

This invention relates to a classifier intended to separate from a flow of solid particles in suspension in a gas stream those particles the size of which is larger than a predetermined dimension and comprising guide blades arranged along the generatrices of a fictitious vertical-axis cylinder and capable of imparting a rotational motion around the axis of the cylinder to the gas stream which enters the said fictitious cylinder, a rotor placed inside the said fictitious cylinder, the axis of which coincides with that of the cylinder and which is provided with vertical regularly spaced blades on its periphery, and a central outlet situated above or below the rotor and through which the gas stream laden with those particles the dimensions of which are smaller than the said predetermined dimension is sucked.

In classifiers of this type, the particles in suspension in the gas stream are subjected to two antagonistic forces: a centrifugal force resulting from the rotational motion and a drag force due to the centripetal flow of the gas stream towards the central outlet. The coarse particles are separated at the level of the outside cylindrical surface of the rotor. If the gas stream is distributed uniformly over the whole height of the turbine, there is only one critical particle diameter or cut diameter corresponding to a particle in equilibrium on the outside surface of the rotor. The particles whose diameter is larger than the critical diameter are thrown against the guide blades by the centrifugal force and fall by gravity into a collecting hopper situated below the blades, whereas those particles whose diameter is smaller than the critical diameter are dragged by the gas stream through the rotor towards the central outlet.

In known units, the rotor is equipped with narrow blades arranged on its periphery and, in operation, a vortex in which a not inconsiderable part of the kinetic energy of the gas stream is dissipated forms at the centre of the rotor.

The purpose of this invention is to improve the performance and to

reduce the energy consumption of a classifier of this type through arrangements which permit an operation free from flow turbulence between the guide blades and the rotor, and prevent the formation of a vortex in the rotor.

5 The classifier forming the subject of this invention is characterized in that the rotor comprises a second set of blades which are arranged between the peripheral blades and the axis, and guide the streams of gas laden with fine particles which come out of the peripheral blades to the central outlet of the rotor. The blades of this second set extend over the whole height of the rotor and can be arranged in radial planes or inclined with respect to these planes.
10 They can be flat or curved, and can consist of an extension of the peripheral blades towards the axis. The central part of the end wall of the rotor opposite the outlet can have a streamlined shape, e.g. a truncated cone shape, favouring the flow of the gas toward the outlet.

15 Thanks to this second set of blades, a considerable part of the gas stream kinetic energy is used to rotate the rotor, which permits to reduce the power of the driving motor. In certain operating conditions, it is even possible to do without this motor, in which case the rotor speed, on which the cut diameter is dependent, is controlled by adjusting the direction of the guide blades.

20 To improve the accuracy of cut, it is advantageous to give the channels delimited by the peripheral blades of the rotor a section growing from the outside towards the inside of the rotor so that the centrifugal and drag forces acting on the grains the diameter of which is equal to the cut diameter practically counterbalance each other over the whole length of the said channels.
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As in any units of this type, the guide blades and the rotor are enclosed in a casing which delimits, around the guide blades, a ring-shaped chamber in which the gas stream, and possibly the materials to be classified, enter. The gas stream can enter this chamber tangentially or parallel to the axis of the
30 unit, from the bottom. The raw materials can be put in suspension in the gas

stream before it enters the said chamber, or introduced separately, from the top, in the space between the rotor and the guide blades ; these two feeding methods can also be used simultaneously.

5 According to a preferred embodiment of the invention, an inverted-cone shaped hopper is placed under the rotor and the guide blades to collect those particles the dimensions of which are larger than the cut diameter, the casing is a body of revolution, concentric with the rotor and surrounds also the said hopper providing around it a ring-shaped section passage, and a vertical duct is connected to the bottom of the said casing, under the said hopper and
10 coaxially with it, so as to direct the gas stream laden with the particles to be classified into the said chamber, through the said passage ; in the plane in which the said duct opens into the said casing, the diameter of the latter is significantly larger than that of the said duct so that the gases laden with particles may be subjected, when they enter the said casing, to a pressure
15 reduction which favours the fall of the heavy particles down to the bottom of the casing. The said duct can be extended upwardly above the bottom of the casing and can delimit with the latter a ring-shaped volume which will collect the coarse particles separated from the air stream in the pressure reduction zone created in this way, the bottom of the said casing being, preferably,
20 sloping and provided with an outlet for the said particles at its lower point. One or several deflectors consisting of flat or truncated-cone shaped rings can be fastened on the outside of the said hopper in order to divert the gas stream and to favour the separation of the coarse particles.

25 Other features of the invention will be brought to the fore by the following description which refers to the drawings appended thereto which show, as a non-limiting example, an embodiment of the invention and in which:

Figure 1 is a vertical section of a classifier constructed according to the invention ;

30 Figure 2 is a sectional view of the unit shown in figure 1 according to a horizontal plane, and

Figure 3 is a cross section of two blades of the rotor of the unit.

5 The classifier represented in the drawings comprises a casing 10 which constitutes the body of the unit and consists of a cylindrical upper part, an inverted truncated-cone shaped middle part, a cylindrical lower part connected to the small base of the truncated cone and a sloping bottom provided with an outlet 12 at its lower point. An inlet duct 14 for the gases laden with the particles to be sorted out runs through the bottom of the casing and extends approximately up to the junction plane of the middle and lower parts. Duct 14 is arranged coaxially to the casing and its end opens out.

10 The top of the casing is closed by a cover 16 provided with a central opening to the edge of which a gas discharge duct 18 is connected.

A rotor 20 is placed in the upper part of the casing, coaxially to the latter. It is attached to the lower end of a vertical shaft 22 mounted in a tubular support 24 fixed to cover 16, through antifriction bearings. The shaft is coupled to a variable speed drive 26 which permits to rotate the rotor at the required speed.

20 Rotor 20 comprises a great number of vertical blades 28 arranged at regular intervals on its periphery. The bottom and top ends of the blades are fixed respectively on a bottom 30 consisting of a flat ring and a central truncated cone integral with shaft 22, and on a ring 32. A labyrinth seal 34, integral with cover 16, ensures a tight joint between the latter and the rotor.

25 Blades 28 are arranged symmetrically to one another with respect to a plane containing the axis of the rotor and, as shown in figure 3, the width of the channels provided between the blades increases from the outside toward the inside of the rotor ($L_1 < L_2$) so that the centrifugal force and the drag force acting on a critical diameter particle (cut diameter) practically counterbalance each other over the whole length of the channels. If the centrifugal and drag forces at the inlet into a channel are referred to as F_{c1} and F_{t1} , and the same forces at the outlet of the channel as F_{c2} and F_{t2} , this operating condition can be expressed by the following relations:

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$$F_{c1} = F_{t1}$$

$$\text{and } F_{c2} = F_{t2}$$

5 The profile of the blades can be determined easily from these mathematical formulae which express the equality of the centrifugal and drag forces acting on a particle having given density and diameter, with a given rotor rotation speed. Balancing conditions can be met, with a given blade profile, for various cut diameters, by adopting various rotation speeds for the rotor.

10 Instead of being arranged radially, blades 28 could form an angle with the radial planes, the channels delimited by the blades growing always progressively wider in the inward direction.

The rotor further comprises a second set of blades 35 arranged between blades 28 and the axis of the rotor. In the example illustrated, blades 35 consist of flat sheets situated in vertical planes containing the axis of the rotor, and fixed to the truncated-cone shaped central part of bottom 30 and to the upper ring 32. These blades are intended to prevent the formation of a vortex inside the rotor, and permit to collect a significant part of the energy of the gas stream flowing through the rotor. Blades 35 could be inclined and/or could form an angle with the planes containing the axis of the rotor, and could also be streamlined as turbine blades. The rotor constituted in this way is comparable to the rotor of a centrifugal compressor which would work as a turbomachine taking energy from a continuous fluid flow to transform it into mechanical energy.

25 Such a construction of the rotor permits to eliminate the vortex which would form inside the rotor if the latter should have no blades 35, and consequently to recover the energy which, otherwise, would be lost in the vortex and, by reducing the speed of the gases, to reduce the wear due to abrasion and the headlosses.

30 The rotor is surrounded by a circular row of vertical guide blades 36 arranged at regular intervals around the rotor. The ends of these blades are

provided with pins 38 housed in holes of an upper ring 40 fixed on the top end of the casing and of a lower ring 42 mounted on the top edge of a truncated-cone shaped hopper 44 placed under the rotor, in the truncated-shaped part of the casing, and supported by legs 46 fixed to the casing.

5 The upper pins are provided with levers 48 linked with each other by a hoop in such a way that, whatever their direction, all the blades form the same angle with the respective radial plane. An actuator permits to remote control the direction of the blades by acting on the hoop.

The classifier described above works as follows:

10 The stream of gas laden with the particles to be sorted out flows upwardly in duct 14. When it reaches the top end of the duct, it is subjected to a sudden pressure reduction because of the significant difference in diameter of the duct and of the casing which surrounds it at that level. The result is a slowdown in the speed of the gas which enables the coarsest
15 particles to fall down to the bottom of the casing, in the ring shaped space provided between the end of the duct and the casing, and to be discharged through outlet 12. One or several deflectors 50 can be fixed to hopper 44, above duct 14, in order to improve this separation.

20 Then, the gas stream rises up to the top part of casing 10, at a nearly constant speed, and flows between blades 36, which impart it a circular movement, and enters the rotor through the channels provided between blades 28. Those particles the size of which is smaller than the cut diameter are dragged into the rotor by the gas stream and removed with the same through duct 18 which is connected to the inlet of a fan through a dust collector which
25 permits to separate the particles from the gas stream. Those particles the size of which is larger than the cut diameter are maintained outside the rotor by the centrifugal force and fall by gravity into hopper 44, through a ring-shaped slot provided between the rotor and ring 42. If one of these coarse particles enters accidentally one of the channels of the rotor, it will be thrown out since the
30 profile of these channels is designed in such a way that the centrifugal force

exerted on such a particle exceeds the drag over the whole length of the channel. The particles collected in hopper 44 are removed through duct 45.

As indicated above, a part at least of the particles to be sorted out could be introduced through one or several inlets 17 arranged above ring 32 of the rotor and thrown by the centrifugal force against a skirt surrounding ring 32 before falling into the space between blades 36 and the rotor and being put in suspension in the crosswise-flowing gas stream.

For a given gas flow rate, the cut diameter depends on the speed of rotation of the rotor. This speed is maintained at the selected value by regulating the speed of motor 26. Considering that, owing to the provisions of the invention, the power transmitted to the rotor by the gas stream flowing through it may exceed the power required to rotate it at the set speed, motor 26 shall be able to work as a brake with speed control. The direction of blades 36 is so adjusted according to the rotor speed that the tangential component of the gas speed and of the particles at the periphery of the rotor may be approximately equal to the peripheral speed of the rotor ; this adjustment can be done by hand or automatically. This measure prevents any impacts of the particles against the rotor blades, and permits to obtain an homogeneous fluid speed right across the channels between the rotor blades.

For some uses, it is possible, thanks to the invention, to do without motor 26, provided that the rotor be mounted free. In this case, the rotor speed is maintained at the set value corresponding to the selected cut diameter, by adjusting the direction of blades 36.

This possibility results in significant savings because it doesn't only permit to do without any driving motor but also to use a lighter supporting structure for the rotor.

Instead of being allowed to pass axially into the casing from the bottom, as in the units described, the gas stream could be allowed to enter it tangentially, at the level of blades 36.

In the embodiment represented in the drawings, the growth, from the

inlet to the outlet, in the cross-section of the channels provided between the blades of the rotor is achieved only by increasing their width. It could be considered increasing also their height by replacing the plane peripheral part of disc 30 and plane ring 32 by truncated-cone shaped rings the large bases of which would face each other.

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Of course it's understood that these modifications and any ones resulting from the substitution of equivalent technical means fall within the scope of the invention.

CLAIMS

1. Centrifugal action air classifier comprising guide blades arranged along the generatrices of a fictitious vertical-axis cylinder, and capable of imparting a rotational motion around the axis of the said cylinder to a gas stream entering the said fictitious cylinder, a rotor placed coaxially inside the said fictitious cylinder and provided with vertical regularly-spaced blades on its periphery, means to introduce the particles to be sorted out between the blades and the rotor and a central outlet through which the gas stream laden with those particles the dimensions of which are smaller than a predetermined dimension is sucked, characterized in that the rotor comprises a second set of blades (35) which are arranged between the peripheral blades (28) and the axis, and guide the streams of gas which come out of the peripheral blades (28) to the central outlet of the rotor.
2. Air classifier according to claim 1, characterized in that the said blades (35) extend over the whole height of the rotor and are arranged in radial planes or inclined with respect to these planes.
3. Classifier according to claim 1 or 2, characterized in that the rotor end wall (30) opposite the central outlet is so streamlined as to favour the flow of the gas toward the said outlet.
4. Classifier according to claim 1, 2 or 3, characterized in that the rotor is mounted free and means are provided to adjust the direction of the guide blades (36) so as to maintain the speed of the rotor at a set value.
5. Classifier according to anyone of the above claims, characterized in that the rotor blades (28) are streamlined in such a way that the channels formed between the blades widen from the outside toward the inside of the rotor.



6. Classifier according to anyone of the above claims, characterized in that it includes an inverted truncated-cone shaped hopper (44) placed under the guide blades (36) and the rotor to collect those particles separated from the gas stream the dimensions of which exceed the said predetermined size, a casing of revolution (10) surrounding the guide blades and the hopper and a vertical duct for conveying the stream of gas laden with the particles to be sorted out (14) which is connected to the lower part of the said casing, the duct, the hopper and the casing being coaxial, and in that, in that plane in which the said duct opens into the casing, the diameter of the latter is markedly larger than that of the said duct, so that the gas laden with particles is subjected, on its entering the said casing, to a pressure reduction which favours the fall of the heavy particles down to the bottom of the casing which is provided with means (12) for discharging the said particles.
7. Classifier according to claim 6, characterized in that the said duct (14) extends upwardly above the bottom of the casing (10) and delimits with the latter a ring-shaped volume in which the heavy particles are collected.
8. Classifier according to claim 6 or 7, characterized by one or several ring-shaped deflectors (50) fixed on the outside of the said hopper (44), at a certain distance above the top end of the said duct (14).
9. Classifier according to anyone of claims 1 to 5, characterized in that it comprises a casing (10) which surrounds the said guide blades (36) and delimits with the same a ring-shaped inlet chamber for the gas stream, means for introducing at least a part of the particles to be sorted out from the top between the rotor and the guide blades (36) and means (14) for allowing the gas stream to pass into the said chamber, either tangentially or from the bottom.

