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(54) **Method and feeder for increasing efficiency of the expanding and drying process of organic plant materials, particularly in a jet drier and a feeder for use in the method**

Verfahren zur Erhöhung des Wirkungsgrades eines Quellungs- und Trocknungsprozesses von organischen Pflanzenmaterialien, insbesondere im Stahltrockner und Dosiereinrichtung zur Verwendung in dem Verfahren

Procédé d'augmentation de l'efficacité du procédé d'expansion et de séchage des matières végétales organiques, particulièrement dans un sécheur à courant utilisé pour des matières végétales organiques comminutées, et alimentateur pour l'utilisation dans le procédé

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Description

[0001] The invention relates to a method and a feeder for increasing efficiency of the expanding and drying process of organic plant materials, particularly a jet drier, used particularly to dry comminuted tobacco materials.

Many methods are known in the art for expanding and drying comminuted organic plant materials, as well as many technological systems having dryers, particularly jet dryers, employing a gaseous drying agent, particularly overheated steam of a temperature in the range up to 400°C. These systems comprise rotating valves operating as valves dosing comminuted products, particularly fluids.

In order to guarantee continuity of feeding the processed organic plant material, particularly comminuted tobacco material in any form, according to a known method, the material is fed gravitationally to the expanding and/or drying zone, as shown for example in US 6185843. However, this known method has practical limitations resulting from a possibility of blocking and jamming the fed material, particularly tobacco material in the outlet zone, resulting in nonuniformity of the material stream fed to the process. Additionally, this solution makes it difficult or practically makes it impossible to carry out a treatment by overpressure in which the working agent, e.g. steam flows in the drying channel under a pressure that is higher than the atmospheric pressure, causing losses (leakage) of the gaseous medium, for example air, carbon dioxide (CO_2), or steam, through the fed layer of the organic material, particularly tobacco material, and condensation of water vapor on the material, moistening the material fed for drying.

Another solution related to feeding of the organic plant materials, particularly tobacco materials, to the expanding zone is presented in US 4791942, where a modified rotating valve is presented, to which a process medium is fed under pressure, and in which the process of tobacco pressure expanding is carried out with the use of steam and carbon dioxide.

Still other solutions are presented in US 6158441, US 6581608, and US 6779527, where just before feeding to the expanding and/or drying zone the processed material is conditioned by injection (adding) water and/or water vapor within the inlet valve assembly. The fluid added in this manner gives out its vaporizing enthalpy (energy) partially to the material fed from outside, heating it up and being condensed on its surface. Due to high dynamics of the feeding process of the organic plant material to the expanding and/or drying device, the condensate layer on the material surface is not absorbed into the cellular structure of the material and stays on its surface being a useless insulator against the thermal energy until the direct contact with the expanding and/or drying medium.

[0002] Fig. 1 of the attached drawings shows exemplary known jet dryers using a gaseous drying agent, particularly overheated steam of a temperature up to 400°C. According to this solution organic plant material, particularly comminuted tobacco material 1, is fed from the production line to the expanding and/or drying zone 9 through a dosing and flow adjusting device 4, wherefrom, after the processing, the material is led out through a feeding and flow adjusting device 10. The term expanding is understood here as increasing the specific volume of the processed material, measured in m^3/g.

[0003] A side effect of the known methods for processing and feeding (transporting) organic plant materials, particularly tobacco materials, to the zone of a direct processing, i.e., the expanding and/or drying zone, is inter alia creation of undesired layer of surface moisture (water), chemically unbound, which will not be able to be absorbed into the cellular structure of the tobacco material before feeding it into the expanding and/or drying zone of access. This layer constitutes a thermal insulation of varied thickness, which significantly hinders or even prevents the processing of the comminuted organic plant material, particularly tobacco material in any form, to be carried out in a homogenous, optimal in terms of quality, and watt-hour efficient manner.

[0004] To illustrate how effective a thermal insulator the moisture (water) can be we will compare two coefficients defining thermal properties of two different materials, i.e., of water (a thermal insulator) and of copper (a very good thermal conductor).

	Water (a thermal insulator)	Copper (a thermal conductor)
Specific heat, c_p [kJ/kg·K]	4.18	0.389
Thermal conductivity, λ [W/m·K]	0.58	386

[0005] The comparison of the specific heat, c_p of both materials shows that one has to deliver about ten times more of thermal energy to heat up a unitary mass of water by one degree (°C or 1 K), than to heat up by one degree the same amount of copper. On the other hand, the comparison of the thermal conductivities, λ, confirms that the water layer acts as a disadvantageous and a very efficient thermal insulator, i.e., a surface water layer of thickness of 1 mm stores as much thermal energy as a copper layer of thickness of about 600 mm (for the above mentioned data 665 times more).

[0006] Additionally, one has to take into consideration that the necessity of vaporizing the surface moisture imposes the necessity of delivering an important amount of additional thermal energy to cause the phase change of liquid into vapor. However, the result of such phase change takes a significant amount of thermal energy from the material, so called vaporization enthalpy, which for water is about 2250 kJ/kg, this in turn causes an undesired effect of cooling

(instead of heating) the material.

[0007] Considering the above issues, it would be advantageous to guarantee that the material fed to the dryer, particularly the jet dryer of the "flash" type, is free of surface moisture, which is an insulator for the thermal energy and makes it necessary to increase the time spent by the product in the drying channel and, as a consequence, to increase the dimensions of the dryer as well as the demand for energy.

[0008] According to the invention a method is provided of increasing efficiency of the expanding and drying process of organic plant materials, particularly in a jet dryer used for comminuted organic plant materials, particularly comminuted tobacco materials, working with the use of a gaseous expanding and/or drying agent under an absolute operating pressure in the range from 2.5 kPa to 10 MPa, the gaseous expanding and/or drying agent being preferably overheated steam.

[0009] The method of the invention is characterized in that during transporting the material from the feeding zone to the zone of contact with the expanding and/or drying agent, a rotary vane feeder is flushed, preferably in a continuous manner, with a gaseous medium which is capable of absorbing moisture, under an absolute pressure in the range from 2.5 kPa to 10 MPa, the temperature of the gaseous medium being preferably in the range from 50 to 200°C, and residues of the gaseous expanding and/or drying agent are removed from the rotary vane feeder, wherein the transported material is saturated by means of the stream of the gaseous medium.

[0010] Preferably the transported material is heated up in the direct contact with the stream of the gaseous medium and residues of the surface moisture are removed from the surface of the material.

[0011] Also preferably defibering process of the material is carried out by means of the stream of the gaseous medium.

[0012] According another aspect of the invention, a feeder is provided for increasing efficiency of the expanding and drying process of organic plant materials, particularly in a jet dryer used for comminuted organic plant materials, particularly comminuted tobacco materials, having vanes rotating within a housing.

[0013] The feeder of the invention is characterized in that two pairs of openings are formed in the housing of the feeder, one pair of the openings delivering gaseous medium to the moving spaces between vanes and the other pair of openings leading the gaseous medium out of the moving spaces between the vanes, the openings being oblong and located respectively in the walls of the housing of the feeder and arranged radially, with their longitudinal axes perpendicular to the inlet and the outlet axis of the material.

[0014] Preferably the openings are radially shifted relative to each other.

[0015] Also preferably the feeder it is equipped with deflectors of the stream of the material.

[0016] The solution according to the invention assures uniformity and continuity of the processes in which optimal expansion and drying to a desired level is obtained. Experts in the field of tobacco processing estimate this level to be in the range of 10 - 14% of humidity.

[0017] The invention is illustrated by an embodiment shown in the accompanying drawings, in which:

Fig. 1 shows schematically a known device for expanding and/or drying comminuted organic plant materials, particularly tobacco materials, comprising a feeding and flow adjusting device;
Fig. 2 shows a cross-sectional view of an inlet feeder according to the invention;
Fig. 3 shows a plan view of the feeder of Fig. 2 with the channels delivering the gaseous medium into the feeder and the channels leading gaseous medium out of the feeder;
Fig. 4 shows a cross-sectional view of a feeder according to the invention in a working position of the driver vanes of the feeder, in which the operating range of the delivered gaseous medium within the feeder is shown.

[0018] According to the invention, in the device for expanding and/or drying comminuted tobacco material an inlet rotary valve is employed in a form of a rotary vane feeder 4, which is located between the feeding zone 6 and the expanding and/or drying zone, i.e., the processing zone 9. Through the rotary vane feeder 4 the organic plant material, particularly tobacco material 1, 1A, is fed to the processing zone 9 in a manner, which eliminates or significantly reduces entering moist gaseous expanding and/or drying agent (also called process gas PG) to the feeding zone 6 of the organic plant material, particularly tobacco material 1.

[0019] Fig. 2 presents a cross-section of the feeder 4 which doses the organic plant material, particularly tobacco material 1, 1A to the processing zone 9. A standard (typical) rotary valve has been modified by forming two zones, an active one and a passive one, which are shown in Fig. 4. In the active zone the comminuted organic plant material, particularly tobacco 1, is transported to the processing zone 9. In the passive (return) zone only the gaseous expanding and/or drying agent PG is transported between the vanes of the valve.

[0020] The rotating vanes 3 define with the housing of the feeder 4 closed moving spaces into which a stream of the gaseous medium is delivered via openings 5 and/or 7. The gaseous medium is then removed via openings 5A, 7A, the gaseous medium being for example hot air of a temperature from 50 to 150°C, under absolute pressure in the range from 2.5 kPa to 1 MPa.

[0021] As shown in Fig. 3, the feeder 4 is equipped with feeding channels 13, 14 feeding the stream of the gaseous

medium to the openings 5, 5A as well as channels 13A, 14A leading the stream of the gaseous medium out.

[0022] In order to intensify the effect of flushing the spaces between the vanes 3 with the gaseous medium, openings 7 and 7A may be shifted along the radius, as shown in Fig. 2 and Fig. 3, which lengthens the path of the gaseous medium stream in the flushed space. In the passive zone, where only the gaseous expanding and/or drying agent (PG) is transported between the vanes 3 and there is no material, particularly tobacco material 1, 1 A, another shape and arrangement of the openings 5 and 5A may be applied so that they do not need to be shifted relative to each other, as shown in Figs. 2 and 3.

[0023] In the described embodiment the openings 5 and 7 delivering the gaseous medium 11 and/or 12 into the housing of the feeder 4 as well as the openings 5A and 7A leading the gaseous mixture 11A and 12A out, are oblong openings arranged radially and perpendicularly to the inlet-outlet direction of the material 1-1A fed for expanding and/or drying processing, as shown in Figs. 2 and 4.

[0024] In order to take optimal advantage of the valve operating spaces, i.e., the spaces between the driver vanes 3 and the housing of the feeder 4, deflectors 2, 2A,8 of the stream of the material are employed, as shown in Fig. 2. Additionally, these deflectors advantageously lengthen the path of the contact between the vanes 3 and the housing of the feeder 4, which advantageously extends the duration of processing with the gaseous medium 11, 12. Simultaneously, as shown in Fig. 4, the deflectors eliminate the adverse phenomenon of entering (leakage) of the gaseous medium delivered to the feeder 4, into the processing zone 9 as well as the feeding zone 6.

[0025] The material 1 A leaving the feeder 4 for the processing zone 9 in which the material contacts directly the expanding and/or drying agent (PG), stops occupying the space between the vanes 3 and the housing of the feeder 4 and the space is immediately filled up with the expanding and/or drying agent (PG) present in the processing zone 9. Next, the expanding and/or drying agent is transported between the vanes 3 and the housing of the feeder 4. In this zone the openings 5 and 7 are formed, as shown in Figs 2 and 3, through which the gaseous medium 11 and/or 12, for example ambient air, is fed to the feeder, as well as the openings 5A and 7A, through which the gaseous mixture 11A and 12A is led out (sucked off).

[0026] As a result of using the above solution no residues of moist expanding and/or drying agent (PG) enter the feeding zone 6 in the moment of reopening the rotating operating chamber of the feeder 4, and as a consequence no condensation of moisture occurs on the organic plant material, particularly tobacco material 1, fed to the process. The organic plant material, particularly tobacco material 1, fed according to this method to be the expanded and/or dried does not have an insulating layer of free chemically unbound surface moisture being a thermal insulator and inhibitor of chemical reactions occurring within the processing zone 9, which allows for significant reduction of the amount of energy delivered from the outside, necessary for obtaining an appropriate expanding and/or drying process.

[0027] As a result of the employed solution, the entire or significant amount of the gaseous expanding and/or drying agent (PG) constituting a carrier of moisture, particularly water vapor is removed from the feeder 4. The said feeder 4 delivers the material 1 and forms a separation from the processing zone 9. The absence of the saturated water vapor in the feeding zone 6 where the material 1 is fed to the feeder 4 reduces or even eliminates condensation of the water vapor (moisture) on the organic plant material, particularly tobacco material, fed to the process. The material having no contact with a moist expanding and/or drying agent , particularly steam, may be advantageously subjected to the influence of hot dry air (streams 11, 12 in Fig. 3), whereby the temperature (internal energy) of the organic plant material, particularly tobacco materialincreases, simultaneously allowing for removal of the residual layer of the surface moisture that remained after the previous processing without creating any additional disadvantageous layer of surface moisture.

[0028] Due to the contact between the comminuted, usually fibrous and swirled organic plant material, particularly tobacco material, fed to the process and the stream of the gaseous medium 11, 12, for example air, the material is defibred (disagglomerated), whereby the uniformity of the expanding and/or drying process of individual particles of the material is significantly increased. Also, due to this solution the expenditure of energy is significantly reduced , by eliminating the portion of energy necessary for removing the useless surface moisture, i.e., efficiency of the process is increased.

[0029] Furthermore, the expanding and/or drying agent (PG) taken from the processing zone 9 and enclosed between the vanes 3 of the feeder 4 is sucked off via the opening 5A and the channel 13A. The expanding and/or drying agent (PG) is removed from the feeder 4 via the opening 5A situated radially, as shown in Fig. 3, by the gaseous medium 11 delivered from outside, preferably air taken from the environment, delivered through the channel 13 and the opening 5, and then removed via the opening 5A and the channel 13A for optional further processing outside the feeder 4, for example for recovering thermal energy (enthalpy) from the waste stream of the gaseous mixture 11A. As a consequence, these effects allow for a shorter time spent by the organic plant materials, particularly tobacco materials, within the expanding and/or drying zone, and this in turn allows for reduction of the dimensions of the drying channels and the whole jet dryer. Moreover, a significant increase of the watt-hour efficiency of the expanding and/or drying process of organic plant materials, particularly tobacco materials is obtained.

Claims

1. A method of increasing efficiency of the expanding and drying process of organic plant materials, particularly in a jet dryer used for comminuted organic plant materials, particularly comminuted tobacco materials, working with the use of a gaseous expanding and/or drying agent under an absolute operating pressure in the range from 2.5 kPa to 10 MPa, the gaseous expanding and/or drying agent being preferably overheated steam, **characterized in that,** during transporting the material (1) from the feeding zone (6) to the zone (9) of contact with the expanding and/or drying agent, a rotary vane feeder (4) is flushed, preferably in a continuous manner, with a gaseous medium (11, 12), which is capable of absorbing moisture, under an absolute pressure in the range from 2.5 kPa to 10 MPa, the temperature of the gaseous medium (11, 12) being preferably in the range from 50 to 200°C, and residues of the gaseous expanding and/or drying agent are removed from the rotary vane feeder (4), wherein the transported material (1) is saturated by means of the stream of the gaseous medium (11, 12).

2. The method according to claim 1, **characterized in that** the transported material (1) is heated up in the direct contact with the stream of the gaseous medium (11, 12) and residues of the surface moisture are removed from the surface of the material (1).

3. The method according to claim 1 or 2 **characterized in that** defibering process of the material (1) is carried out by means of the stream of the gaseous medium (11, 12).

4. A feeder for increasing efficiency of the expanding and drying process of organic plant materials, particularly in a jet dryer used for comminuted organic plant materials, particularly comminuted tobacco materials, having vanes rotating within a housing, **characterized in that** openings (5, 7) and openings (5A, 7A) are formed in the housing of the feeder (4), the openings (5, 7) delivering gaseous medium to the moving spaces between vanes (3) and the openings (5A, 7A) leading the gaseous medium out of the moving spaces between the vanes (3), the openings (5, 7, 5A, 7A) being oblong and located respectively in the walls of the housing of the feeder (4) and arranged radially, with their longitudinal axes perpendicular to the inlet and the outlet axis of the material (1).

5. The feeder according to claim 4 **characterized in that** the openings (7) and (7A) are radially shifted relative to each other.

6. The feeder according to claim 4 **characterized in that** it is equipped with deflectors (2, 8) of the stream of the material.

Patentansprüche

1. Verfahren zur Erhöhung des Wirkungsgrades eines Quellungs- und Trocknungsprozesses von organischen Pflanzenmaterialien, insbesondere im Strahltrockner, genutzt für zerkleinerte organische Pflanzenmaterialien, insbesondere für zerkleinerte Tabakmaterialien, arbeitend mit Ausnutzung eines gasförmigen Quellungs- und/oder Trocknungsmittels unter einem absoluten Arbeitsdruck im Bereich von 2,5 kPa bis 10 MPa, wobei das gasförmige Quellungs- und/oder Trocknungsmittel vorteilhaft der überhitzte Dampf ist, **dadurch gekennzeichnet, dass** während des Transportes vom Material (1) aus der Zone der Schüttung (6) in die Zone (9) des Kontaktes mit dem Quellungs- und/oder Trocknungsmittel, der Schaufelradentleerungswagen (4) vorteilhaft kontinuierlich mit einem Gasmedium (11, 12), das die Feuchtigkeitsabsorptionsfähigkeit aufweist, unter dem absoluten Druck im Bereich von 2,5 kPa bis 10 MPa gespült wird, die Temperatur des Gasmediums (11, 12) vorteilhaft im Bereich von 50° C bis 200° C liegt, und die Rückstände des gasförmigen Quellungs- und/oder Trocknungsmittels vom Schaufelradentleerungswagen (4) beseitigt werden, wobei das transportierte Material (1) mit Hilfe vom Strahl des Gasmediums (11, 12) gesättigt wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** das transportierte Material (1) im unmittelbaren Kontakt mit dem Strahl des Gasmediums (11, 12) erwärmt wird und die Rückstände der Oberflächenfeuchtigkeit aus der Oberfläche des Materials (1) beseitigt werden.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** der Prozess von Zerfaserung des Materials (1) mit Hilfe vom Strahl des Gasmediums (11, 12) durchgeführt wird.

4. Dosiereinrichtung zur Erhöhung des Wirkungsgrades eines Quellungs- und Trocknungsprozesses von organischen Pflanzenmaterialien, insbesondere im Strahltrockner, genutzt für zerkleinerte organische Pflanzenmaterialien, ins-

besondere für zerkleinerte Tabakmaterialien, ausgestattet mit den im Gehäuse rotierenden Schaufeln, **dadurch gekennzeichnet, dass** im Gehäuse der Dosiereinrichtung (4) die Öffnungen (5,7) und die Öffnungen (5A, 7A) angefertigt sind, wobei über die Öffnungen (5, 7) das Gasmedium in die beweglichen Räume zwischen den Schaufeln (3) zugeführt wird und über die Öffnungen (5A, 7A) das Gasmedium aus den beweglichen Räumen zwischen den Schaufeln (3) abgeführt wird, die Öffnungen (5, 7, 5A, 7A) eine längliche Gestalt haben und entsprechend in den Wänden des Gehäuses der Dosiereinrichtung (4) angeordnet sind, wobei sie auf solche Weise radial angeordnet sind, dass ihre Längsachsen senkrecht angesichts der Ein- und Austrittachse des Materials (1) sind.

5. Dosiereinrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** die Öffnungen (7) und (7A) radial gegeneinander verschoben sind.

6. Dosiereinrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** sie mit Deflektoren (2, 8) des Strahles des Materials (1) ausgestattet ist.

Revendications

1. Procédé d'augmentation de l'efficacité du procédé d'expansion et de séchage des matières végétales organiques, particulièrement dans un secheur à courant utilisé pour des matières végétales organiques comminutées, particulièrement pour le matériau du tabac comminuté, le sécheur fonctionnant avec un agent d'expansion et/ou de séchage gazeux sous pression absolue opérationelle dans une plage de 2.5 kPa jusqu'à 10 Mpa, le agent d'expansion et/ou de séchage gazeux étant de préférence la vapeur surchauffée, **caractérisé en ce que** pendant le transport du matériau (1) de la zone d'entrée (6) à la zone (9) de contact avec l'agent d'expansion et/ou de séchage gazeux, un médium gazeux (11, 12) est écoulé, de préférence de manière contiunue, à travers une vanne rotative alimantateuse (4), le médium gazeux (11, 12) étant apte à absorber l'humidité sous pression absolue dans une plage de 2.5 kPa jusqu'à 10 Mpa, la température du médium gazeux (11, 12) se situant de préférence dans une plage de 50 jusqu'à 200 °C, et les résidus de l'agent d'expansion et/ou de séchage gazeux sont évacués de la vanne rotative alimantateuse (4), le matériau (1) transporté (1) étant saturé au moyen du courant du médium gazeux (11, 12).

2. Procédé selon la revendication 1, **caractérisé en ce que** le matériau (1) transporté (1) est chauffé par le contact direct avec le courant du médium gazeux (11, 12) et les résidus d'humidité superficielle sont évacués de la surface du matériau (1).

3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que** le procès de défibrage du matériau (1) est effectué au moyen du courant du médium gazeux (11, 12).

4. Alimentateur pour augmentation de l'efficacité du procédé d'expansion et de séchage des matières végétales organiques, particulièrement dans un secheur à courant utilisé pour des matières végétales organiques comminutées, particulièrement pour le matériau du tabac comminuté, l'alimentateur ayant des aubes tournant dans un logement, **caractérisé en ce que** les orifices (5, 7) et (5A, 7A) sont formés dans le logement d'alimentateur (4), les orifices (5, 7) fournissant du médium gazeux aux espaces mobiles entre les aubes (3) et les orifices (5A, 7A) ramenant le médium gazeux (11, 12) au-dehors des espaces mobiles entre les aubes (3), les orifices (5, 7, 5A, 7A) étant oblong et situés de manière radiale, leur axes longitudinaux étant perpendiculaires à l'axes d'entrée et de sortie du matériau (1).

5. L'alimentateur selon la revendication 4, **caractérisé en ce que** les orifices (7) et (7A) sont déplacés radialement l'un par rapport à l'autre.

6. L'alimentateur selon la revendication 4, **caractérisé en ce qu'**il est équipé de déflecteurs (2, 8) du courant du matériau.

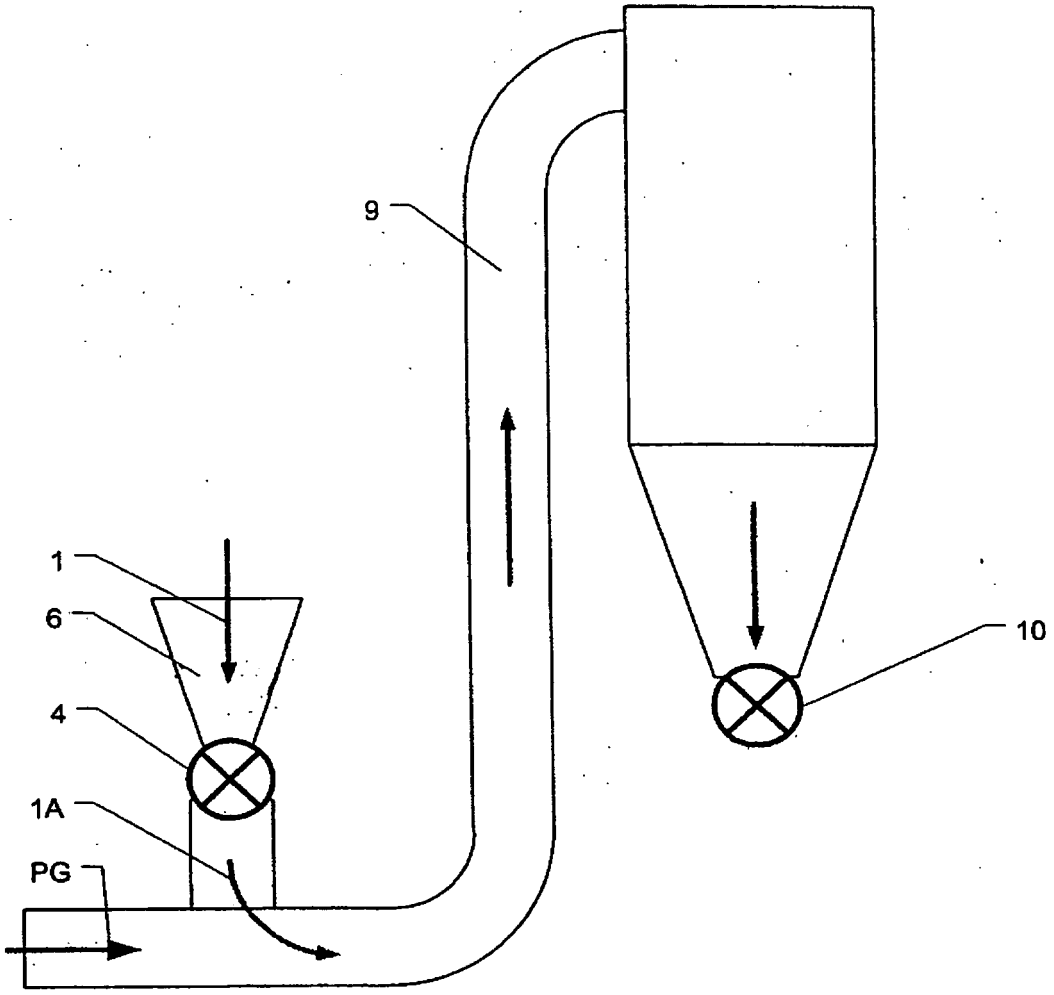

Fig. 1

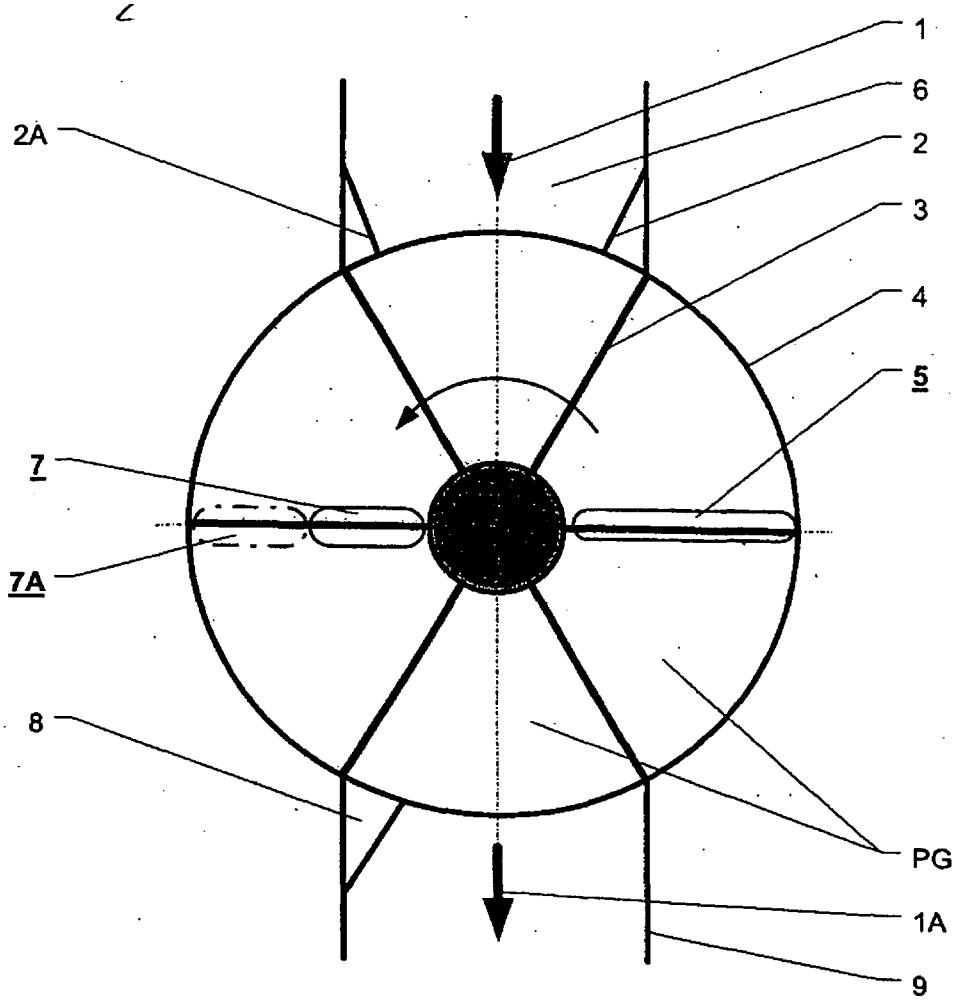

Fig. 2

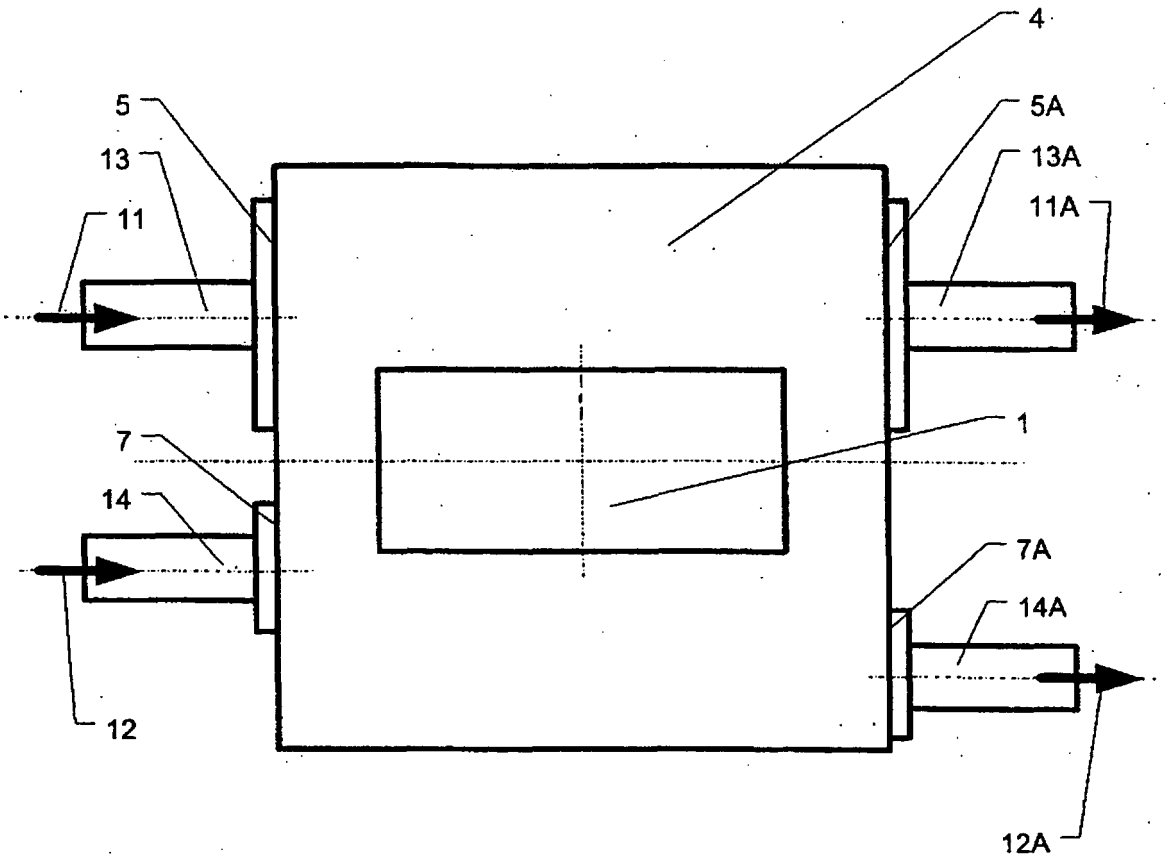

Fig. 3

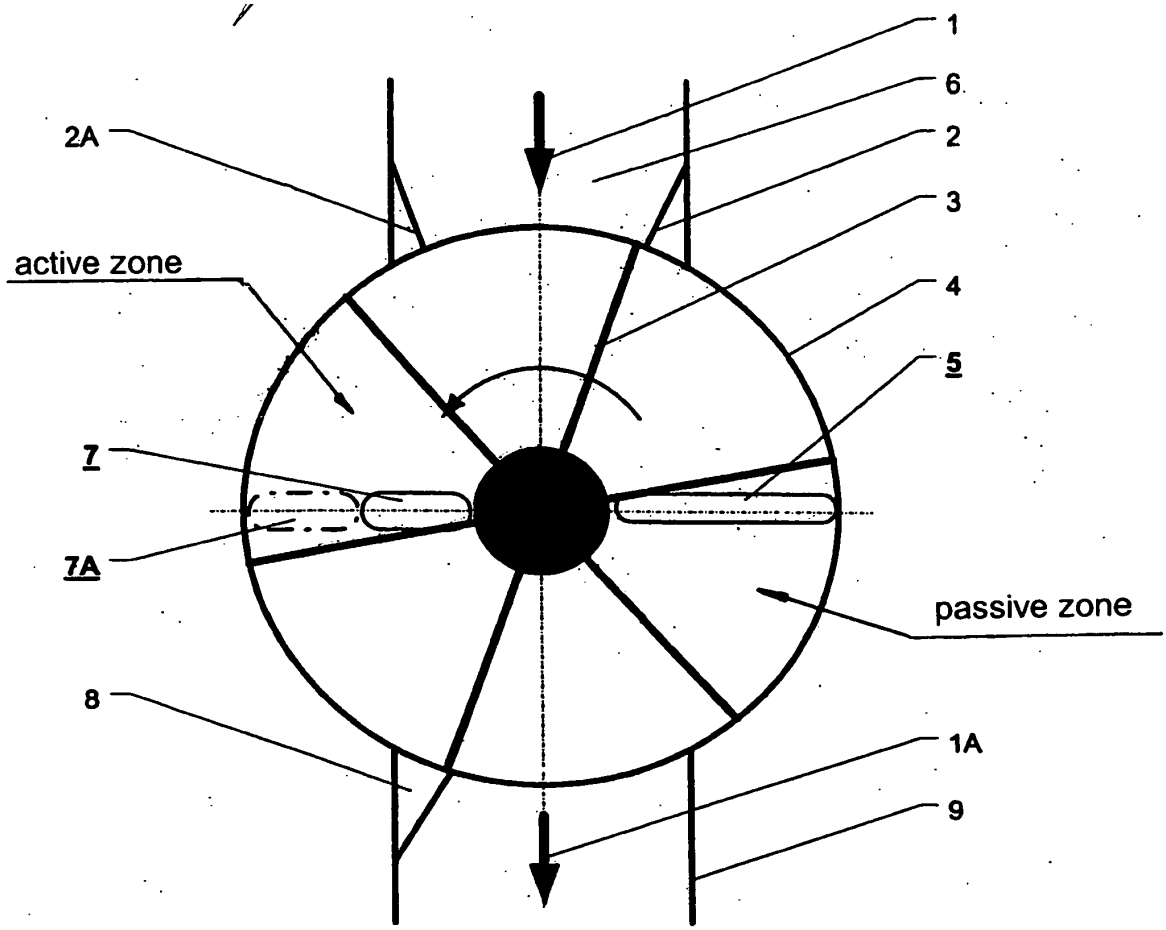

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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