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Oi et al.

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[54] METHOD AND APPARATUS FOR CENTRIFUGAL CLASSIFICATION

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[51] **Int. Cl.**.....**B04c 3/00**

[58] **Field of Search**.....209/144, 211; 55/77, 267, 474

[56] **References Cited**

UNITED STATES PATENTS

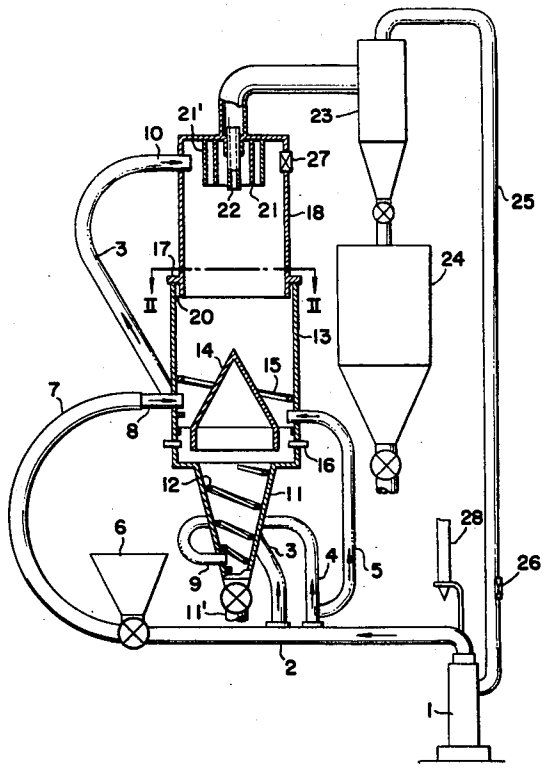
1,023,082	4/1912	Kluge	209/144
1,367,637	2/1921	Sturtevant	209/144 X
2,252,581	8/1941	Saint-Jacques	209/144
2,620,925	12/1952	Tedman	209/211

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Assistant Examiner—Ralph J. Hill
Attorney—Waters, Roditi, Schwartz & Nissen

[57] **ABSTRACT**

A method and apparatus for classifying powdery material comprising a tangential inlet for the material suspended in a gas, means above and below the tangential inlet for introducing additional gas tangentially in the same direction as said tangential inlet. Helical guides are provided for guiding the material inflow and lower gas inflow upwardly. A peripheral inlet for inducing air from the outside of the apparatus is provided between the upper gas inflow and the material inflow to aid in dispersing the powdery material.

4 Claims, 2 Drawing Figures



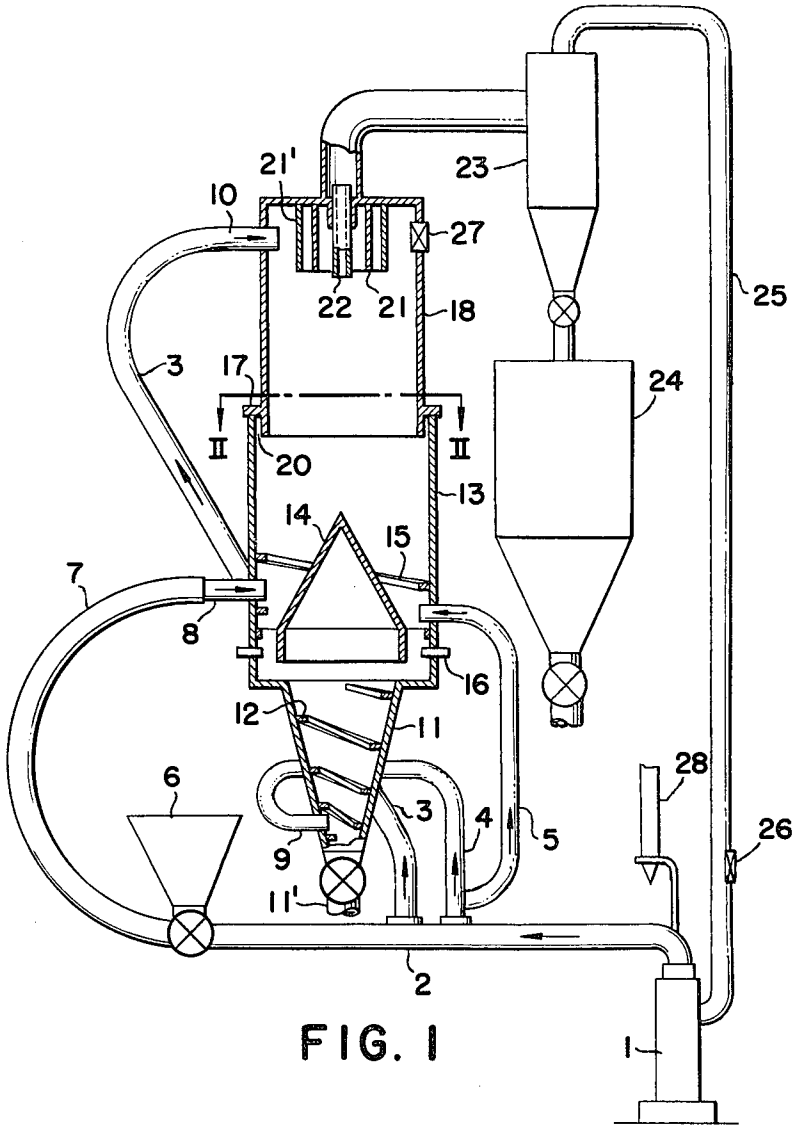

21'
23
10
27
25
22
21
18
3
17
24
II
II
20
13
14
15
7
8
16
12
11
28
6
3
4
5
26
9
11'
2
1

FIG. 1

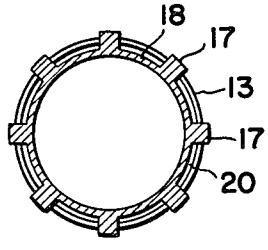

18
17
13
17
20

FIG. 2

METHOD AND APPARATUS FOR CENTRIFUGAL CLASSIFICATION

The present invention relates to a method and an apparatus for precisely classifying or separating according to relative size the powdery material such as pulverized talc, clay and other powdery materials for industrial use. More particularly, it relates to such classifying method and apparatus in which the flow of fluid such as air not containing the powdery material-to-be-classified is blown up along a spiral structure having suitable gradient and width provided on the inner peripheral wall of a cone below the main classifying body, and such fluid is also blown from above into said classifying body from an air supply port provided at the top of said body, while the flow of admixed fluid containing the powdery material-to-be-classified is blown along a spiral structure provided on the inner peripheral wall of said body, said blowing-in of said mixture fluid being effected in the same swirling direction as that of the first said fluid such as air through a guide member, whereby the fed amount of air from above and that of the admixed fluid containing the material-to-be-classified are adjusted so that the powdery material-to-be-classified is classified into two portions, one portion being guided towards an upper outlet of the body and the other portion towards a lower discharge port.

The present inventors had doubts in utility of the conventional structures of this type machines. Namely, if the principle of air separation is long established theory, why, then, the existing machines of this type are made of a construction in which wind velocity or centrifugal force is inevitably diminished? Also, why is the structure used in which wind force or wind direction is not directly utilized, but instead a one-section medium is provided? In this connection, the fact should be noted that this type of machinery is subject to pressure loss due to centrifugal force, pressure loss in piping arrangement, and pressure loss incidental to blow-up of the raw material, and these losses directly lead to loss of the amount of air flow, wind pressure or electric power. The present inventors have found particular significance in inducing rotation, not of the machine or fluid, but of the particles themselves which are to be classified. A series of developments of classifiers including Mikroplex (Alpine AG., West Germany), Superclassifier (The Sharples U. S. A.) and Micron Separator (Hosokawa Tekkosho, Japan) well explain the above mentioned doubts of the present inventors. In effect, the previously known classifiers have functions in which an air flow is first rotated by means of rotation of mechanical part in the machine, and then the admixture containing powdery materials to be classified is rotated by means of the rotational movement of the admixture self.

The present inventors, as a result of extended studies and experiments, have also succeeded in tracing the characteristic properties of the powdery material which is hard to classify. It was found that the powder which is hard to classify is of the following properties: (1) strongly cohesive, (2) abundant with ultra-fine particles, (3) having particle sizes which are mostly of, or close to, the limit size possible for classification, (4) extremely small in specific gravity, (5) mixed up with many alien substances having different specific gravities, or (6) irregular in particle shape. Also, the classifier, in order to meet various requirements for industrial use, is requested (1) to have high classifying efficiency, (2) to be able to effect classification at any desired degree, (3) to be low in cost for classification, (4) to be manufactured at low cost, and (5) to be easy in operation.

In order to avoid forced vortex and to produce free vortex in a most rational way and by most simple means, the present invention contemplates utilization of the theory of air separator (cyclone) to the maximum degree and also incorporates the results of studies on limit capability thereof, thereby to realize combination of the varied and multiple classification principles only by adjustment of the amount of air supplied. The object of the invention, therefore, is to provide a method which permits delicate classification at extremely high precision and also allows recovery of fine powder particles at high yield.

To accomplish this object, the present invention introduced the following features:

1. A cylindrical main classifying body having a portion through which the material-to-be-classified is blown in is disposed between a cone assembly adapted to introduce air supply from below and an upper body portion adapted to introduce air supply from above, and in said main body is retained a guide means having a space in the inside thereof;

2. Spaced arrangement is formed around the upper peripheral wall of said body to achieve effective dispersion;

3. During recovery of the classified powdery material, the upper central outlet is suitably to allow further finer classification of the powdery material, and spiral sentences are provided at each inner peripheral wall of the main body, and a cone is provided below the main body.

Now, the present invention will be described in more detail by way of its preferred embodiment with reference to the drawings.

FIG. 1 is a longitudinal section view of an apparatus adapted for practising the method of the present invention; and

FIG. 2 is a sectional view taken along the line II—II of FIG. 1.

In the drawings, reference numeral 1 denotes an air blower, 2 an air supply pipe, 3, 4 and 5 respectively a branch pipe, 6 a hopper for supplying powdery material such as pulverized talc, clay or other similar material for industrial use, 7 a pipe for supplying admixture of air with the powdery material-to-be-classified, 8 an inlet to the classifier, 9 and 10 respectively an air inlet, the inlets 8, 9 and 10 being provided tangentially at the outer wall of each body, 11 a cone having formed on its inner peripheral wall a spiral structure 12 having a suitable gradient and width, 11' an discharge port at the bottom of the cone 11, and 13 a main body portion having a cylindrical or other suitable configuration and connected to the top portion of the cone 11, said main body 13 also having provided therein a conical guide means 14 forming a conical space in the inside thereof. Said guide means 14 is so disposed as to form a slight space between its outer periphery and the inside of the main body 13. Also provided on the inner peripheral wall of the main body 13 is a one-turn spiral structure 15 of the same construction as the structure 12 of said cone 11. Further, numeral 16 is a tertiary air port. On top of the main body 13 is mounted a top body portion 18 which is secured to the main body portion by means of retaining elements 17 formed around the outer periphery of said top body portion 18, and a small space 20 is formed between the top end of the main body 13 and the outer periphery of the top body 18. Also in the drawings, reference numeral 21 denotes a central outlet pipe located in a cylindrical guide 21', with an annular spacing therebetween, 22 a vertically movable adjusting and holding pipe provided in the central outlet pipe 21, 23 a cyclone collector, 24 a tank, 25 an air circulation pipe, 26 and 27 respectively a metering instrument, and 28 a bag filter.

In operation of the present device, the admixture containing the powdery material-to-be-classified is blown tangentially through the supply pipe 7 and through the inlet 8 into the main body portion 13 of the classifier where said mixture is blown upwards along the spiral structure 15 on the inner peripheral wall of the main body 13.

In this case, the powdery materials in the admixture are blown up into the main body portion 13 and the coarse materials separated by the centrifugal circular movement in the main body portion 13 are rotated along the inner peripheral wall surface of main body portion 13 whereby the frictional resistance produced by the centrifugal force of the blowing admixture causes said coarse materials to descend. The descending coarse materials are deposited on the top of spiral structure 12 provided at the inner peripheral wall surface and gradually descend along the surface of spiral structure 12 by the centrifugal flow which is blown tangentially from the lower end of cone 11 through the inlet 9 of cone 11, so that the over-

blown coarse materials from the top of spiral structure **12** descend from the top of cone **11** to the lower end thereof. Accordingly, the action in which the powdery materials are separated from the coarse materials sticking to the powdery materials thereabout is effectively carried out and only the coarse materials are discharged through the discharge port **11'**.

On the other hand, the powdery materials remaining in the one-turn spiral structure **15** of the main body portion **13** are always blown upwardly by the centrifugal upward flow, while a part of the powdery materials descends and the remainder of powdery materials continues to rise along the inner peripheral wall of main body portion **13** in a rapid circular movement together with the flow action caused by the small space **20** formed between the top end of main body **13** and the periphery of the top body **18**. In effect, through the atmospheric air pressure in the small space **20**, the powdery materials are more finely disposed for promoting the classifying effects, and the powdery materials are then fed to the top body portion **18**. The powdery materials in the top body portion **18** are fed into the vertically movable adjusting and holding pipe **22** by a strong centrifugal whirl produced by adding the air which is blown tangentially through the inlet **10** into the top body portion **18**.

Concurrently, the air not containing the powdery material is blown tangentially through the branch pipe **4** and the inlet **9** thereof into the cone **11** where the air is blown up revolving, in the same direction as said powdery material flow, along the spiral structure **12** on the inner peripheral wall of said cone **11**. It will be noted that the powdery material and the blowing air are respectively blown upwardly along the spiral structures **15** and **12**, respectively, and blown up spirally into the inside spaces at the upper parts of the main body **13** and the cone **11**, respectively, thereby achieving effective blowing up operation. The branch pipe **3** extends upwardly along the main body portion **13** and connects through the inlet **10** into the top body portion **18**, whereby the air is also blown revolvingly, in the same direction as said powdery material flow, into the main body portion **13** from above thereof. In this manner, by the combined action of the upwardly and downwardly blown in air in the main body portion **13**, and the air ascending along said guide member **14** from below, the powdery material impinging on the outer peripheral wall of the guide member **14** retained in said main body portion **13** is guided out through the central outlet pipe **21** or **22** into the cyclone collector **23** for circulation. Thus, one portion of the powdery material (mainly coarse powder) descends along the inner peripheral wall of the main body portion **13** and that of the cone **11** and is discharged through the discharge port **11'** to be collected, while the remainder is guided out through the central outlet pipe **21** or **22** into the cyclone collector **23** and thence into the tank **24**. If desired, secondary air or tertiary air may be supplied through the branch pipe **5** or the tertiary air port **16**, as the case may be, whereby even better classification can be effected.

As viewed above, since the fluid such as air containing the powdery material-to-be-classified is blown along the spiral structure having a suitable gradient and width provided on the inner peripheral wall of the main body portion, said fluid is guided to creep up in the form of a bundle of flow along the spiral structure. Also, the air is blown in to vertically ascend along the similar spiral structure provided in the cone, and since said structure is spread out upwardly because of its conical configuration, said air is blown up with a force which is larger than the force with which the air was blown into the main body portion. Further, provision of the guide member in said main body portion and revolution of air blown in downwardly from the top body portion above the main body help to further expedite classifying operation of the powdery material to achieve initial classification most effectively. In this case, it is to be noted that the flow of fluid such as air blown in from above of the main body portion is orientated to have the same revolving direction as the flow blown in from below, so that the strongest centrifugal force is produced near the central outlet pipe. This results in expediting separation of the powdery material and also producing a tendency for the coarse particles to move towards the outside and for the fine particles to preceed to the inside, thus attaining precise classifying effect. Moreover, provision of a small space **20** formed between the main body portion **13** and the top body portion **18** proves helpful to better dispersion of the material to even more enhance the effect of ensuing classification. Also, the position or opening of the discharge port may be adjusted by vertically moving the adjusting pipe provided in the central outlet pipe **21**, thereby to obtain still more bettered fine classification effect.

What is claimed is:

1. A materials classifying method for a powder material utilizing a housing arrangement having a lower portion comprising a cylindrical member and a downwardly depending conical portion extending from the bottom of said cylindrical member, a hollow conical guide having an upwardly extending apex being positioned in said cylindrical member, and an upper portion comprising a cylindrical member disposed on said first mentioned cylindrical member so as to define a narrow peripheral air inflow space therebetween; said method comprising; blowing a supply of air into said conical portion in tangential relationship to the inner peripheral surface thereof while concurrently guiding said air in a helically upward flow path; concurrently blowing a second tangentially directed flow of air into the upper cylindrical member in a direction corresponding to the tangential flow direction of said first flow of air; concurrently blowing an admixed tangential flow of air and powdery material into said lower cylindrical member along the inner wall thereof in a direction corresponding to the tangential flow direction of said air supply flows, inducing air into said lower portion through said said peripheral air inflow space, guiding said admixed flow along said inner wall upwardly in a substantially helical path for mixing with said first and second air supply flows and with the air from said peripheral air inflow space, and withdrawing finer material and air from at least portions of said admixture through an upper outlet and conveying the coarser particles towards a lower outlet in said conical portion.

2. A materials classifier comprising a main body having an essentially upright open ended cylindrical portion and a conical portion depending from the bottom of said cylindrical portion, said conical portion being provided with a helical structure extending along its inner peripheral wall and having a predetermined gradient and width, an air inlet connected to the lower part of said conical portion for tangential air inlet flow, and a discharge port in the lower apex end of said conical portion, said main body portion including an inlet for tangential inflow of an admixture containing powdery material being classified, the direction of tangential flow of which corresponds to the direction of tangential flow through said conical portion; a top body portion of essentially upright cylindrical shape being supported on said main body portion, a central outlet pipe being provided in the upper surface of the inner wall of said top body portion, an inlet for tangential air inlet flow being provided in the side wall of said top body portion, the direction of flow of which corresponds to the direction of flow of said other air and admixture inlets, means defining a narrow peripheral space for permitting inflow of air being provided at the juncture between said main and top body portions; a hollow conical guide having an upwardly projecting apex being positioned in said main body in space relation to the inner peripheral wall thereof and above said conical portion; and a further helical structure of predetermined gradient and width extending along the inner peripheral wall of said main body portion the gradients of said helical structures rising in the direction of flow of said tangential inlets.

3. A classifier as defined in claim **2**, wherein a central outlet pipe is connected to the outlet pipe at the inside upper surface of said main body portion, and a discharge flow controlling pipe is slidably positioned interiorly of said outlet pipe.

4. A classifier as defined in claim 2, including retaining elements positioned about the lower outside peripheral wall of said top body portion, said element being supported on the top edge of said main body portion so as to form said small space.

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