based on the determined components and concentrations of substances contained in the sample for regulating the flow through the outlet valve when dispensing the pumpable material.

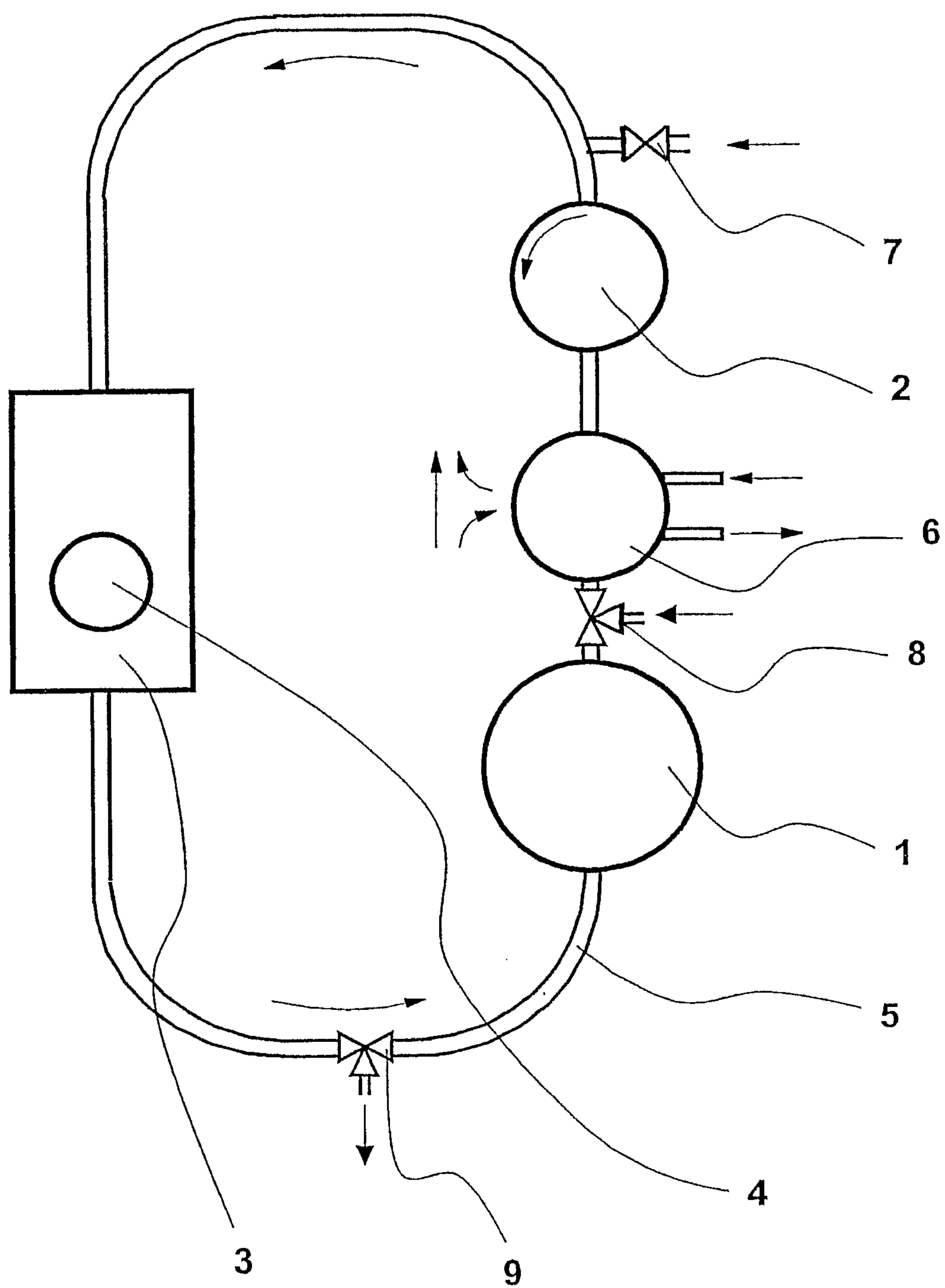
20 35. Method according to any one of claims 24 to 34, wherein previously determined soil values and the instantaneous speed of the vehicle are taken into account by the controlling and evaluating unit in addition to the determined components and concentrations of substances contained in the sample in order to generate a control signal for regulating the flow through the outlet valve while dispensing the pumpable material.



36. Method according to any one of claims 24 to 35, wherein the pumpable material is a pumpable organic waste.



Figur 1



Figur 2



