March 15, 1966 JEAN-PAUL VANDENHOECK 3,240,335

CLASSIFIER WITH GAS FLOW DISTRIBUTOR

Filed Dec. 11, 1961

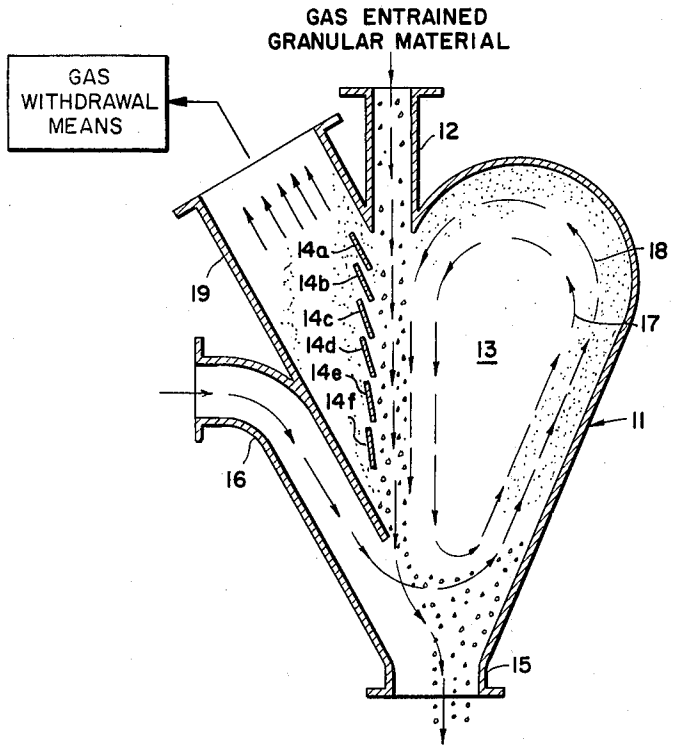


FIG. 1

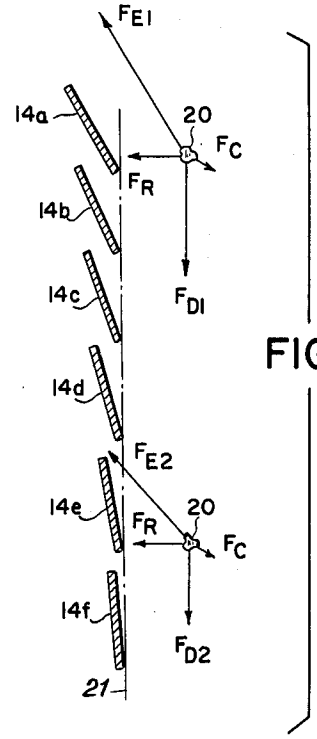


FIG. 2

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United States Patent Office 3,240,335 Patented Mar. 15, 1966

3,240,335

CLASSIFIER WITH GAS FLOW DISTRIBUTOR

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Filed Dec. 11, 1961, Ser. No. 158,509
3 Claims. (Cl. 209—136)

This invention relates to apparatus for classifying granular material and, more particularly to apparatus for classifying granular material employing gravitational classifying techniques.

Heretofore, classification of granular material using gravitational classifying techniques has been effected by conveying a gas entrained granular material downwardly in a stream. As the material flows downwardly, gas is withdrawn from the stream, carrying with it particles of a certain size through an exhaust duct. The remainder of the gas and granular material pass downwardly through a second exhaust duct. The degree of classification is varied by varying the amount of gas withdrawn from the falling stream of gas entrained granular material and thereby the size of the heaviest particles carried away with the withdrawn gas.

In a system of the type just described, the total downward forces acting upon any particular particle of material in the stream decrease at successively lower positions in the stream due to the "braking" effect on the downward movement of the particle by the gas that is withdrawn. If, then, the same exhaust force is applied to the stream at all points in its downward course, as is the case with systems of the prior art, the net forces acting upon any particular downwardly flowing particle do not remain constant throughout the downward travel, and, therefore, the classification effected is not uniform.

This invention is directed toward providing a classifying system utilizing gravitational and or inertial classifying techniques in which the net forces acting upon any downwardly flowing particle of granular material are equal throughout the entire course of the particle's downward flow. This is accomplished by varying the exhaust forces acting upon the particles during their downward flows in accordance with the decreasing downward forces acting upon the particles.

In an illustrative embodiment of the invention, the varying exhaust forces are provided by a substantially vertical series of cascaded vanes positoned adjacent the downwardly flowing stream of material. Each of the vanes forms a different angle with a vertical plane, the angles decreasing from top to bottom through the series of vanes. By this arrangement, adjacent vanes effectively form single exhaust ducts, and, because of the varying angular positions of the vanes, each duct provides a gas flow characteristic different from any other duct. Specifically, the flow resistances progressively increase at successively lower positions in the stream, thereby providing decreasing exhaust forces on a particular particle as it proceeds downwardly past the vanes to compensate for the decreasing downward force acting upon the particle. Thus, the net force acting upon the particle remains substantially constant, and a uniform clasisfication is effected.

A detailed description of the invention follows, which is to be read in conjunction with the appended drawing in which:

FIG. 1 is a sectional view of a typical classifying unit embodying the principles of the invention; and

FIG. 2 is a view of a series of cascaded vanes shown in FIG. 1, together with vector diagrams of the forces acting upon a single particle of material at two different positions in front of the vanes.

Referring to FIG. 1, a typical classifying unit **11** is shown having an input line **12** into which a stream of gas entrained granular material is introduced, as shown by the arrows in the figure. The gas entrained granular material flows downwardly through the input line **12** and into a classifying chamber **13**. Within the chamber, the stream flows downwardly past a series of cascaded vanes **14***a* through **14***f* toward a coarse material outlet duct **15** provided at the lower portion of the classifying chamber **13**. A subsidiary flow of gas is also applied to the classifier through a gas inlet **16** to help establish an eddy current within the chamber **13** as indicated by the arrows **17** and **18**. This eddy current returns some of the particles of granular material at the bottom portion of the chamber **13** to the top of the chamber adjacent the vane **14***a* so that these particles again may flow downwardly past the vanes **14***a* through **14***f*.

As the particles of granular material flow downwardly past the vanes **14***a* through **14***f*, gas is withdrawn from the stream through an exhaust duct **19** to provide a pressure differential across the vanes and, along with the withdrawn gas, relatively fine ones of the particles flowing past the vanes are also withdrawn. Relatively coarse particles of the material not passing through the vanes **14***a* through **14***f* are exhausted through the coarse material outlet duct **15**.

The action of the cascaded vanes **14***a* through **14***f* in providing a uniform classification, i.e., in uniformly withdrawing particles smaller in size than a predetermined reference particle, is best understood with reference to FIG. 2. In that figure there is shown a particle **20** of granular material at an upper position adjacent the top vane **14***a* and at a lower position adjacent the vane **14***e*. Examining first the particle **20** in its upper position, there are effectively four forces acting upon the particle. The first is a downward force F_{D1} which is related to the mass of the particle and to its downward movement. An exhaust force F_{E1} is exerted upwardly and generally parallel to the vane **14***a* by the gas that is withdrawn from the gas entrained stream of particles past the vane **14***a*. A small centrifugal force F_C is imparted to the particle as a result of its spin. The resultant of all these forces is indicated as F_R, which is substantially horizontal since the particle **20** is deemed to be the "cut point" particle. That is, with a horizontal resultant force acting upon the particle, the particle has as much of a chance of being swept upwardly through the vanes **14***a* through **14***f* and into the exhaust duct **19** as it has a passing downwardly past the vanes and into the coarse material outlet duct **15**. Of course, particles of a size greater than the cut point particle **20** would have resultant forces which are directed downwardly from the horizontal, thus increasing their chances of reaching the exhaust outlet **15**. On the other hand, particles smaller than the cut point particle **20** would have resultant forces directed upwardly with respect to the horizontal, thereby increasing their chances of passing through the vanes **14***a* through **14***f*.

As the particle **20** passes downwardly past the vanes **14***a* through **14***f*, the centrifugal force F_C remains substantially constant. The total downward force acting on the particle decreases, however, due to the progressive withdrawal of gas from the stream through the vanes **14***a* through **14***f*. Thus, the downward force F_{D2} acting upon the particle **20** in its lower position adjacent the vane **14***e* is less than the force F_{D1} acting upon the particle in its upper position adjacent the vane **14***a*. Accordingly, if the resultant force F_R acting upon the particle in this lower position is to remain unchanged, thereby rendering constant the cut point characteristics of the classifier throughout the entire series of the vanes **14***a* through **14***f*, the exhaust force F_{E2} must change correspondingly. This is what is accomplished by the cascade vanes **14***a* through **14***f*.

As may be seen, each of the vanes 14*a* through 14*f* is positioned at an angle with respect to a vertical reference plane 21. The angle that each vane forms with the vertical plane 21 is larger than the angle formed by any lower vane. Thus, the vanes 14*a* through 14*f* overlap to form what may be considered separate exhaust ducts between adjacent ones of the vanes. Because of the overlapping and varying angular arrangements of the vanes, these ducts exhibit varying gas flow characteristics. The flow characteristics are graded or varied so that the gas flow resistances provided by the ducts increase for progressively lower ducts, i.e., so that gas is withdrawn from the stream at progressively decreasing velocities at successively lower positions in the stream. In this fashion, the exhaust forces applied to the particles decrease as the particles pass downwardly past the vanes. As may be seen, the exhaust force F_{E1} acting on the particle 20 in its upper position is greater than the exhaust force F_{E2} acting on the particle in its lower position. In this fashion, the resultant force F_R remains constant, and the cut point characteristics of the classifier do not change.

It is apparent that a novel classifying unit has been provided utilizing a series of individual exhaust passages or ducts having varying gas flow characteristics. It may be appreciated that the embodiment shown is susceptible of being modified in a manner which would nonetheless retain it within the scope of the invention. Therefore, the invention should not be deemed to be limited except as it is defined by the following claims.

I claim:

1. Apparatus for effecting a uniform classification of gas entrained particles, comprising a substantially upwardly extending main exhaust duct, gas flow control means including a plurality of smaller substantially upwardly extending exhaust ducts in said main exhaust duct, means for providing a pressure differential across said gas flow control means to provide gas flow therethrough, means for conveying a stream of the gas entrained particles downwardly in front of said gas flow control means thereby providing passage of gas through the stream of downwardly flowing particles and through the plurality of smaller exhaust ducts to remove predetermined ones of the particles from the stream, the passage of gas through the stream acting to decrease the downward forces acting on the particles, said gas flow control means providing resistances to the flow of gas therethrough increasing in a downward direction therealong thereby to pass gas at successively lower velocities through the stream to provide a net force on the particles that remains substantially constant.

2½. Apparatus as recited in claim 1 wherein said plurality of smaller exhaust ducts are formed from a plurality of inclined vanes spaced one over another adjacent the stream, each smaller duct being formed from a pair of adjacent vanes, and the vanes being more steeply inclined for successively lower vanes.

3. The method of uniformly classifying a flowing stream of particles, comprising the steps of passing gas through and at least partially counter to the direction of the stream to withdraw predetermined ones of the particles from the stream, the gas passing through the stream acting to slow the movement of the particles remaining in the stream and thus to decrease the force acting on the particles in the direction of stream movement, and progressively decreasing the velocity at which the gas passes through the stream at successive positions in the stream in the direction of stream movement to provide a net force on the particles that remains substantially constant.

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