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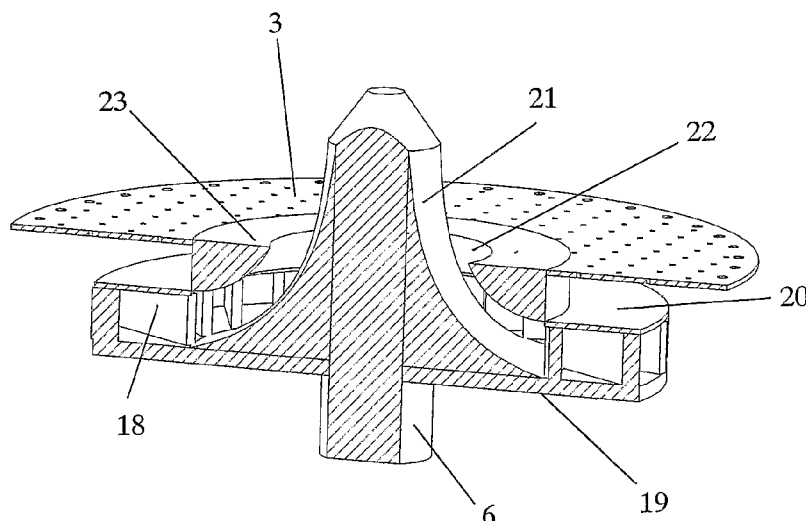


FIG. 3

(57) Abstract: The subject of invention is an enhanced processing apparatus for particle coating using a new airflow vortex generator (4), which enables achieving flow characteristics of the gas vortex flow within the areas inside the separation cylinder (5) and between the separation cylinder (5) and the perforated flow distribution plate (3), leading to an improved uniformity and quality of the coating application, with a higher material and thermal efficiency during the coating process, where the particles move upward in a circular path in the spraying and drying area inside a vertical pipe of the separation cylinder (5), positioned above the gas distribution plate (3), and downward in the second drying and particle retention area outside the separation cylinder (5).

**ENHANCED PROCESSING DEVICE FOR COATING PARTICLES VIA
A NEW AIRFLOW VORTEX GENERATOR METHOD**

5

The invention is an enhanced processing apparatus for particle coating using a new airflow vortex generator that will contribute to the field of chemical and pharmaceutical technology. The invention represents an improvement in particle processing equipment by spraying from beneath
10 and functions on the principle of a vortex generator. More precisely, the invention can be regarded as a design solution to the essential features of a particle coating device that improves the quality of the coating. The invention falls within the A61J3/06 class in accordance with international patent classifications.

15 The invented device solves the technical problem of effectively ensuring a narrow variation in coating thickness from particle to particle, for small as well as large particles. The functional coating of particles is a common technological process in chemical and pharmaceutical industries. This is especially true in the case of pharmaceutical products, whose
20 function depends on the prolonged release of therapeutic substances, for which the dissolution rate of the therapeutic substance depends upon the diffusion through the coating, whilst the thickness and the uniformity of the coating from particle to particle play a vital part in achieving the requisite

kinetic substance release. Constructing a processing device that ensures a narrow variation in coating thickness from particle to particle is also important in the case of coating particles to protect them from atmospheric, physiological and other environments. In such a case, less matter is required to achieve the functionality of the coating applied to the particle, and subsequently, the technological process requires less time and energy. The main problem is the coating of small particles (50-300 microns), which, due to a low mass and inertia, are more prone to the undesirable effect of agglomeration. Independent and coated small particles are important in pharmaceutical and chemical technology due to their larger surface area, compared to larger particles. When coating particles by spray dispersion containing a therapeutic substance, it is particularly important in the pharmaceutical industry to maximise the material efficiency of coating process, which is most often dependent on the location and angle of the nozzles and the density of particles around the nozzle.

The known particle-coating processing devices which work on the fluidised bed principle are ideal for coating particles in the size range from 50 microns to 6 mm

Processing devices for coating particles that use the vortex technology can be roughly divided into groups: those devices which spray from above; devices which spray tangentially; and devices which spray from below. The processing devices which spray from above are primarily

intended for granulation, however, in the case of coating, due to the need for the dispersion of small droplets to achieve the desired coating quality, a stronger undesirable effect of spray drying of coating solution is achieved. If the position of nozzle is lowered, then the distance from the
5 nozzle to the particles is reduced, however due to the opposite air current of fluidisation, and the compressed air of the dual-channel nozzles, the movement pattern of the particles is disturbed, and the mesh at the bottom of the device becomes excessively wet. Processing devices for coating via a tangential spray in combination with a rotating plate are
10 problematic from the point of view of the close contact of particles in the pattern of movement and the relatively small flow of heat through the process chamber, which tends to result in the agglomeration of those small particles which require coating.

In the case of a processing device that sprays from below, the distance
15 between the nozzle and particles is short, whilst at the same time the nozzle is aimed in the direction of airflow for fluidisation, or the particles. The known version of the device that sprays from below contains a separation cylinder - or so-called inner cylinder- positioned centrally above the nozzle and a little above the distribution plate. By including a
20 separation cylinder, the processing chamber works according to the principles of a circulating fluid bed, a technology which is named after its inventor: a Wurster chamber. The advantage of this device is that the particle coating area is separate from the drying area, and further, due to

the pneumatic transportation of particles within the cylinder and around the nozzle, the velocity of particles is relatively greater (0.7 - 2 m / s), thus reducing the possibility of particle agglomeration. The movement of particles is repetitive and circular, i.e. a form of controlled movement.

5 However, the problems of coating using a classical Wurster chamber are demonstrated by the uneven deposits of coating film across the population of particles. This is a consequence of the effect of the particles shading one another in the dispersion of the coating spraying area, the effect of a "blind spot" in the flow of particles, and a consequence of the

10 disproportionate acceleration of the smallest and largest particles in the population of particles undergoing the coating procedure. The volume share of the pellet in the spraying area and the effect of mutual shading depend on the through-flow medium of fluidisation (air or another inert gas) and on the adjusted height of the separation cylinder. The effect of

15 the "blind spot" on the stream of particles occurs in the corner between the outer wall of the processing device and the distribution plate, since the particles located nearer to the outer wall of the separation cylinder previously repeatedly pass into the area of horizontal transportation, and into the area of coating and vertical transportation, and so repeatedly

20 circuit through the cylinder during coating, and consequently receive more coating. The effect of the "blind spot" is stronger at lower positions of the inner cylinder, in spite of the fact that in the area of the blind spot in the distribution plate, larger perforations are found, which with the localised

increased through-flow of gas, ought to reduced or eliminate this problem. If a particle population with a broad distribution of sizes is coated, then at the end of the procedure, the larger particles will have a thicker coat than smaller particles. This happens due of the nature of the vertical
5 transportation of particles, since smaller particles have a better relationship between their cross-sectional area and their mass than larger particles, and consequently, after crossing the separation cylinder, smaller particles have a greater velocity than larger particles and thus rise higher, as a result of which the rising and falling time is increased for smaller
10 particles compared with larger particles in the processing chamber. Throughout the entire coating time, the number of times a particle crosses through the separation cylinder is shown to depend on the particle's initial size.

Furthermore, due to the relatively high density of particles at the inner
15 wall of the separation cylinder and the inter-particle collisions, agglomeration of particles in the size range of 50 to 300 microns can build up relatively quickly, in spite of drying, due the large localised through-flow of heated air.

Known solutions to the issues of the Wurster device are detailed in the
20 followed.

It is known that the vortex flow of the fluid inside some pipes improves the transfer of heat to the two-phase flow, as a consequence of the extended fluid path (and subsequently the time of contact with the particle)

at a certain distance in the axial direction of the current (Algifri AH et al, Heat-transfer in turbulent decaying swirl flow in a circular pipe, International Journal of Heat and Mass Transfer, 1988, 31(8):1563-1568). Due to the improved transfer of heat, the problem of coating smaller
5 particles should be reduced.

There is also a known article on improving the thermal efficiency during drying inside a device that does not have the same structure as a Wurster device, but rather works on the principle of a vortex and has an airflow vortex generator in the form of a blade. By using a device with a vortex
10 flow, an improvement of between 5 and 25% was achieved in terms of drying time and the specific speeds of drying, and an improvement in drying effectiveness by up to 38% (M. Özbej, M.S. Söylemez, Energy Conversion and Management, 46, (2005), 1495-1512).

The inclusion of a vortex flow in the Wurster chamber reduces the
15 variation distribution in coating thickness in the population of coated particles with a narrow variation in size by approximately 43% (PWS Heng et al., International Journal of Pharmaceutics, 327, 2006, 26-35). Compared to a conventional Wurster chamber it also substantially reduces the occurrence of agglomeration (ESK Tang et al., International
20 Journal of Pharmaceutics, 350, 2008, 172-180), while the efficiency of the coating for the given version compared with a conventional chamber was somewhat worse.

The U.S. Patent document number 5,718,764 (vortex flow) details how the firm, Aeromatic, implemented a solution to protect the airflow vortex generator within the framework of the coating device by spraying from beneath (i.e. a Wurster chamber). The examples performed showed a
5 certain improvement in the uniformity of the coating films, i.e. through the effect of pigment from the coated core dissolving through a more or less continuously insoluble coating layer. Given that the preceding was already a known effect of the vortex flow on the transfer of heat (Algifri AH et al, Heat-transfer in turbulent decaying swirl flow in a circular pipe,
10 International Journal of Heat and Mass Transfer, 1988, 31(8):1563-1568), the document describes its own design to achieve the vortex airflow. The U.S. Patent document number 6,492,024 B1 (granulation through a vortex flow), describes the process of granulation in combination with the use of an airflow generator coating device, from patent no. US 5,718,764.

15 The Slovenian patent application no. P-200800295 describes the technical problem of reducing the distribution variation in the thickness of coating film, reducing the agglomeration of particles and the increase in the efficiency of particle coating, solved by the innovative design of an airflow vortex generator, however, which does not enable a great flexibility
20 in achieving two-phase flows. The possibilities for the optimisation of the coating process are thus limited. Moreover, during the coating process, strings of solid particles form within the separation cylinder, consequently

leading to particles shading one another in the area of the coating spray solution, and thus a reduction in the uniform thickness of the coating film.

There exists a constant need for a particle coating processing device,

- which can, in comparison with the existing design solutions of the Wurster chamber, provide an materially and energy-efficient process of particle coating, the result of which would be a population of coated particles with a suitable narrower variation distribution in the coating film and the reduction in the agglomeration of particles;
- which can, due to its flexibility, enable an optimal flow setting, and a high quality coating for a wide spectrum of potential products, including the provision of quality coating of as broad variation as possible in particle distribution sizes.

The above features require a compact processing device for coating, in association with low investment costs which would enable simple up-scaling.

The invention presented solves the technical problem of reducing the distribution variation in coating film widths, the problem of reducing the agglomeration of particles, and also the problem of increasing the efficiency of the coating. This is achieved by using an innovative airflow vortex design (see figures 3, 4, 5), which gives a different profile of air speed at the entrance to the bottom part of the cylinder, than that which is characteristic of the vortex current performances known up until now. The

reduction in the relative standard deviation (RSD) in coating film thickness is also greater in comparison to other known devices, and significantly so in comparison with the classical Wurster chamber (PWS Heng et al, International Journal of Pharmaceutics, 327, 2006, 26-35). The innovative
5 design of our device also reduces the problem of dependence of the coating film thickness on the initial size of the particle being coated. The features of the two-phase particle-gas flow, which affect the coating quality, can to a large extent be influenced by altering certain components of the airflow vortex generator, allowing the device to be used for a wide
10 range of products.

The invention will be further explained on the basis of the examples performed and the corresponding figures, which show:

- figure 1** a schematic cross-section of the processing
15 equipment invented for particle coating;
- figure 2** detail of the processing device with the airflow vortex generator; vortex generator;
- figures 3, 4, 5** the geometry of the vortex generator
- figures 6,7** schematic implementation of a semi-industrial or
20 industrial device invented for particle coating;

Figure 1 presents a schematic cross-section of the particle coating processing device, which consists of an outer wall (1), which at the bottom

part of the device is in the shape of a cylinder shell, or a truncated cone. At the bottom of the device, where the particles remain during the coating process, is the generator (4) for the vortex airflow with the gas distribution plate (3) in the outer part, by the outer wall (1) of the device. The gas
5 distribution plate (3), which on the plan has the shape of a ring, can be flat, curved, inclined or stepped. Just above the gas distribution plate (3) and the vortex generator (4) is the metal mesh with perforations of the order 10-100 microns. Through the airflow vortex generator (4), the spray nozzle (6) introduces the suspension or dispersion coating spray centrally.
10 This can be a single or multiphase operation. The twin-channel nozzle (6) for spraying (see figure 1) has a conduit (7) for the coating dispersion, and a conduit (8) for the compressed gas. Below the level of the gas distribution plate (3) and the airflow vortex generator (4), the wall of the processing device (2) forms a space into which a fluidising medium (9)
15 (usually air) is supplied. The pressure in this part of the processing device is high given the space of the processing device above the airflow vortex generator (4) and the gas distribution plate (3). The separation cylinder (5) is fastened centrally in the processing chamber, is tubular in shape and fixed on such a height, that it creates between the vortex generator
20 (4) and the gas distribution plate (3) a slit (most often of 5 to 25 mm).

In serial implementation of the processing device, particles were found to form a layer around the separation cylinder (5) above the flat or curved gas distribution plate (3). Whether this layer takes the form of a loose

static build up, or a fluid (floating) state depends upon the number and the arrangement of perforations in the outer gas distribution plate (3), the vortex medium for fluidisation (9), and the size and density of particles. In the horizontal cross-section of the separation cylinder (5), the centrally
5 positioned airflow vortex generator (4) creates a vortex (17) with an axial and a tangential component. The airflow vortex (17) in the slit area, between the separation cylinder (5) and the outer gas distribution plate (3) creates a negative pressure, due to the large local variations in the movement velocities of the gas. This results in the horizontal traction of
10 particles (11) into the slit area. Owing to the sufficiently large axial and tangential velocity nature of gas, the particles from the level of the vortex generator (4) rise vertically in the direction of the arrow (12) along the separation cylinder (5), where they partly follow the movement of gas in the form of a vortex due to the tangential nature of the airflow. As the
15 particles move vertically upwards, they fly through the spraying area (10) where the coating solution is dispersed. In this area (10), particles and droplets randomly collide, after which, the droplet is spread across the surface of the particle, and a part of the liquid may also penetrate the interior of the particle.

20 The particles along the entire cylinder (5) accelerate; however, as they leave the cylinder (5) their velocity starts to decrease, since the local air velocity rapidly decreases due to the rapid expansion of this section of the processing device, and thus the greater resistance force on the particle in

the gas current. Particles beyond the reach of the maximal height in the expansion part (13) of the processing device fall back down between the outer wall of the separation cylinder (5) and the outer wall (1) of the processing device, until they reach the level of the particle bed at the bottom of the device. The drying process is taking place the whole time during the upwards and downwards movement of the particles, and consequently, on contact with the particle bed, the particle is practically dried out. Conditions are created during the coating process which favours the process of coating rather than the agglomeration of particles.

This is due to the balanced velocity of the dispersion supplied for the coating, the regulation of droplet size through the flow of spray, and the strength of the heating current which is regulated via the through-flow and temperature of the fluidisation medium. During the coating, the movement of particles in the chamber can be described as repetitive and circular, passing the coating area several times. Therefore, over time, the surface of the particle acquires a continuous coating first, the thickness of which is increased during the coating process.

Figure 2 shows a detail of the processing device in the vicinity of the airflow vortex generator (4), and the spraying nozzle (6) with the distribution and form of the local currents (15), (16), (17) of the fluidisation medium. On the outer gas distribution plate, (3) there is a distinctive distribution of perforations, according to density and diameter. In the area of the gas distribution plate (3), on the outer wall (1) of the processing

device, there is usually located a band of perforations of a larger diameter, which locally generate a greater flow (16) of the medium, than the other gas distribution plate (3) perforations. In this way, there is a reduction in the number of particles that are detained in the corner, between the gas
5 distribution plate (3) and the outer wall (1) of the processing device.

Figures 3, 4 and 5 show the geometry of the airflow vortex generator (4). Barriers (18) for directing the gas are set between two rotationally symmetrical walls (19) and (20). Given the nature of the central plan of the walls, (19), (20), the barriers (18) to direct the airflow are positioned at an
10 angle α , most often from 10 to 80 °.

A horn-shaped frame (21) is mounted in the centre of the lower plate (19). The shape of the frame (21) directs the airflow coming from the area enclosed by plates (19) and (20), in which barriers are installed (18) to create a vortex, upwards through the annular slit (22) that is formed by
15 the inner edge and the inner wall of the frame (23), located between the upper plate (20) and the gas distribution plate (3) on one hand, and the frame wall (21) on the other. This is what creates the vortex current. The flow properties of the gas depend upon the shape and positioning of the barriers (18) for directing airflow, on the shape of the frame (21), and on
20 the available surface area of the annular slit (22) between bodies (21) and (23). The surface area of the annular slit can, for certain gas through-flows, influence the velocity of the gas underneath the separation cylinder (5). This speed is one of the parameters affecting the flow of pellets in the

separation cylinder (5), and thus the structure of the dual-phase current within the separation cylinder (5). If we imagine the structure of the airflow vortex to be in the form of a helix, then the shape of the helix can be easily influenced by angling barriers (18) to direct airflow, the frame shape (21) and the inner walls of the frame (23). The design set-up makes it possible and easy to alter those parts which do the regulating, and in so doing to create the appropriate helix airflow structure for achieving optimum coating conditions, which may vary according to individual applications. The nozzle (6) for spraying the solution or coating dispersion is positioned centrally through the horn-shaped frame (21).

The airflow vortex generator (4) reduces the relative standard deviation (RSD) in the thickness of coatings (compare the results of Table 2 and Table 3). This is because the subsequent circular motion of particles, following the airflow, reduces the incidents of particles shading one another; since the particles are simultaneously more uniformly distributed throughout the volume of the separation cylinder (5). Due to a higher total air velocity (axially and tangentially), the airflow vortex is more effective at sucking up the particles, which reduces the effect of the blind spot, thus also reducing the variations in coating thickness. Compared to the performance detailed in patent application no. P-200800295, the flow of particles within the separation cylinder (5) in the device that we have invented does not contain strings formations of particles, and is significantly more homogeneous. Due to the previously described particle

movement within the cylinder which results from the vortex airflow, the coating efficiency and the uniform thickness of the coating film are increased. Due to the improved heat transfer (as a result of the longer path of particle motion, on its route through the cylinder and the expansionary part of the appliance), and the reduction in the local density and the pellet collisions against the cylinder wall, significantly less particles were observed to agglomerate in a processing device that uses a vortex generator (4), than in a conventional Wurster chamber. Due to the centrifugal particle movement, smaller particles fall towards the bottom of the device after passing through the cylinder. This reduces the problem of the coating thickness depending on the initial particle size, which is a characteristic of the classical Wurster chamber.

Figures 6 and 7 indicate the implementation of a semi-industrial or industrial particle coating device with a vortex generator (4), in which an increase in the device capacity is achieved through an increase in the number of airflow vortex generators (4), spraying nozzles (6), and separation cylinders (5) within a single processing device, limited by the outer wall (1).

It is understood that the above descriptions and the related images have been provided as examples. Thus, variations that do not depart from the essence of the invention are intended to be within the scope of the invention. For example, the gas distribution plate (3) can be flat, curved, inclined or stepped. The perforation of the distribution plate (3) can consist

of holes, slits or, for example, may involve a wide variety of punching methods. In the same way, the upper edge (21b) of the horn (21) and the nozzle (6) height can be located above, underneath or at the same height as the distribution plate (3). Airflow routers (18) can be straight or e.g. curved and can be made in the shape of a vane or e.g. a groove. It is also not necessary for the bottom surface of the bottom wall (19) to be flat. It can be produced, e.g., in the shape of a hemisphere, which helps reduce gas pressure loss as it passes through the airflow vortex generator (4).

10 Implementation examples

For the implementation examples 1 and 2 we used 1 kg of pellets and coated them with the food dye tartrazine. During this coating process, we also sprayed 915 g 8% (w/w) HPMC aqueous solution with 10.9 % (w/w) dye content. At the end of the coating process, we sampled 30 pellet samples of 10 pellets each and dissolved them in phosphate buffer, pH 6.5. Then we determined the dye concentration using the spectrophotometer by setting its wavelength to 425 nm. From a population of measurements using a dye concentration, the relative standard deviation (RSD) of film coating was calculated, since with a narrow and defined distribution of round pellets, the variation in the concentration of dissolved dye is an indication of the thickness of the film coating of the pellet prior to its dissolving. To calculate the coating film RSD values between the pellet sets we used methods and equations given in Cheng

XX, Turton R, The prediction of Variability Occurring in Fluidized Bed Coating Equipment. II. The Role of Non-uniform Particle Coverage rates in a Bottom-Spray Fluidized Bed Coater. Pharm Dev. Tech., 5, 2000, 323-332.

5 With implementation examples the following process parameters were defined:

During all preliminary coating trials in a modified process chamber the air flow rate was 141 m³/h. Coating trials were performed using separation cylinders 10 and 20 mm high (distance from the distribution
10 plate) and annular apertures between nozzle and distribution plate with external diameters of 38.5 mm, 45 mm and 52 mm. In total, we performed 6 preliminary coating trials, during which we determined the coating film RSD values, coating efficiency and agglomeration of pellets.

To calculate the coating efficiency we divided the actual increment in
15 pellet mass during the coating with the theoretically calculated amount of dry particulate material in the dispersion, which we sprayed during the coating process. We also performed 6 repeat coatings using the implementation method that is subject of patent application no. P-200800295. The coating film RSD values, coating efficiency and
20 agglomeration of pellets were also determined during these trials.

Results in Tables 2) and 3) represent the mean of six measurements.

In each pellet coating trial we coated 1000 g pre-sieved pellets in the 800 to 1000 µm size interval. During all pellet coating trials the inlet-air

relative humidity fluctuated between 30 and 34% and the ambient temperature was held at 17°C.

Process	temperature		spraying		
	Supply air [°C]	Product [°C]	Pressure [bar]	Pump [pos]	Amount[g/min]
preheating	55	-	-	-	-
tempering	55	45	-	-	-
spraying	55	40-42	2	8	~10.5
drying	70	40-54	-	-	-
sampling	70	55	-	-	-
stop		61-63			

Table 1 Coating trial process parameters

5

The diameter of the hole/the size of the slit [mm]	RSD thickness [%]	Coating efficiency [%]	The degree of agglomeration [%]
2r=38.5			
10	6,84	73,3	0
20	7,07	74	0
2r=45			
10	9,10	72,1	0
20	6,99	77,9	0
2r=52			
10	8,81	68,3	0
20	9,39	73,4	0

Table 2 Trial results on the coating performance of the chamber, i.e. the subject of the invention

Comparative experiments

	The thickness of the RSD coating layer [%]	Coating efficiency [%]	The degree of agglomeration [%]
Mean value – Implementation 3	9,7+- 0.4	75.0	0
Mean value – Classical Würster chamber	16,1	74,0	0

Table 3 Trial results in comparative performances

The results of these experiments show, that the implementation of the new airflow vortex generator (4) improves the material efficiency of coatings and coating uniformity.

CLAIMS

1. This improved particle-coating apparatus based on the new airflow vortex generator (4) model intended for application of the coating solution or dispersion onto the surface of particles, whose interior wall (1) has been fitted with one or more units where each unit consists of an airflow vortex generator (4), which is enclosed by a gas distribution plate (3) and a separation cylinder (5), with at least one single or multi-phase spraying nozzle (6) with the inlet opening for a coating solution/dispersion inserted through the central opening of the airflow vortex generator, and in the case of a multi-phase nozzle spray, with a supply pipe for compressed air, where particles move upwards, along a circular path through the separation cylinder (5) and downwards in the area outside the separation cylinder.

15 **characterised in that**

the gas vortex generator (4) is attached to the distribution plate (3) in the area underneath the separation cylinder (5) in such a way that at least two rotationally symmetric walls are positioned in a way that gives the intersection imaginary flat surfaces, perpendicular to the rotation axis of symmetry of these walls and a space limited by said walls, in the form of an annular slit, and that these walls in the area underneath the separation cylinder (5) form an annular opening between the distribution plate (3) and the nozzle (6), and that the said walls are

enclosing a space, inside which barriers have been fitted (18) to achieve vortex flow of the gas and that the gas vortex generator (4) is connected to the gas source, with gas pressure on the generator inlet (4) port higher than at the generator (4) outlet port.

5

2. Enhanced processing device for coating particles via a new airflow vortex generator method according to claim 1,

characterised in that

the gas flow barriers are positioned between two at least almost
10 rotationally symmetric walls and in such a way so that the angle
between the horizontal projection of the speed vector of a gas flow and
its radially-oriented horizontal component equals 10 to 80 °.

3. Enhanced processing device for coating particles via a new airflow
15 vortex generator method according to claims 1 and 2,

characterised in that

the total slit clearance area, defined by the rotationally symmetric walls
of the airflow vortex generator (4), at the position where the generator is
attached to the edge of the distribution plate (3), ranges between 5% to
20 90% of the horizontal cross-sectional area, defined by the inner edge
(5a) of the separation cylinder (5).

4. Enhanced processing device for coating particles via a new airflow vortex generator method according to the previous claims,

characterised in that

the ratio between the surface area of the geometric solid, defined by the lower edge of one of the rotationally symmetric walls that form the airflow vortex generator (4) in an area, and the horizontal cross section area of the geometric solid defined the upper edge of the same wall, ranges between 1 and 200.

5. Enhanced processing device for coating particles via a new airflow vortex generator method according to the previous claims,

characterised in that

the barriers (18) for providing vortex flow are located below the level of the gas distribution plate (3).

15

6. Enhanced processing device for coating particles via a new airflow vortex generator method according to the previous claims,

characterised in that

the barriers for directing gas flow (18) are flat, curved, inclined or stepped.

20

7. Enhanced processing device for coating particles via a new airflow vortex generator method according to the previous claims,

characterised in that

the barriers for directing medium flow (18) are parallel to the axis of rotational symmetry of the device.

- 5 8. Enhanced processing device for coating particles via a new airflow vortex generator method according to the previous claims,

characterised in that

the barriers for directing medium flow (18), through which cuts an imaginary plane in such a way that the rotation axis of the airflow vortex
10 generator (4) lies thereon, are not parallel with this same plane.

9. Enhanced processing device for coating particles via a new airflow vortex generator method according to the previous claims,

characterised in that

15 the external of the two rotationally symmetric walls that constitute the airflow vortex generator (4), where the barriers for producing vortex gas flow are fitted, is attached to the edge of the distribution panel (3).

10. Enhanced processing device for coating particles via a new airflow
20 vortex generator method according to the previous claims,

characterised in that

the inside of the two rotationally symmetric walls that constitute the airflow vortex generator (4), where the barriers for producing vortex gas

flow are fitted, reaches above the lowest position of the distribution plate (3).

11. Enhanced processing device for coating particles via a new airflow
5 vortex generator method according to the previous claims,

characterised in that

the walls that constitute the airflow vortex generator (4), within the area where the barriers for producing vortex gas flow (18) are fitted, are horizontal.

10

12. Enhanced processing device for coating particles via a new airflow vortex generator method according to the previous claims,

characterised in that

that the distribution plate (3) can be flat, curved, inclined or stepped,
15 with a free surface to allow gas flow (e.g. perforations) of 1% to 50%.

13. Enhanced processing device for coating particles via a new airflow vortex generator method according to the previous claims,

characterised in that

20 that it can have multiple separation cylinders (5), one or more nozzles (6) and multiple airflow vortex generators (4).

14. Device for producing the vortex flow of the medium,

characterised in that

that at least two rotationally symmetric walls are positioned in a way that gives an intersection with flat surfaces, perpendicular to the rotation axis of symmetry of these walls and a space enclosed by said walls, the shape of the annular slit, and that these walls enclose an area inside which there are barriers to achieve gas flow and the device for achieving the vortex flow of the medium is connected to the processing medium, where the processing medium pressure is higher at the inlet port than at the outlet port of the device.

10

15. Device or achieving the vortex flow of gas or liquid, as per claim 14,

characterised in that

the barriers for directing gas flow are positioned between at least two at least almost rotationally symmetric walls and in such a way so that the angle between the medium flow velocity vector and its radially-oriented horizontal component is between 10 and 80 °.

15

16. Device for achieving the vortex flow of the medium, as per claims 14 and 15,

20

characterised in that

the walls of the device, located in the area where the barriers for directing the flow of the medium are located, must be horizontal.

17. Device for achieving the vortex flow of the medium, as per claims 14 to 16,

characterised in that

the ratio between the surface area of an imaginary geometric figure,
5 defined by the longer edge of any of the rotationally symmetric walls that constitute device for achieving the vortex flow of the medium in an area, and the surface area of the imaginary geometric figure **defined** by the shorter edge of the same wall, ranges between 1 and 200.

10 18. Device for achieving the vortex flow of the medium, as per claims 14 to 17,

characterised in that

the barriers for directing medium flow, through which cuts an imaginary plane in such a way that the rotation axis of the device for achieving the
15 vortex flow of the medium sits thereon, are not parallel with this same plane.

19. Device for achieving the vortex flow of the medium, as per claims 14 to 18,

20 **characterised in that**

the barriers for directing the flow of the medium are flat or curved.

20. Device for achieving the vortex flow of the medium, as per claims 14 to 19,

characterised in that

the barriers for directing medium flow are parallel to the axis of
5 rotational symmetry of the device.

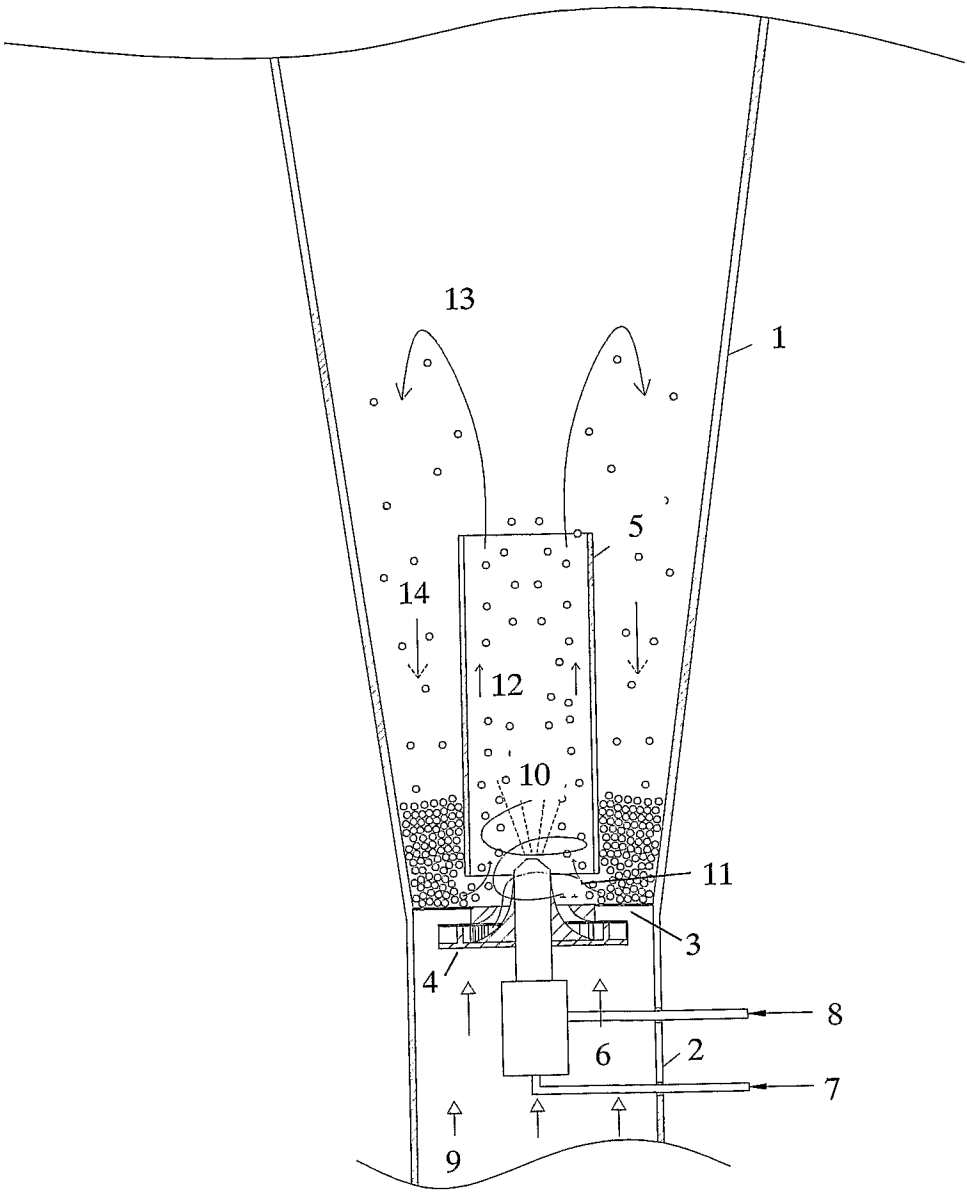


FIG. 1

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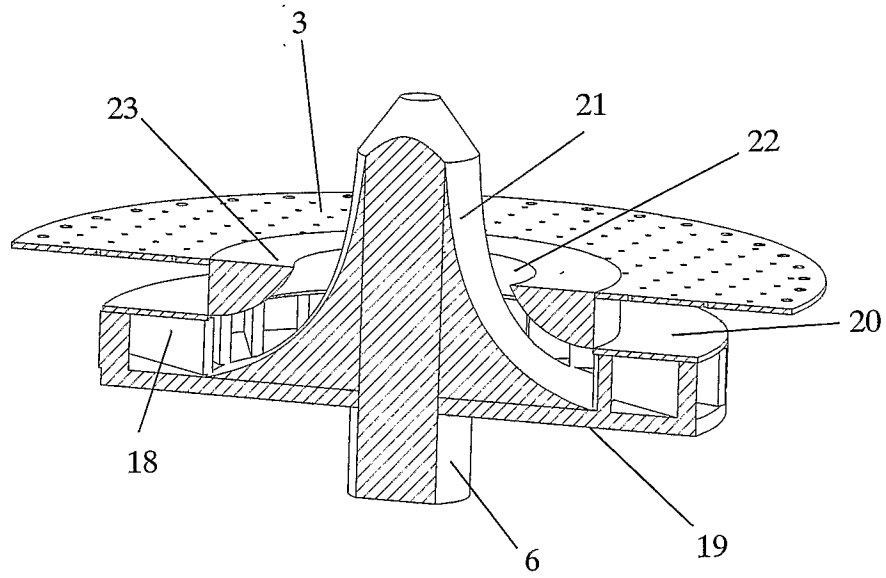


FIG. 3

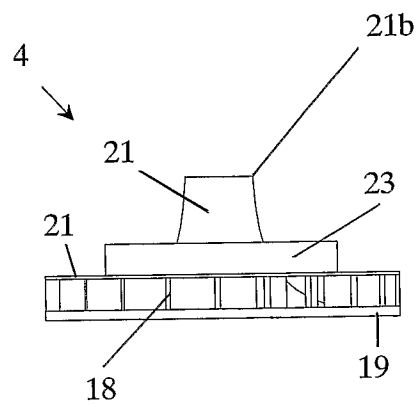


FIG. 4

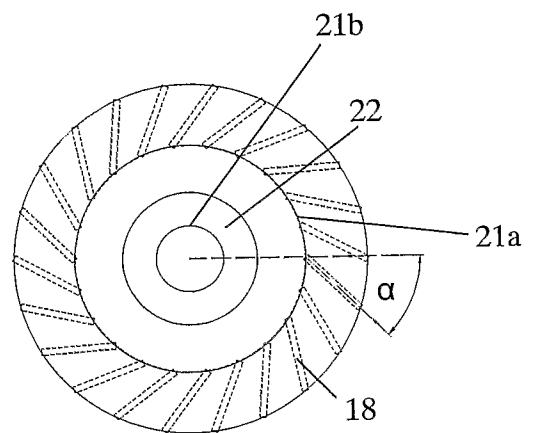


FIG. 5

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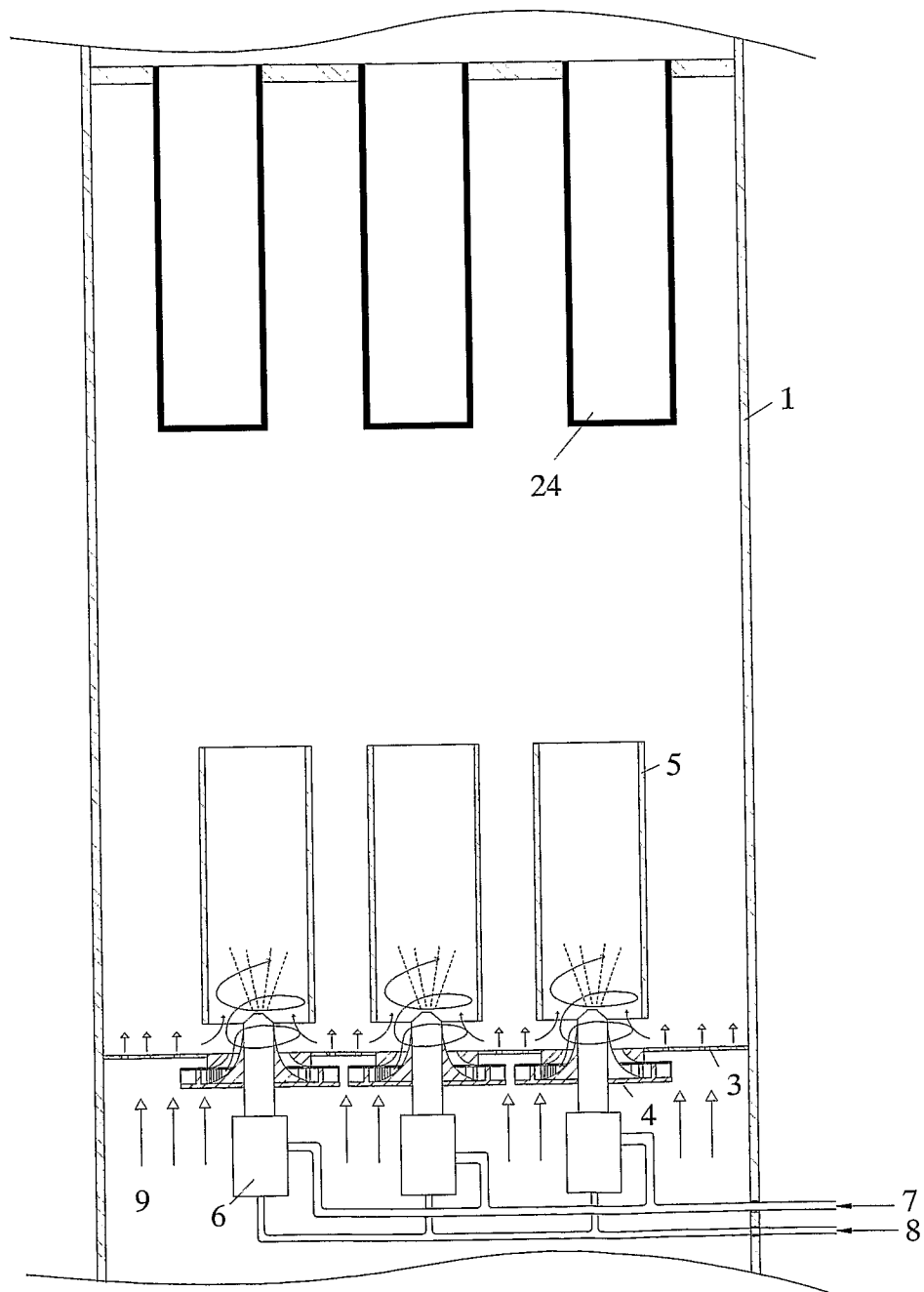


FIG. 6

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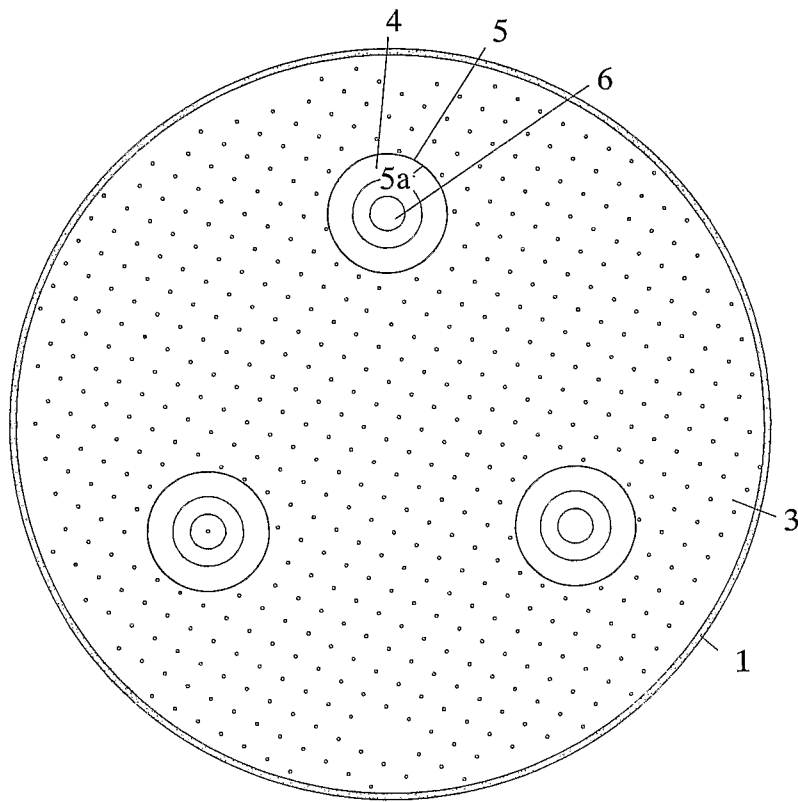


FIG. 7