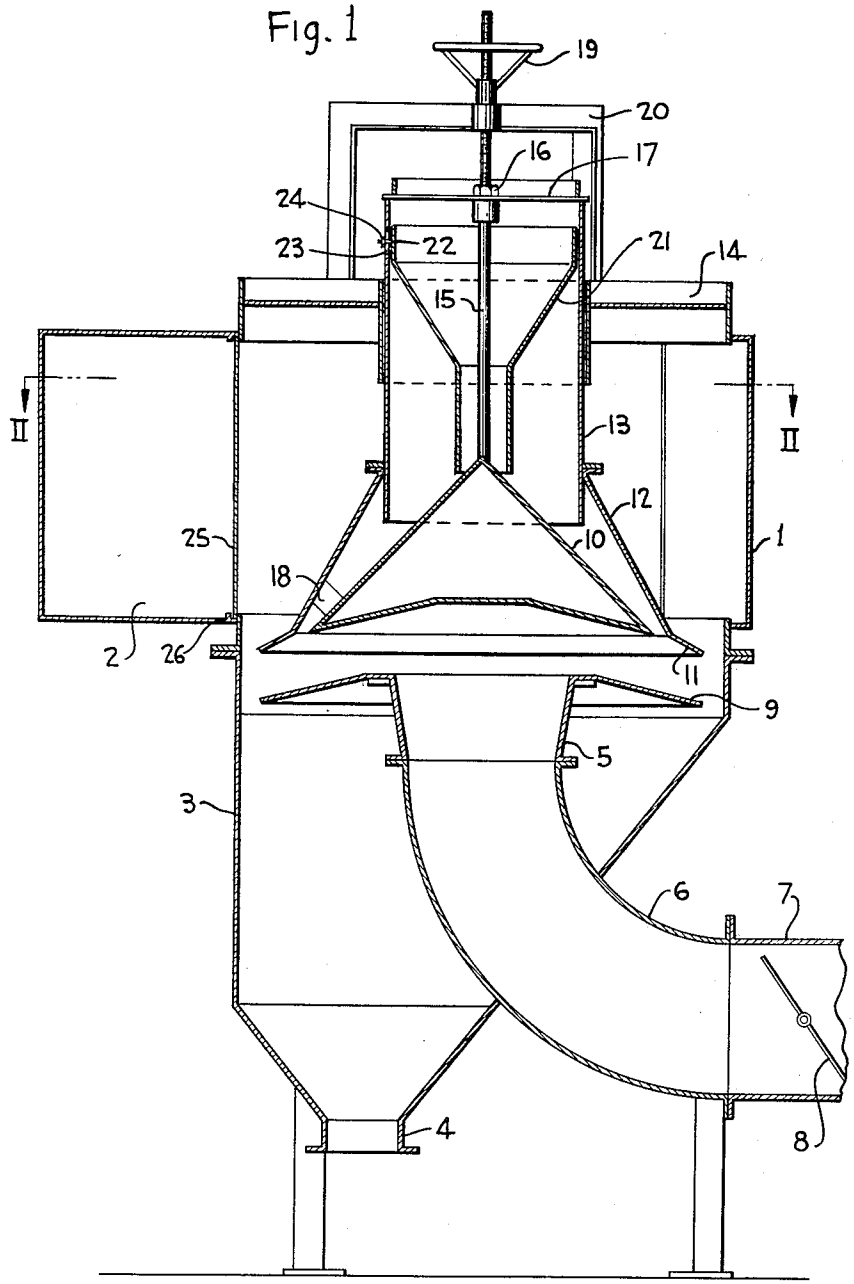
Jan. 26, 1960 K. A. G. GUSTAVSSON ET AL 2,922,520

CENTRIFUGAL WIND CLASSIFIERS

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Fig. 1



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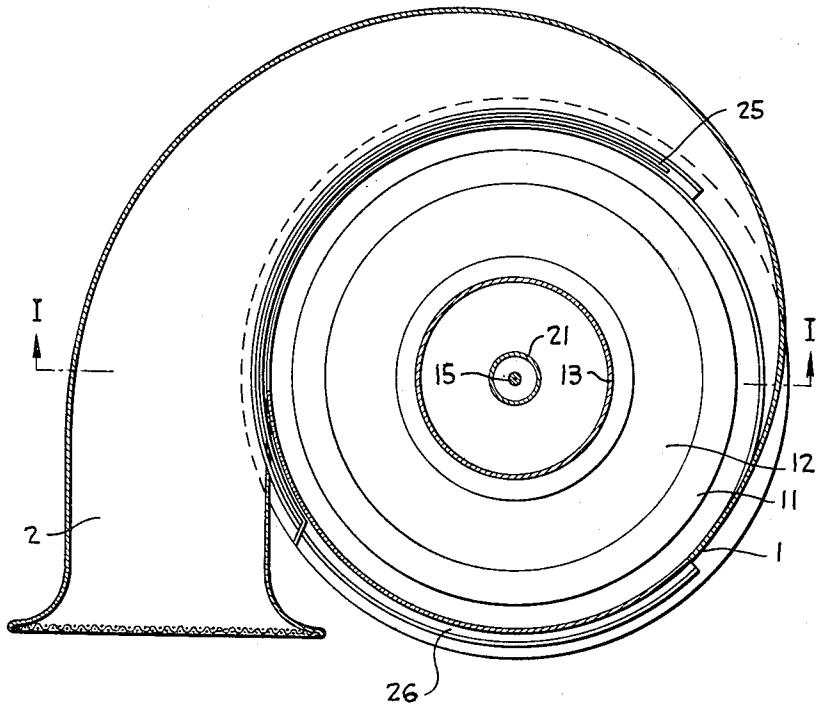
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CENTRIFUGAL WIND CLASSIFIERS

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Fig. 2



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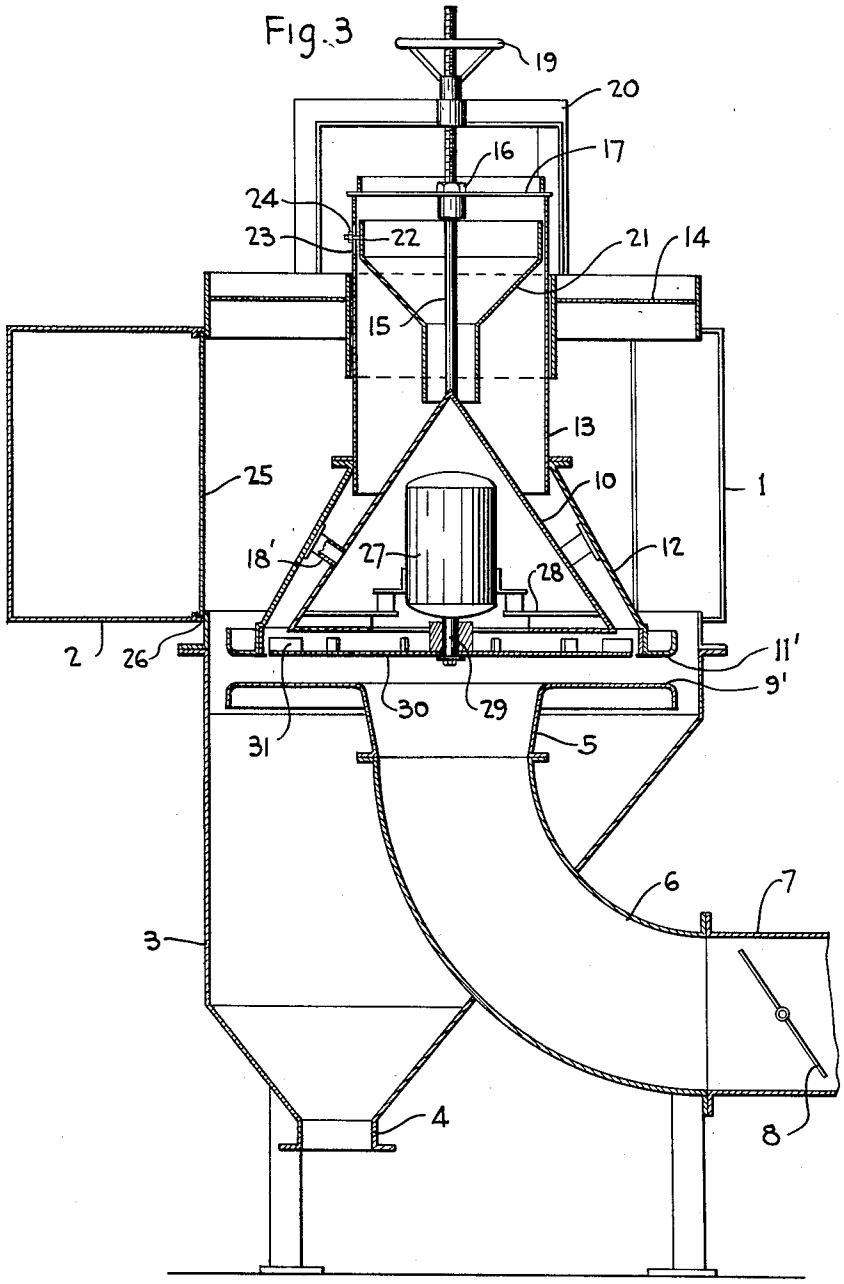
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CENTRIFUGAL WIND CLASSIFIERS

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Fig. 3



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CENTRIFUGAL WIND CLASSIFIERS

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Application March 4, 1958, Serial No. 719,076

Claims priority, application Sweden March 8, 1957

4 Claims. (Cl. 209—144)

The present invention relates to a centrifugal wind classifier for separating or fractionating granular or pulverulent material. The main object of the invention is to arrange a centrifugal wind classifier so that a sharp fractionation limit can be achieved for all types of material which are to be treated in the classifier with regard to the special characteristics of the materials, as well as to achieve the most efficient possible utilization of the classifier.

The invention relates to a centrifugal wind classifier of the type in which the material to be classified is introduced into a stationary separation chamber as an evenly distributed annular curtain and is separated in the separating chamber into a coarse and a fine fraction by means of a gas current which is introduced into a space surrounding the separating chamber through a tangentially directed gas inlet and is thereby imparted a rotary motion and then enters the separating chamber around the circumference thereof and finally leaves at the center of the separating chamber. The above-mentioned main object of this invention is achieved thereby that the width of the tangential gas inlet and the height of the separating chamber are adjustable whereby it is possible to vary both the tangential and the radial velocity components of the gas current flowing through the separating chamber.

In a preferred embodiment of the invention, the separating chamber contains a rotatable plate provided with blades, said plate being mounted to rotate in a plane substantially perpendicular to the annular curtain of material and to impart to the material a tangential velocity component substantially corresponding to the tangential velocity component of the gas current when the width of the tangential air inlet is adjusted to a middle position. Thereby, the material to be classified will be imparted an initial tangential velocity component which normally is close to that which it is to be imparted by the gas current so that the work which the gas current has to perform to impart to the material the desired tangential velocity will correspond only to a minor acceleration or, possibly, deceleration of the material. Thereby, the fractionation efficiency of the apparatus will be improved.

The invention will be described more in detail below with reference to the accompanying drawings which show two embodiments serving to illustrate but not to limit the invention.

Figure 1 shows one embodiment in vertical central cross-section.

Figure 2 shows a horizontal cross-section along line II—II in Figure 1.

Figure 3 is a vertical central cross-section similar to Figure 1 but illustrating a second embodiment.

Referring to Figures 1 and 2, the centrifugal wind classifier comprises a substantially cylindrical casing 1 formed integral with a tangentially directed air inlet 2, and a conical bottom part 3 attached to the casing 1, the part 3 forming a hopper for collecting the coarse

material separated and having an outlet 4 for discharging the coarse material. A central air outlet 5 is disposed adjacent the center of the upper portion of the bottom part 3 and communicates through a conduit 6 which passes through the wall of the bottom part 3 with a conduit 7 which leads to a fan (not shown) and is provided with a damper 8 by means of which the rate of air flow can be regulated.

Affixed around the circumference of the air outlet 5 is a conical annulus 9 which forms the lower wall of the separating chamber. Upwardly, the separating chamber is defined by the bottom wall of a conical material distributor 10 and by a frustoconical flange 11 attached to a conical jacket 12 surrounding the material distributor 10. The jacket 12 is attached to a cylinder 13 which extends upwardly through a central opening in a roof 14 which closes the top of the classifier. The material distributor 10 is attached to a rod 15 concentric with the cylinder 13. The upper portion of the rod 15 is threaded and carries a nut 16 which rests on a yoke 17 attached to the cylinder 13. By tightening the nut 16, the jacket 12 can be caused to engage a number of spacer members 18 attached around the material distributor 10, which spacer members determine the width of the clearance between the material distributor 10 and the jacket 12. The upper threaded part of the rod 15 also carries a handwheel 19, which rests on a yoke 20 carried by the roof 14. By means of this handwheel the assembly comprising the material distributor 10, the cylinder 13 and the jacket 12 with associated parts can be lifted or lowered, so as to vary the height of the separating chamber.

Disposed in the cylinder 13 and surrounding the rod 15 is a material feeding funnel 21 which is vertically displaceable. Around its upper circumference the funnel 21 has a number of bolts 22, which project through slots 23 in the cylinder 13 and which carry nuts 24, by means of which the funnel can be fixed in the desired position.

The tangential air inlet 2 can be partly or wholly closed by a damper consisting of a substantially semicircular plate 25 which is adapted to slide in guiding channels 26.

In operation, the material to be classified is fed through the funnel 21 and slides along the conical outer surface of the material distributor 10 at a rate determined by the clearance between the top end of the material distributor 10 and the lower end of the funnel 21, which clearance is adjusted by positioning the funnel 21 as explained above. Thereupon, the material falls into the separating chamber as an annular curtain through the clearance between the material distributor 10 and the jacket 12. Air enters through the inlet 2 and is given a rotating motion within the casing 1. During continued rotation the air then enters the separating chamber from which it flows through the outlet 5. The material to be classified is carried along in the rotating movement of the air in the separating chamber. The fine material is carried by the air current towards the center of the separating chamber and may be recovered from the air flowing away through the conduit 7, while the coarse material is thrown out toward the circumference of the separating chamber by the centrifugal force to fall down into the lower part 3 of the classifier from which it may be discharged through the opening 4. The tangential velocity component of the air in the separating chamber is adjusted by closing the air inlet to a desired extent by means of the damper 25, while its radial velocity component is determined by the height of the separating chamber which is adjusted as above explained. By this combined possibility of adjustment a very sharp fractionating limit may be set within wide limits of

particle sizes, and at the same time both the radial and the tangential velocity components may be varied within wide ranges, whereby it will be possible to adjust the conditions in the separating chamber to suit the character of the material treated and also to utilize the classifier in the most efficient way possible for the material in question. This will be understood from the following explanation.

A particle in the separating chamber is subjected to the actions of two oppositely directed forces. One of them is directed radially outwardly and is a function of the tangential velocity of the gas, the radius of rotation and the diameter and specific gravity of the particle. The other force is directed radially inwardly and results from the friction of the gas on the particle surface. It is a function of the radial velocity of flow of the gas, the particle diameter, the specific weight of the gas and a coefficient of resistance which in its turn is a function of Reynolds' number and of the cinematic viscosity of the gas. The two forces can be expressed by the following equations:

$$C=\frac{\pi D^3 \gamma_p}{6g}\cdot V_t^2\cdot\frac{1}{R}$$

$$F_x=C_x\cdot\frac{\pi D^2}{4}\cdot\frac{\gamma_1 \cdot V_R^2}{2g}$$

Where

C=the force directed radially outwardly
D=the particle diameter
γ_p=the specific gravity of the particle
V_t=the tangential gas velocity
R=the radius of rotation (radius of the separating chamber)
F_x=the force directed radially outwardly
γ_1=the specific gravity of the gas
V_R=the radial gas velocity
C_x=a coefficient of resistance
g=the gravitation constant

For a given rate of gas flow, V_t is a function of the gas inlet width and V_R is a function of the height of the separation chamber.

If $C=F_x$, D can be solved, provided that the values of the other variables are known. A particle having a diameter D determined in this way will be in equilibrium (i.e. it will rotate without moving either inwardly or outwardly), while larger particles are thrown outwardly and finer particles are carried along inwardly by the gas current. Thus, this diameter D is the fractionation limit under the conditions prevailing in the separating chamber.

From a study of the above equations it will be seen that for a certain particle in equilibrium (a certain fractionation limit) an arbitrary value for V_t or V_R can be selected and a corresponding V_R or V_t, respectively, can be calculated. Thus, if a certain separating chamber height has been selected, a gas inlet width corresponding thereto can be calculated and adjusted. On the other hand, if a certain inlet width has been selected, a corresponding separating chamber height can be calculated and set.

It is seen from the above, that if the height of the separating chamber is invariable, a predetermined fractionation limit may be obtained only with a definite value for the tangential air velocity (width of air inlet). On the other hand, if the width of the air inlet is invariable, a predetermined desired fractionation limit can be obtained only with a definite radial air velocity (height of separating chamber). In both of these cases therefore, the classification operation is restricted to a definite value for both the tangential and the radial gas velocity components to obtain a certain desired fractionation limit. In contrast, if according to the present invention both the width of the gas inlet and the height of the separating chamber can be varied, the desired fractionation limit can be obtained within wide ranges of both radial and tangential air velocities provided that these two variables are adjusted to each other in accordance with the equations above. This means that it is possible to select either the radial air velocity or the tangential air velocity freely in a manner such that it is suitable for the material to be treated and thereupon adjust the tangential velocity or the radial velocity respectively so that the desired fractionation limit is obtained. Thus, e.g., for some types of material, it may be suitable to subject the material to an intense centrifugal field. In such a case a high tangential air velocity will be selected, whereupon a high radial air velocity corresponding to the tangential velocity and to the desired fractionation limit is determined. Furthermore, for some types of material it may be desirable to work with a great height of the separating chamber (if the material to be classified is voluminous). In such a case the fractionation limit may be obtained by adjusting the air inlet width to a corresponding value.

It appears from the above considerations, that the combination of this invention permits a sharp adjustment of a desired fractionation limit with simultaneous regard to the character of the material treated in a manner which is impossible to achieve if only the tangential air velocity or only the radial air velocity is variable. Furthermore, for each material it is possible to select the conditions such that the apparatus is utilized as efficiently as possible for the material by selecting the highest possible air velocities which can be withstood by the material.

The embodiment of Figure 3 is substantially similar to that described above with reference to Figures 1 and 2, and the parts which are similar have the same reference characters. These parts need not be described anew.

In this embodiment the lower defining wall of the separating chamber, which is denoted **9'**, is plane instead of conical and similarly, the flange **11'** of the jacket **12** is plane. Furthermore, an electric motor **27** is arranged within the air distributor **10** and is carried by a support **28** disposed within the air distributor. On the motor shaft **29** there is attached a disc **30** provided with blades **31**. These blades will impart to the material falling down between the distributor **10** and the jacket **12** a tangential component of velocity which is substantially equal to the tangential component of velocity of the air current when the damper **25** is in a middle position. Thereby, the fractionation efficiency will be improved, as explained hereinbefore. In this embodiment, the material distributor is rigidly secured to the jacket **12** by means of the spacers **18'**, which in this case are tubular. Through them air will be aspirated by the blades **31** to cool the motor **27**. Otherwise, the function of this embodiment is in every respect similar to that which has been described above with reference to Figures 1 and 2.

While specific embodiments and details have been shown and described, the invention is not limited to them, since many modifications and variations obvious to those skilled in the art are possible without departing from the spirit and scope of this invention.

We claim:

1. A centrifugal wind classifier comprising a vertical substantially cylindrical casing, two substantially horizontal walls disposed in said casing concentric therewith and spaced therefrom to define a separating chamber within said casing, a tangential gas inlet tangentially intersecting said casing, a central gas outlet in one of said horizontal walls, whereby a gas introduced into said casing through said tangential inlet has imparted to it a rotating movement and passes through said separating chamber and out through said central outlet, means for feeding material to be classified as an evenly distributed annular curtain into said separating chamber adjacent its circumference to cause separation of said material into coarse and fine fractions by said gas current, means for varying the height of said separating chamber, and a substantially

semi-cylindrical damper slidable along the circumference of said casing to vary the width of said tangential air inlet.

2. A centrifugal wind classifier as in claim 1 in which said means for varying the height of the separating chamber comprises means for vertically displacing its upper defining wall.

3. A centrifugal wind classifier as in claim 1, in which said means for feeding material into said separating chamber comprises a conical material distributor and a funnel disposed above said material distributor to feed material to the outer surface of the material distributor and which is adjustable relatively to the material distributor to vary the rate of material feed.

4. A centrifugal wind classifier as in claim 1, also comprising a plate mounted in said separating chamber to

rotate in a plane substantially normal to the annular curtain of material, blades mounted on said plates, and means for rotating said plate to impart to the material a tangential velocity component substantially equal to the tangential velocity component of the gas when the width of the tangential gas inlet is adjusted to a middle position.

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