

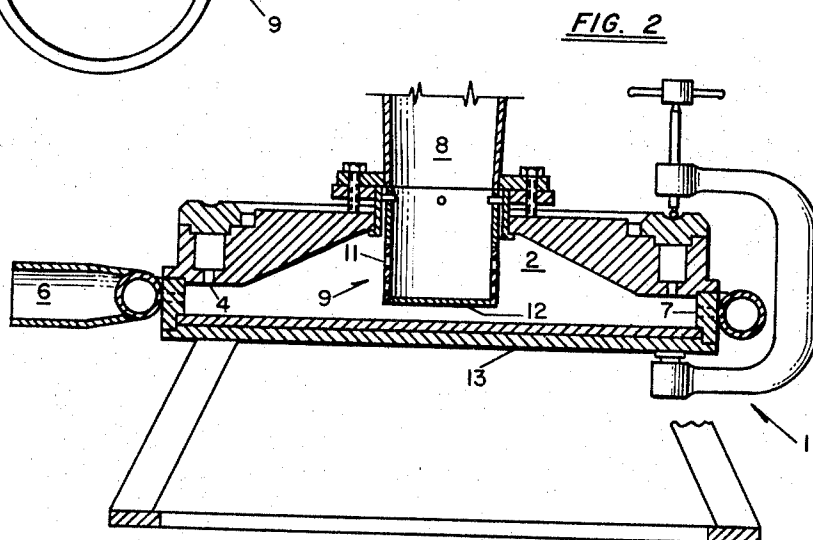
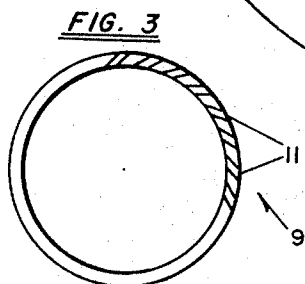
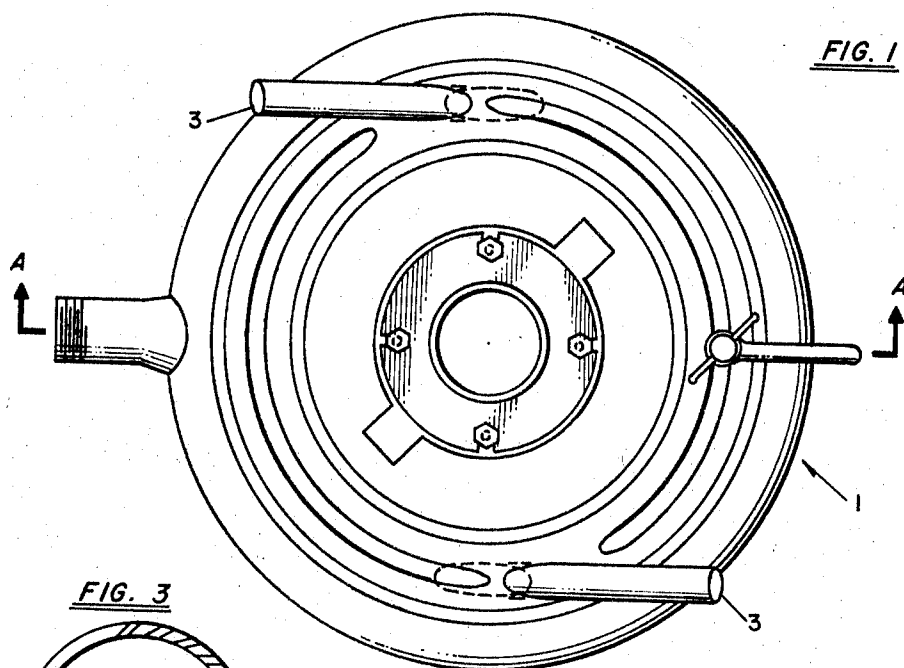
Feb. 4, 1969

C. F. DOYLE ET AL
FLUID ENERGY MILL

3,425,638

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Sheet 1 of 2



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FIG 4

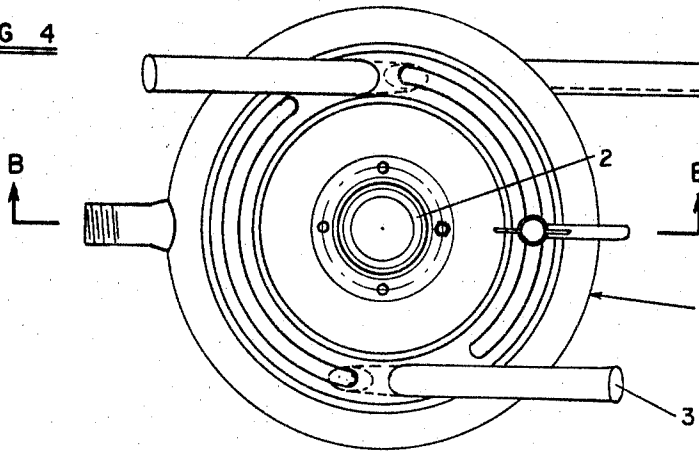
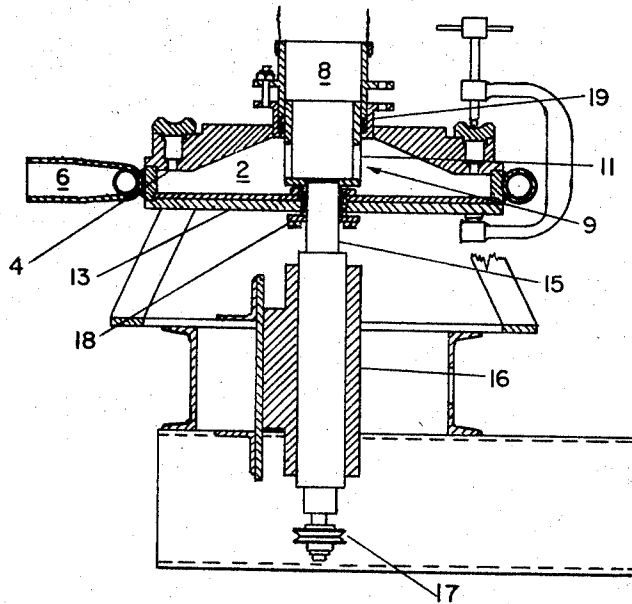


FIG. 5



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FLUID ENERGY MILL

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4 Claims

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ABSTRACT OF THE DISCLOSURE

An improved fluid energy mill which is provided with a cylindrical baffle which extends into the grinding chamber of the mill. The cylindrical baffle provides an efficient means for segregating fine particles from a product stream.

This invention relates to improvements in fluid energy mills, and more particularly to a novel method of preventing the premature withdrawal of coarse particles from the treatment zone of the mill.

Fluid energy mills, "micronizers," are employed for finely grinding various materials, i.e., silica, salt, pigments and the like, into a powder-like form. The grinding action is produced by attrition, in that the particles of the treated material actually impact upon one another and are physically torn apart and reduced in size.

Conventional micronizers generally provide a grinding chamber in which streams of gas under pressure are directed in such a manner so as to produce a vortex within the chamber. The material to be treated is fed into the chamber and the vortex action therein causes the particles to impact against one another, the larger particles being carried outwardly by centrifugal force; the finer particles drifting inwardly until they are withdrawn from the central portion of the grinding chamber.

The feed inlet of these micronizers is placed so as to introduce the feed material near the periphery of the grinding chamber. This is done to prevent the coarse feed particles from being swept out of the mill before they are ground. Any tendency of the coarse particles to be prematurely withdrawn is detrimental.

Feeding arrangements generally introduce the material to be treated at an angle such that the direction of movement is forwardly in the direction of rotation maintained within the grinding chamber. This arrangement further assists in reducing the tendency of the coarse particles to be prematurely withdrawn.

In discharging from the mill the particles can be directed either upwardly through the top, or downwardly through the bottom of the mill, depending upon whether or not the mill is equipped with an integral collector. In those mills with an integral collector, the discharge is accomplished by a 90° turn downward into the collector, while those mills without this device cause the particles to make a 90° turn into an outlet pipe. Normally, a solid wall-type cylinder is used in both types of mill outlets. In the top discharge mill the cylinder can extend down into the milling chamber to varying depths and act as a barrier or baffle. This is reversed in mills with a downward charge.

In spite of the various arrangements and precautions which have been taken by prior art methods and apparatus, there still remains a marked tendency for coarse particles to be prematurely withdrawn from the milling chamber, thereby reducing the efficiency of the operation.

It is, therefore, an object of this invention to accomplish finer grinding in fluid energy mills, and to improve classification of the ground particles by hindering the premature escape of the larger size particles from the milling chamber.

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This and other objects of the invention will become apparent from the following detailed description and specific examples and drawings wherein FIG. 1 is a top view of a micronizer type fluid energy mill; FIG. 2 is a cross-sectional view of the micronizer through A—A; FIG. 3 is a cross-sectional view of the baffle; FIG. 4 is a top view of a micronizer which is equipped with a rotating baffle means; and FIG. 5 is a cross-sectional view of the micronizer of FIG. 4 through line B—B.

Broadly, this invention contemplates the use of a slotted, cylindrical baffle in the mill outlet to prevent premature escape of the coarse particles from the mill.

Referring now to the drawings, wherein like reference characters designate corresponding parts throughout the several views used, there is shown a typical micronizer type fluid energy mill 1, containing a grinding chamber 2 and feed conduits 3, which are connected to and communicate with the feed inlets 4. The grinding medium is a gas such as steam or air under pressure and is supplied to the grinding chamber 2 via conduit 6 which is connected and communicates with jet orifices 7. The ground particles and the gaseous grinding medium are discharged from chamber 2 via a discharge outlet 8.

The novel feature of this invention is the cylindrical slotted baffle 9. This baffle 9 is so constructed and located that all of the ground material and gaseous medium must pass through it before discharge into the outlet 8.

FIG. 2 shows a cross-sectional view of the baffle 9 which has a plurality of slots or passageways 11 on the vertical surface and a closed horizontal end 12. The passageways will be hereafter referred to as slots, though it is understood that the passageways are not restricted as to shape and may be rectangular, square, circular, etc. Of particular importance is the fact that the slots or passageways 11, are set on an angle to the radius of baffle cylinder 9. This is shown in a top view of the baffle 9 in FIG. 3. The angle of the slots 11 is such that it is opposite to the direction of the rotation of the particles in the grinding chamber 2. In normal operations the direction of rotation of the particles in the chamber 2 will be clockwise (view from top) and the angle of the slots 11 will be opposite or counterclockwise (viewed from top). Though it is understood that rotational direction of the particles can be counterclockwise and slot 11 angle can be clockwise.

In the operation of this invention the material to be ground such as silica gel is fed into feed conduits 3 through feed inlets 4 into the grinding chamber 2. In the chamber 2 steam or other gas at high velocity is introduced through a plurality of jet orifices 7. The pressure of the entering gas is transformed into velocity head by expansion to a substantially atmospheric pressure within the grinding chamber 2. The force of these expanding streams, directed somewhat tangentially, causes the material entering chamber 2 via inlets 4 to rotate at high speed (approx. 3–500 m.p.h.). The rotation of the particles causes them to impinge upon themselves with a subsequent reduction in particle size. The particles in the mill are withdrawn through the slotted baffle 9. Since the end 12 of the baffle 9 is closed, the only exit is through the slots 11. The angle of the slots 11 is opposite to that of the directional rotation of the particles and hence, the particles must reverse their direction to exit through the slots 11. The larger the particles that are traveling about the grinding chamber 2, the less likely they are to reverse their direction of rotation and therefore, the more likely they are to be comminuted. It is an embodiment of this invention to rotate the baffle 9 through means shown in FIG. 4 and FIG. 5, while the mill is in operation. This rotation may be either clockwise or counterclockwise.

Referring specifically to FIG. 5, it is seen that the slotted baffle 9 is rotatively mounted within the grinding

chamber 2 by means of rotating shaft 15. The shaft 15 is mounted through bearing means 16, and is driven by an external power source (not shown) by pulley 17. At the point the shaft 15 enters the grinding chamber 2, a seal means 18 is provided to prevent escape of gas from the mill. Similarly, the upper end of baffle means 9 is provided with a seal means 19 at the point it interconnects with the outlet 8.

The invention is illustrated but not limited by the following specific examples. These examples illustrate the effectiveness of the novel baffle 9 of this invention in producing a finer ground material than can be produced with conventional apparatus.

The mill used in these examples was a 2 inch (inside diameter of the grinding chamber 2) micronizer (manufactured by the Sturtevant Mill Co.) with the integral collector removed and fitted with a top outlet and equipped with a dual tangent 12-jet grinding ring, and a solid bottom wear plate. The mill head was a 6-feed-port head. Each port having an inside diameter of $\frac{5}{8}$ inch and being on a 20° angle to the horizontal. A venturi-type feeder was used for feed injection. The feeder had a nozzle with a 0.228 inch inside diameter and a venturi with a $\frac{1}{8}$ inch inside diameter throat. The mill was connected to a compressed air supply, with a maximum pressure in the range of 150–165 p.s.i.g. The product was collected in No. 10 duct bag filters having a 700 sq. ft. filter area. The feed to the venturi-type injector was controlled by a Vibra-Screw feeder. Variations in feed rate were less than $\pm 2\%$ on one minute samples on rates of 100 pounds per hour or higher.

The novel slotted baffle 9 extended into the grinding chamber 2 from the top. This baffle 9 had a closed end 12. In the vertical wall of the baffle 9 were 24 slots 11, $\frac{3}{16}$ inch wide spaced 15° apart. The horizontal center lines of the slots 11 were on a 45° angle to the radius of the baffle. The inside diameter of the baffle 9 was 3.826 inches, and the outside diameter was 4.5 inches. The slots 11 were 2 inches long and were parallel, that is the center line of their major dimension was parallel to the center line of the sleeve 9. The bottom end of the slots was one inch above the bottom of the milling chamber.

In Examples 1–6, the feed material was a microspheroidal spray-dried silica gel (Code 968 Base manufactured by the Davison Chemical Division of W. R. Grace & Co.). This is a high surface area (650–700 sq. meters per gram) low pH (3.8–4.0) high density (28–30 pounds per cubic foot) silica gel.

In Examples 7–9, the feed material was an activated intermediate density silica gel. This gel has a high pH (7.0–7.5) low total volatile content (3.0–6.0% at 1750° F.) low surface area (200–300 sq. meters per gram) gel. This gel is also manufactured by the Davison Chemical Division of W. R. Grace & Co.

Example I

Silica gel was fed to the mill at a rate of 300 lbs. per hr. while maintaining a grind air pressure of 150 p.s.i.g. and an injection air pressure of 155–160 p.s.i.g. The compressed air had a temperature of 60° F. The ground product was collected and examined for particle size.

Microscopic examination (970 $\times$, fine size gel dispersed in water at 2 grams/100 ml. water) showed that the largest particles in product were eight (8) micron "diameter" and that there were 225 of the 1–2 micron "diameter" particles per field.

Particle size was also determined by sedimentation in water. These results are as follows:

Percent:	Microns (diameter)
10	<1.45
20	<2.10
40	<3.50
50	<4.30
60	<5.30
80	<7.80

Example II

Silica gel was fed to the mill at a rate of 100 lbs. per hr. The grinding air pressure was maintained at 150 p.s.i.g. and the injection air pressure at 110 p.s.i.g. The temperature of the compressed air was 58° F. The ground product was collected and examined to determined particle size.

Microscopic examination (made as in Example No. I) showed that the largest particles in the product were 6.4 micron "diameter," and that there were 250 of the 1–2 micron "diameter" particles per field.

Particle size determination by sedimentation in water showed the following:

Percent:	Microns (diameter)
10	<1.50
20	<1.90
40	<2.45
50	<2.70
60	<3.05
80	<3.90

Example III

Silica gel was fed to the mill at a rate of 45 lbs./hr. The grinding air pressure was maintained at 150 p.s.i.g. and the injection air pressure at 130 p.s.i.g. The temperature of the compressed air was 59° F. Milled gel was examined to determine particle size.

Microscopic examination (made as described in Example I) showed that the largest particles in the product were 4.8 micron "diameter" and there were 300 of the 1–2 micron "diameter" particles per field.

Particle size determined by sedimentation in water showed the following:

Percent:	Microns (diameter)
10	<1.45
20	<1.73
40	<2.2
50	<2.45
60	<2.7
80	<3.5

Example IV

In this example the mill and associated equipment was the same as in Examples I–III, except the slotted baffle 9 was removed and replaced by a single barrier sleeve which extended into the grinding chamber through the center of the top of the mill with the bottom end $\frac{3}{4}$ inch above the bottom of the milling chambers. The barrier sleeve used has a four (4) inch inside diameter and was open on the lower end. Thus, for the grinding medium and the ground product to leave the grinding chamber it was necessary for them to exit at the lower end of this sleeve. Silica gel was fed to the mill at a rate of 100 lbs./hr. The grinding air pressure was maintained at 145 p.s.i.g. and the injection air pressure at 155–165 p.s.i.g. The temperature of the compressed air was 61° F. It was desired to maintain the grinding pressure at 150 p.s.i.g. as in Example I to III inclusive; however, the back pressure from the mill through the injection feeder was too great at 150 p.s.i.g. to permit uniform feed. The energy was not being consumed to the same degree in the mill as in Examples I, II, and III and exerted itself in backpressure. Therefore, the material in the mill was not being ground to the same degree. This was the result of the poorer baffling.

The mill product was collected and examined for particle size.

Microscopic examination (made as described in Example I) showed that the largest particles were 16 micron "diameter" and that there were 150 of the 1–2 diameter particles per field.

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Particles size determined by sedimentation in water showed the following:

Percent:	Microns (diameter)
10	<1.62
20	<2.45
40	<4.3
50	<5.6
60	<7.0
80	<12.5

Example V

With the mill and the associated equipment the same as in Example IV, silica gel was fed into the mill at a rate of 300 lbs./hr. The grinding air pressure was maintained at 150 p.s.i.g. and the injection air pressure at 132 p.s.i.g. The compressed air temperature was 56° F. The silica gel milled under these conditions and collected in bag filters was examined to determine its particle size.

Microscopic examination (made as described in Example I) showed that the largest particles were 32 micron "diameter" and that there were 75 of the 1-2 micron "diameter" particles per field.

Particle size determined by sedimentation in water showed the following:

Percent:	Microns (diameter)
10	<1.9
20	<2.75
40	<4.5
50	<5.6
60	<7.0
80	<11.9

Here, as in Example IV, poor baffling contributed to reduced grinding efficiency.

Example VI

The mill was the same as in Example IV, except a second barrier sleeve was attached to the bottom of the milling chamber and the height of the first sleeve adjusted to bring its lower open end $\frac{3}{8}$ inch above the bottom of the grinding chamber. The second barrier sleeve which was attached to the bottom of the grinding chamber was concentric with the first sleeve. The inside diameter of the second sleeve was six (6) inches and it had a height of one (1) inch. Therefore, the sleeves had an $\frac{1}{8}$ inch lap. With this arrangement of barriers it was necessary for particles to make essentially a 90° turn downward before leaving the grind chamber. Silica gel was fed into the mill at 100 lbs./hr. The grinding air pressure was maintained at 140 p.s.i.g. and the injection air pressure at 160 p.s.i.g. Compressed air temperature was 61° F. As in Example IV, it was not possible to maintain 150 p.s.i.g. air grind pressure and get uniform feeding with the air injector because of poor baffling.

The silica gel milled under these conditions was collected in the bag filters, removed and examined to determine particle size.

Microscopic examination made as described in Example I showed that the largest particles were eight (8) micron "diameter" and that there were 150 of the 1-2 micron "diameter" particles per field.

Particle size determined by sedimentation in water showed the following:

Percent:	Microns (diameter)
10	<1.9
20	<2.45
40	<3.5
50	<4.1
60	<4.7
80	<6.8

Example VII

The mill and associated equipment was the same as described in Example VI. An "activated" intermediate

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density silica gel was ground at the rate of 100 lbs./hr. The grinding air pressure was maintained at 150 p.s.i.g. and injection air pressure at 165 p.s.i.g. The compressed air had a temperature of 57° F.

The silica gel milled under these conditions was collected in bag filters, removed and re-examined to determine particle size.

Microscopic examination made as described in Example I showed that the largest particles were eight (8) micron "diameter" and that there were 225 of the 1-2 micron "diameter" particles per field.

Particle size determined by sedimentation in water was as follows:

Percent:	Microns (diameter)
10	<1.9
20	<2.8
40	<4.7
50	<5.8
60	<7.1
80	<11.9

Example VIII

With the mill and the associated equipment the same as in Example I, that is with baffle 9 in place, the intermediate density silica gel was milled at 100 lbs./hr. The grinding air pressure was maintained at 150 p.s.i.g. and the injection air at 120 p.s.i.g. The compressed air had a temperature of 60° F.

The silica gel ground under these conditions was collected in bag filters and examined for particle size.

Microscopic examination made as described in Example I showed that the largest particles were 6.4 micron "diameter" and that there were 250 of the 1-2 micron "diameter" particles per field.

Particle size determined by sedimentation in water was as follows:

Percent:	Microns (diameter)
10	<1.2
20	<1.7
40	<2.6
50	<3.2
60	<4.0
80	<6.4

Example IX

With the mill and associated equipment the same as in Example I, that is with the baffle 9 in place, the intermediate density silica gel was milled at the rate of 51 lbs./hr. The grinding air pressure was maintained at 150 p.s.i.g. and the injection air pressure at 155-160 p.s.i.g. The compressed air had a temperature of 60° F.

The silica gel ground under these conditions was collected in bag filters and examined for particle size.

Microscopic examination, made as described in Example I, showed that the largest particles were 4.8 micron "diameter" and that there were 300 of the 1-2 micron "diameter" particles per field. There were only trace quantities of the 4.8 micron "diameter" particles in the product.

Particle size determined by sedimentation in water was as follows:

Percent:	Microns (diameter)
10	<1.1
20	<1.4
40	<1.9
50	<2.4
60	<2.5
80	<3.5

What is claimed is:

1. In a fluid energy mill comprising a cylindrical grinding chamber, material inlet means communicating with

said grinding chamber, air inlet means communicating with the said grinding chamber at the periphery thereof, material discharging means communicating with said grinding chamber, the improvement which comprises a cylindrical baffle communicatively connected with said discharging means and extending into the said grinding chamber, said baffle being closed at one end and having a plurality of passageways on the said cylindrical surface.

2. The apparatus according to claim 1 wherein the said passageways are at an angle to the radius of the said cylindrical baffle.

3. In a fluid energy mill comprising a cylindrical grinding chamber, material inlet means communicating with said grinding chamber, air inlet means communicating with the said grinding chamber at the periphery thereof, material discharging means communicating with said grinding chamber, the improvement which comprises a cylindrical baffle communicatively connected with said discharging means and extending into the said grinding

chamber, said baffle being closed at one end and having a plurality of passageways on the said cylindrical surface, said discharging means containing means to rotate said baffle.

4. The apparatus according to claim 3 wherein the said passageways are at an angle to the radius of the said cylindrical baffle.

References Cited

UNITED STATES PATENTS

2,032,827	3/1936	Andrews	241—5
2,219,011	10/1940	Kidwell et al.	241—39
2,763,437	9/1956	Marchant	241—474

JAMES M. MEISTER, *Primary Examiner*.

U.S. Cl. X.R.

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