

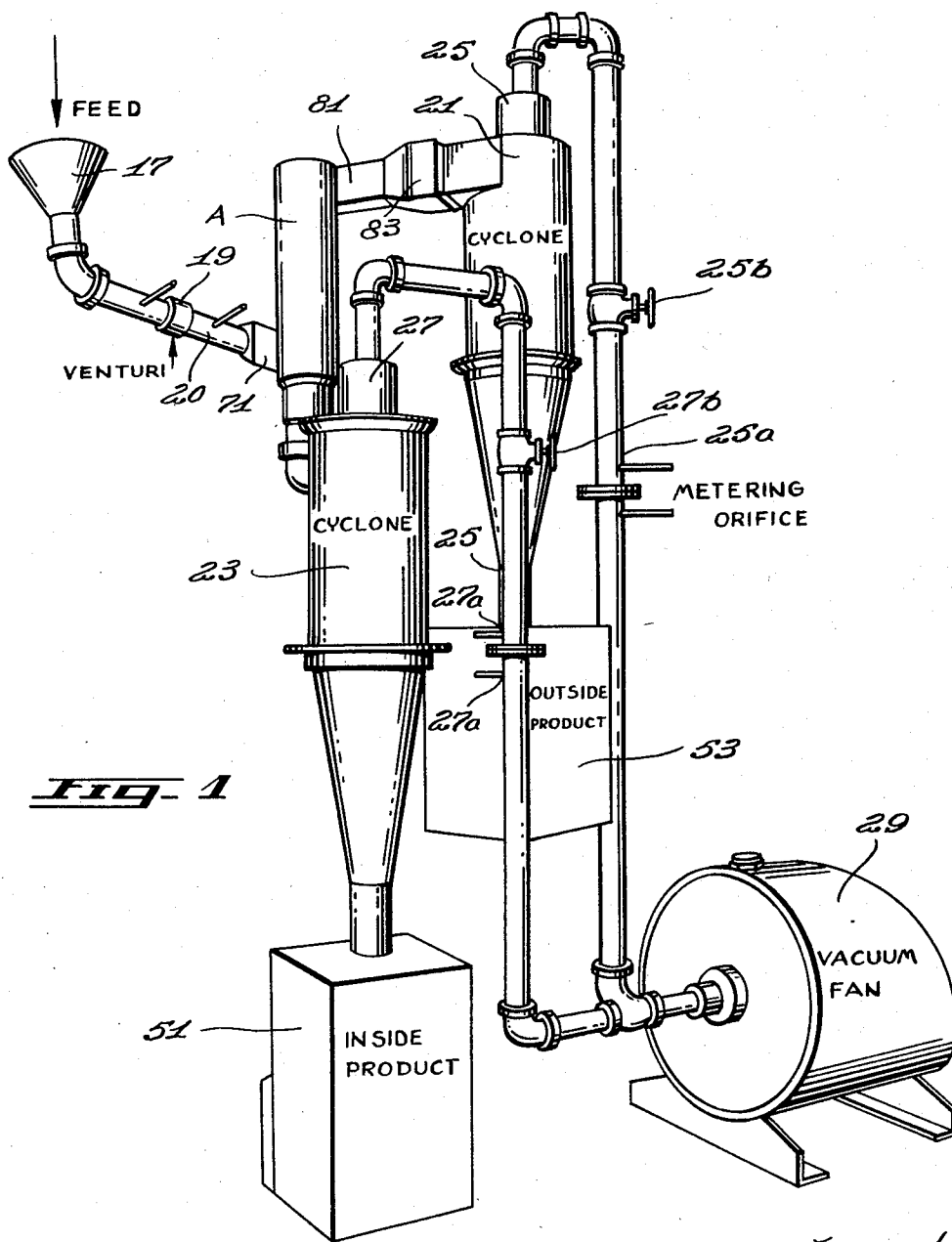
Oct. 27, 1959

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MATERIAL CLASSIFICATION

2,910,178

Filed Oct. 31, 1957

2 Sheets-Sheet 1



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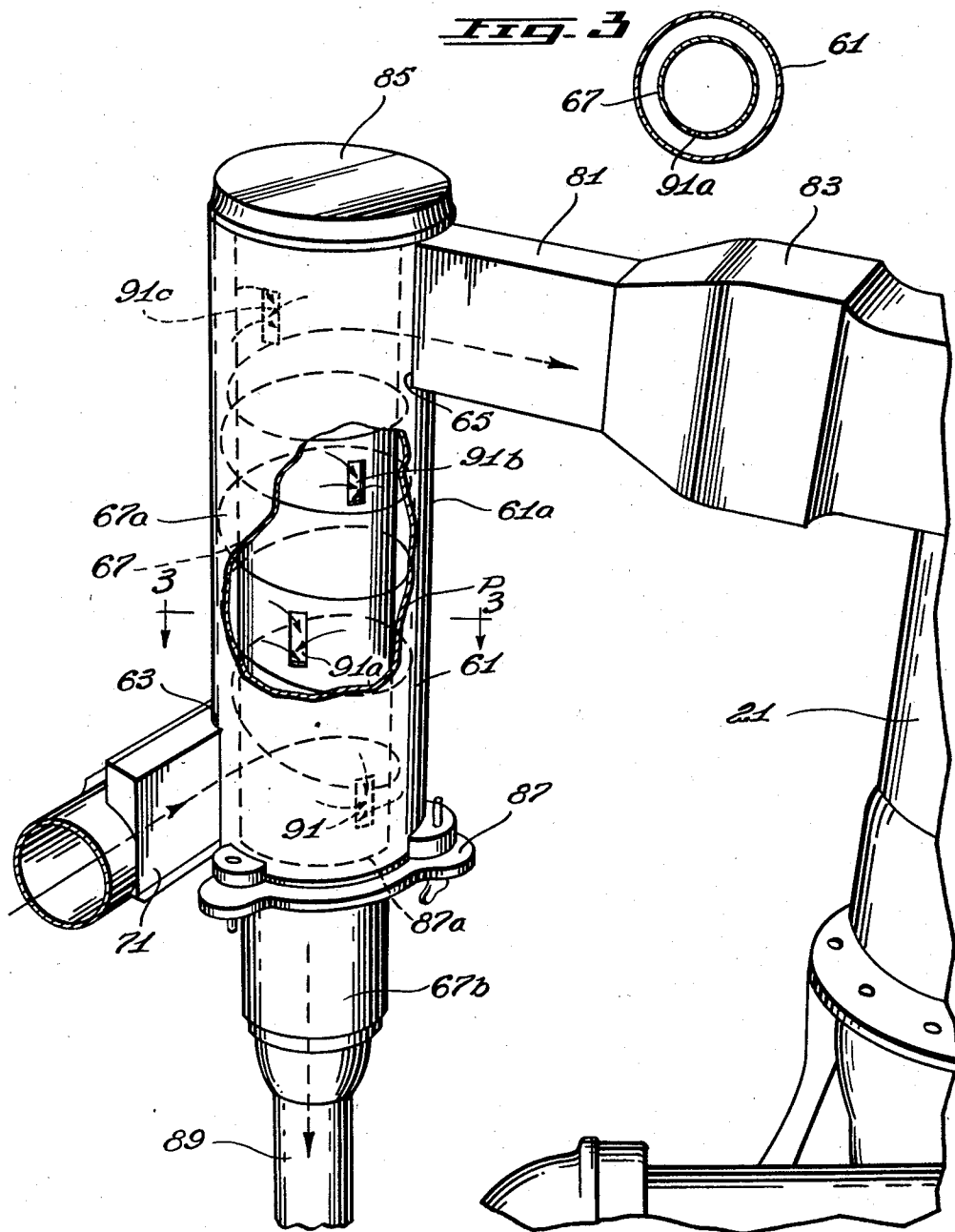


Fig. 2

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2,910,178

MATERIAL CLASSIFICATION

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Application October 31, 1957, Serial No. 693,575

Claims priority, application Canada September 7, 1957

4 Claims. (Cl. 209—144)

This invention relates to improvements in segregating the particles of a finely divided material into controlled fractions.

More specifically, the invention relates to a type of separation which, broadly speaking, functions on the principle of the separation method of United States Patent 2,616,563, to Hebb, November 4, 1952, and is particularly applicable to roughly equidimensional particles, acicular particles or flaky particles.

In this type of separation, the material to be separated is subjected to the opposed forces of fluid flow and centrifugal force. The viscous forces influence one group of particles while another group of particles stays in the flow.

One of the disadvantages of the prior processes falling within this general class is that they are not adaptable to various types of material without substantial change in the apparatus. The applicant has developed a method capable of being calibrated to handling different materials merely by adjusting the absolute values and the ratio of the forces.

The method comprises setting up a spiral stream of air by projecting the air tangentially into the inside of one end of a cylinder while withdrawing air from the other end of the cylinder, thereby setting up centrifugal force in the stream and limiting the outward draw on the particles by the cylinder wall. At the same time, a contrary force is imposed against the centrifugal force at spaced apart intervals by acting on the particles with negative pressure. The lighter particles are thus drawn inward out of the spiral stream and the heavier particles held in this stream, by the centrifugal force. The lighter particles are drawn off and removed and the heavier particles remain in the stream and are removed separately. This method may be varied to change the nature of the fractions separated from the particles by changing the ratio of the force tending to draw off the lighter particles in relation to the force tending to retain them in the stream.

Applicant's development

The applicant's apparatus is made up as follows. It includes an elongated hollow outer cylinder and an inner cylinder within the outer cylinder. This outer cylinder has an imperforate wall which includes an inlet opening at one end and an outlet opening at the other end, and the inner hollow cylinder has a wall spaced from that of the outer cylinder to form therebetween a feed passage. A feed duct is connected to the inlet opening and is so disposed as to project material into the passage tangentially to the wall of the outer cylinder. An outlet duct is connected to the outlet opening. A cylinder is arranged within the outer cylinder. The inner cylinder also provides an inner passage for a fraction of the material. The inner cylinder is closed at the end near the outlet of the outer cylinder and is at the other end provided with an outlet opening. The wall of the inner cylinder is provided with openings arranged along the length of the cylinder, preferably in a spiral. A supply line leads

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to the inlet duct. A suction line leads from the outlet of the inner cylinder. Another suction line leads from the outlet of the outer cylinder. Each suction line is connected to a vacuum source. Means is provided for controlling the respective vacuum sources, whereby there are differential forces exerted on the respective particles of the entering material causing particles having a certain characteristic to enter the inner cylinder and particles having other characteristics to stay in the outer cylinder. Two groups of particles are thus separated and may be drawn away.

Preferably, each of the suction lines leads to a separator, for example a cyclone. In this case each separator has an outlet for separated fractions of the material and for air respectively. Each of the air outlets is connected to a controllable vacuum source. Respective metering devices indicating the flow in each of the air outlets and at the material feed inlet are provided.

In accordance with the invention, the area and distribution of the openings in the inner cylinder is such that the velocity of the air entering the inner cylinder is high enough to produce viscous forces acting on a certain group of particles, superior to the centrifugal forces acting on the same particles. Preferably, the applicant has found that elongated or rectangular openings are most satisfactory. The cylinders may be made out of any suitable abrasion-resistant material.

The invention has been generally described and it will now be referred to in more detail by referring to the accompanying drawings which illustrate a preferred embodiment and in which:

Figure 1 is a general arrangement showing the relationship of the various parts of the apparatus.

Figure 2 is a perspective view showing the separator proper.

Figure 3 is a horizontal cross section along the line 3—3 of Figure 2.

The invention will now be described in more detail with reference to the drawings in terms of the operation of the apparatus.

The material to be separated, which for example is asbestos, is fed into the funnel 17, it passes through a venturi-meter 19 and through a pipe 20 into the separator proper, A. In the separator A the material is separated into the exterior and the interior product respectively. A cyclone separator 21 receives the exterior product and a cyclone 23 the interior product.

The fresh air outlets 25 and 27 of the respective cyclones are metered by orifices or other means 25a and 27a and are connected to a fan 29 which acts as a vacuum source. While a fan has been shown, this could be any suitable source of vacuum.

A manometer panel (not shown) is provided with instruments where the differential pressure readings may be noted for the orifices 25a and 27a and the venturi. The air flow in the two outlets 25a and 27a is adjusted by valves 25b and 27b. The legend "metering orifice" has been applied at 25a. This, of course, presumes the necessary metering apparatus.

The inside product is discharged into a hopper 51 and the outside product into a hopper 53.

Separator proper

The separator proper A is made up as follows. It includes a hollow outer cylinder 61. The outer cylinder has an imperforate wall which includes an inlet opening 63 at one end and an outlet opening 65 at the other end. An inner hollow cylinder 67 is mounted within the outer cylinder 61. The inner cylinder 67 has a wall 67a spaced from the wall 61a to form between the two walls, a feeding passage. A feed duct 71 is connected to the inlet opening 63 and is so disposed as to project

material into the passage between the walls 61a and 67a tangentially to the wall 61a. The duct is preferably of substantially the conformation shown, being a somewhat rectangular discharge mouth. An outlet duct 81 is connected to the outlet opening 65 and thence to a duct 83 leading to the cyclone 21. The duct 83 does not have to widen out, as shown, but can be tied to the inlet to the cyclone 21 without change in dimensions.

The inner cylinder and the outer cylinder both terminate at a common head 85, which blocks the top end of each. The bottom end of the cylinder 61 carries a header 87, the cylinder 67 projects through an opening 87a and has a portion 67b projecting beyond the header to a connection with a conduit 89, which leads to the cyclone 23. The wall 67a of the inner cylinder is provided with a number of openings 91, 91a, 91b and 91c. These openings are preferably arranged spirally on the wall 67a.

Operation of separator unit A

The fiber coming from the funnel 17 is drawn by the vacuum pressure applied to the cyclones through the inlet chute 71 and into the passage between the walls 61a and 67a. The total material to be treated is projected tangentially into the passage between the walls 61a and 67a and the suction from the outlet chute 81 causes it to take a spiral path, as shown in dash lines, from the bottom to the top of the passage P. The negative pressure within the cylinder 67 acts on the inside product causing it to pass through the openings 91, 91a, etc. The outside product continues to remain in the spiral stream and reaches the outlet chute 81. In this way, the material to the apparatus is separated into an inside and an outside fraction.

The required flows in the respective outlet ducts 83 and 89 can be readily adjusted. The different velocities of the respective fractions cannot be estimated with any great accuracy. Moreover, the projected area and drag coefficient for one given particle or fiber are beyond the experimental determination. However, both forces will play one against the other and their values may be controlled by controlling the out flows. By varying the values and ratios of these outflows, a given granulometric composition can be had in the fiber or particle carried by one or both of the outflows from a specified feed material.

The classifier functions on the theory that if a particle or fiber is admitted tangentially with a certain velocity inside the cylinder 61 it will tend to hug the inside surface of the cylinder. The force which throws the particle or fiber against the inside surface is

$$\frac{w v^2}{g r}$$

where w is the weight in pounds of the particle or fiber, g is the acceleration due to gravity in feet/sec.², v is the tangential speed of the particle or fiber in feet/sec. and r is the radius of the cylinder in feet.

With the smaller cylinder 67 inside the cylinder 61, part of the incoming air is forced to pass through the small openings 91, 91a, etc. in the wall 67a, thereby creating a large inward velocity at those openings, a further force thus being generated on the particle or fiber, that force results from the fact that air is viscous and will tend to carry with it particles or fibers. This force due to viscosity is expressed by the formula

$$F_D = C_D \rho v^2 A$$

where C_D equals drag coefficient, ρ equals air density in slugs/pi³, v equals air velocity relative to the particle in feet/sec., A equals projected surface of the particle in feet².

I claim:

1. An apparatus for segregating particles of finely divided material including particles of different sizes, comprising an elongated outside cylinder, and an elongated inside cylinder co-extensive therewith and mounted concentrically therein to provide an annular space between the outside and inside cylinders, said outside cylinder having a wall including an inlet opening at one end and an outlet opening at the other end, said inside cylinder having a wall provided with inlet openings distributed along its length and an axial outlet opening at the end near the inlet opening of the outside cylinder, means closing the ends of both cylinders adjacent to the outlet opening of the outside cylinder, means closing the space between the outside and inside cylinders at a position on the side of the inlet opening of the outside cylinder remote from said closed ends the outside and inside cylinders forming therebetween a passage for a heavier fraction of finely divided material and air leading from the inlet opening to the outlet opening of the outside cylinder, a feed duct connected to the inlet opening of the outside cylinder and so disposed as to project material into the outside cylinder substantially tangentially to its wall thereby to impart to the material a whirling path, an outlet duct connected to the outlet opening of the outside cylinder, a supply line for feeding material leading to the inlet duct, a negative pressure line leading from the outlet of the inner cylinder for applying negative pressure to said inlet and a negative pressure line leading from the outlet of the outer cylinder for applying negative pressure thereto independent of the negative pressure applied to the inner cylinder outlet whereby the relative negative pressure in the respective cylinders may be adjusted.

2. An apparatus as defined in claim 1 in which the feed openings on the inside cylinder wall are arranged in a spiral.

3. An apparatus as defined in claim 1 in which each negative pressure line is connected to a separator for separating air from the entrained particles, each separator having an outlet for separated fractions of the material and for air, each of said air outlets being connected to a controllable vacuum source, and respective metering devices for indicating the flow at each of said air outlets and of the material feed inlet.

4. An apparatus as defined in claim 1 in which each negative pressure line is connected to a controllable vacuum source whereby the relative amount of negative pressure applied to the respective lines may be controlled so as to vary the amount and ratio of negative pressure.

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