

[54] **FLUID ENERGY GRINDER FOR INCREASING BULK DENSITY OF MATERIALS**

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[57] **ABSTRACT**

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A grinder for increasing the bulk density of finely divided materials, using an energetic stream of driving fluid to act upon the particulate materials within a suitable grinding chamber. Particle sizes are reduced sufficiently by impact grinding to give a product of increased bulk density. The grinder is especially effective for the size reduction of hard abrasive materials.

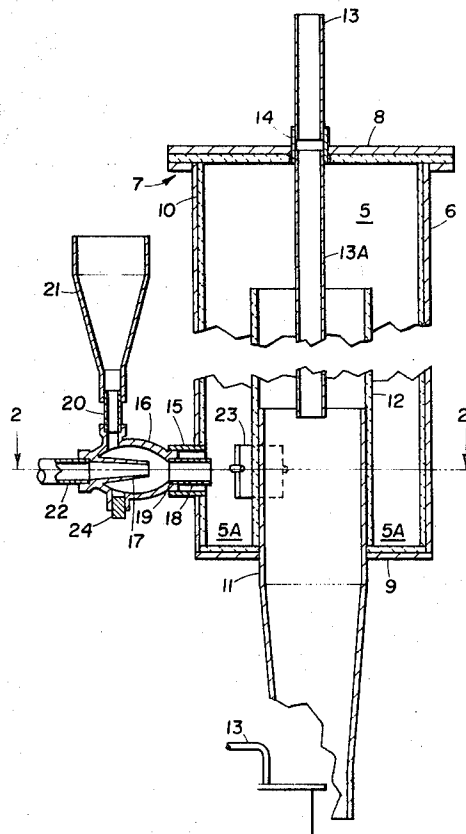
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[58] Field of Search 241/5, 39, 40

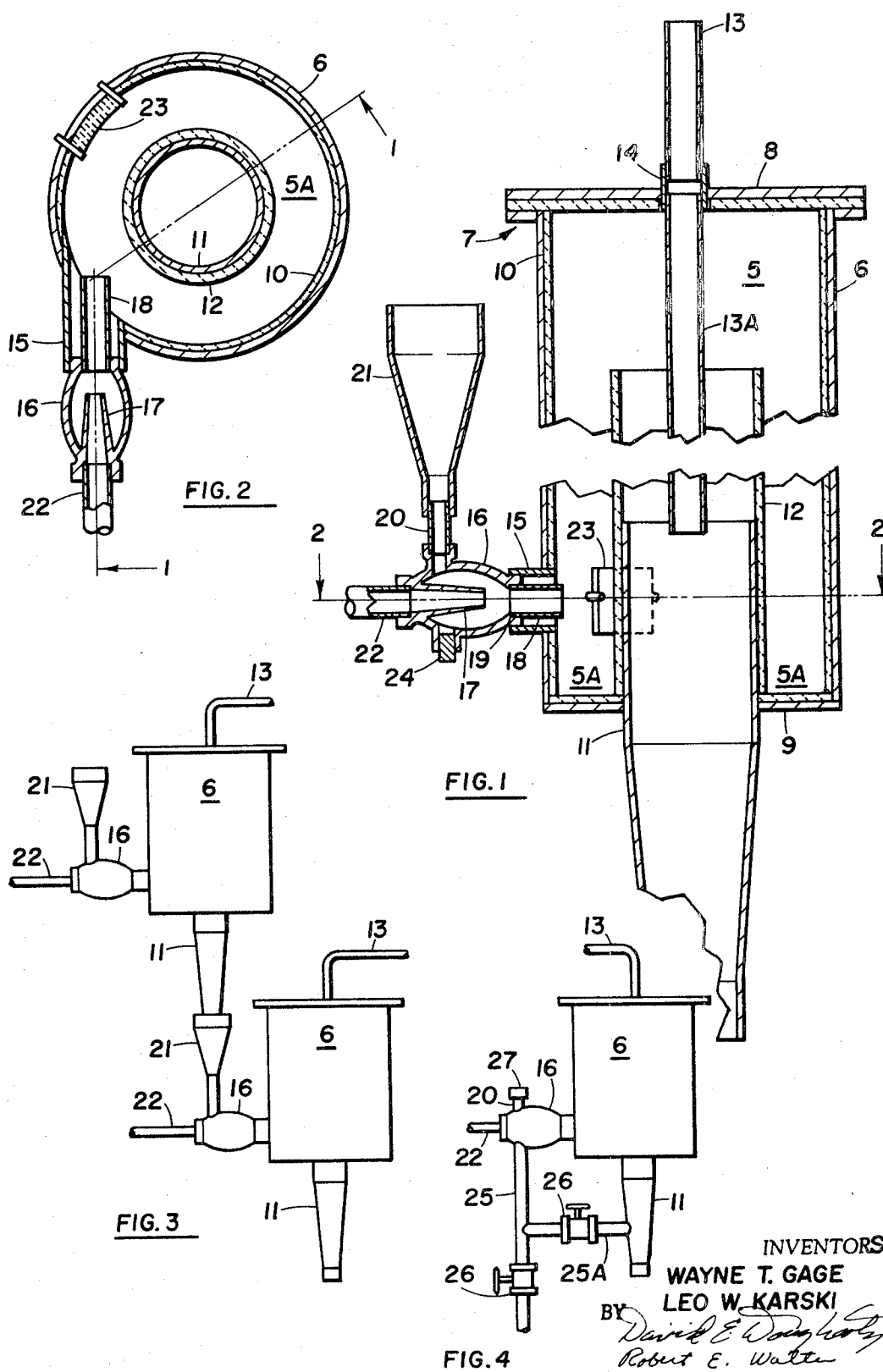
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4 Claims, 4 Drawing Figures





FLUID ENERGY GRINDER FOR INCREASING BULK DENSITY OF MATERIALS

BACKGROUND OF THE INVENTION

Processes for the size reduction of solid materials have been known for many years and have resulted in the development of many diverse types of equipment, adapted to the types of material processed and the degree of size reduction desired. Various theories concerning size reduction have been proposed and formulations for equipment design have been developed. These are well-known in prior art and will not be described here. While the term "size reduction" has been used to cover a broad field of operations, a more common usage is to refer to size reduction as a "grinding operation" and to speak of "grinding equipment" to designate the devices for accomplishing the desired size reduction. Grinders using mechanical means such as revolving stones, rollers, hammers, etc. are quite satisfactory for the reduction of relatively coarse materials to a finer state, such as 100 mesh. While mechanical equipment may be used to grind to finer mesh sizes, their operation is less satisfactory due to partial blinding or filling of the grinding surfaces by the finer material, loss of material by dusting, and increased wear on the grinding surfaces resulting from the closer rubbing contact necessary to produce the required particle size reduction. This latter effect is especially pronounced if hard abrasive materials are being ground, the grinding surfaces wear rapidly and require frequent replacement as a result.

Fluid driven impact grinders have been developed as a means to overcome, at least partially, some of the aforementioned drawbacks of mechanical grinders. In a fluid grinder, the particles of solid to be ground are fed into a rapid stream of fluid, such as compressed air or dry steam, and thus carried into a suitable grinding chamber. Grinding is accomplished principally by the impact of the particles upon each other by collisions during their rapid motions in the grinding chamber. The size of the resulting particles may be controlled by regulating the point of exit from the grinding chamber. While this type of grinder is an improvement over those using mechanical grinding means, the disadvantage of wear-out remains, especially at the feed inlet and on the sides of the grinding chamber.

The present invention therefore provides a fluid energy grinder of improved construction, having easily interchangeable wearing members at the points of greatest wear. The invention further provides a positioning of the fluid driving jets and product exit tube so that wear on the lower part of the grinding chamber is reduced and the ground product is automatically classified before withdrawal.

SUMMARY OF THE INVENTION

A fluid energy grinder in accordance with the present invention includes, a cylindrical grinding chamber of wear resistant material, a top closure plate containing a centrally located fluid exit tube, and a bottom closure plate which contains a centrally located product exit tube. A feed chamber and a nozzle associated with the feed chamber are provided for driving fluid through the feed chamber and the nozzle which is fixed in tangential relationship to the side of the grinding chamber. The nozzle is arranged to discharge driving fluid into the interior of the grinding chamber, and feed means

are attached to the nozzle chamber for introducing particulate feed material into the stream of driving fluid.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a sectional side view on line 1—1 of FIG. 2 of the fluid energy grinder.

FIG. 2 shows a top view of the grinder on line 2—2 of FIG. 1, sectioned at the fluid inlet level.

FIG. 3 is a side view of two grinding units arranged in stacked relationship.

FIG. 4 is a side view of the grinder with suction feed and product recycle connection.

DESCRIPTION OF THE INVENTION

The structure of the fluid energy grinder is shown in FIG. 1. The grinding chamber 5 is of substantially cylindrical shape, having an outer shell 6 made of suitable material, such as steel. The top of the chamber 5 has a suitable flange 7 to which the top closure plate 8 is secured by bolts or other suitable fastening means. The bottom of the chamber 5 is closed with a bottom closure plate 9, which may be welded in place. All interior surfaces of the grinding chamber and its closure plates are covered with a protective layer of abrasion resistant rubber 10. A product exit tube 11, made of steel or similar material is centrally located in the bottom closure plate and extends vertically into the grinding chamber for a substantial distance. A heavy rubber tube 12 fits around the vertical extension of exit tube 11 and may be moved slidably thereon for vertical height adjustment. A fluid exit tube 13, made of steel or similar material and having an outside diameter substantially less than the inner diameter of product exit tube 11 is centrally located in the top closure plate 8. The tube 13 is threaded into coupling 14 and has a downward extension 13A, also threaded into coupling 14 and positioned within product exit tube 11.

A receiving coupling 15 is attached to the side of the grinding chamber 5 in tangential relationship to the internal circular surface of the chamber. The coupling has an internal thread into which the feed chamber 16 and driving fluid nozzle 17 are attached by means of matching threads on the feed chamber outlet. A protective nipple 18 is threaded into the feed chamber outlet 19. The feed chamber 16 is supplied with particulate feed material from a conduit 20 which is filled from the hopper 21.

During operation of the grinder compressed air or dry steam is supplied from the pipe 22 and passes through the nozzle 17 to form a jet of high velocity. This jet carries feed particles from the feed chamber 16, passing through the protective nipple 18 and entering the grinding chamber 5 at high velocity. The tangential entrance of the jet stream generates a rapid whirling motion of fluid borne particles within the grinding chamber. Since the particles are moving at different velocities, there are innumerable collisions between them, resulting in the desired size reduction or grinding action. A classifying action also takes place with the larger particles forming the lower strata of the whirling mixture while the smaller particles rise toward the upper part of the grinding chamber. As these particles become smaller, the centrifugal force exerted on them by the whirling fluid stream becomes less and the particles tend toward the center of the grinding chamber. Here they pass over the top of the rubber sleeve 12 and then drop out of the fluid stream and through tube

11 into suitable collectors. Retention time of the ground product may be regulated by changing the height of tube 12. The longer the retention time within the grinding chamber, the greater the number of particle contacts, resulting in more grinding and higher bulk density. The fluid stream, nearly free of solid material, passes out through the tube 13A. Small amounts of dust are carried with it, this is removed in a suitable dust collector attached to tube 13.

As mentioned previously, the reduction of wear is an important factor in the design of fluid impact grinders. Although a lining of abrasion resistant rubber, either natural or synthetic, has been employed in the grinder of this invention, other abrasion resistant linings of ceramic materials such as carbides, nitrides or oxides may be used. Wear is concentrated on the grinding chamber area which receives the full force of the jet of driving fluid; this is protected by a plate of wear resistant material 23 which may be easily replaced. Another rapid wear point is the protective nipple 18 which is attached to the discharge outlet of the feed chamber. This is an inexpensive part and is designed for easy replacement. The driving jet and nozzle assembly are positioned at a suitable distance above the bottom closure plate of the grinder so that a layer of material will always be present in the lower space 5A of the grinding chamber. This layer of relatively coarse material is rotated around the lower space 5A of the grinding chamber by the action of the driving jet above the layer. This layer of particles moves at a velocity which is much less than that of the driving jet, however, and therefore has little wearing action on the lining of the lower closure plate 9 while acting as a protection against the much higher velocity particles in the driving jet stream above. The above-mentioned design features therefore combine to give a grinder which is specially suited for processing hard abrasive materials such as silicon or boron carbides or nitrides, alumina, zirconia and compositions of these and similar refractory oxides, silica or silica containing compositions, and the like.

While the grinder of the invention has been shown with one driving fluid jet and hopper feed, it is not restricted to this alone. Several jets and feed hoppers may be installed around the periphery of the grinding chamber, depending on the size of the grinder, and the feed material may be supplied, not only from hoppers, but by other means such as mechanical or pneumatic conveyor systems. Two or more of these grinders may also be used in a stacked relationship, with the product discharge of the first grinding unit arranged to discharge into the feed supply of the second grinding unit below. FIG. 3 shows two grinding units with the product from the first being fed to the second unit for further grinding; more than two units may be arranged in this manner if required.

The action of the fluid jet from nozzle 17 generates a strong suction in feed chamber 16. A suction feed may therefore be devised by removing the threaded plug 24 (see FIG. 1) at the lower part of feed chamber 16 and installing a suitable tube 25 (see FIG. 4) extending downward into a feed container. For this type of operation, the hopper 21 is removed and pipe 20 is closed by a cap 27, or other suitable means. This method of feed eliminates dusting during feeding and also permits a continuous automatic recycle of ground product, if necessary for further size reduction. If product recycle is desired, a branch line 25A may be installed to con-

nect the suction feed tube 25 with product discharge tube 11. For recycle, tube 11 is closed at the bottom and suction flow is regulated by slide or pinch valves 26. While compressed air is the preferred driving fluid other fluids such as nitrogen, carbon dioxide or dry steam may be used, depending on the characteristics of the material being ground. Fluid pressures ranging from 10 to 50 psig may be used, the preferred pressures being in the range of 25 to 30 psig.

Bulk density is an important property in many operation involving the use of particulate materials. Within certain ranges, this density usually increases as particle sizes decrease. Grinding tests have shown that a batch of product which can be ground to a standard bulk density in a relatively short time in the grinder of the invention will, when using a mechanical grinder, require a grinding period up to three times longer to achieve the same result. Loss of material in the mechanical grinder is usually double that lost in fluid grinding, due probably to the extended processing time required in the mechanical system.

The grinder of the invention is designed to be assembled from easily available materials, using well-known methods of fabrication. The initial cost of the unit is therefore considerably lower than that of a mechanical grinding unit of similar capacity. Since the grinder has no moving parts, maintenance costs are greatly reduced, involving only an occasional change of wear plates or protective nipples. This maintenance can be done quickly and grinder down-time is cut to the minimum, resulting in a unit of substantially improved production capacity.

What is claimed is:

1. A fluid energy grinder for particulate size reduction by impact grinding, comprising in combination:

- a. a substantially cylindrical grinding chamber of wear resistant material;
- b. a top closure plate on the chamber, the plate having a first aperture centrally located therein;
- c. a fluid exit tube positioned within the first aperture for the exit of fluid;
- d. a bottom closure plate on the chamber, said bottom closure plate having a second aperture therein;
- e. a product exit tube positioned within the second aperture for the exit of product; and
- f. fluid driving means, comprising a feed chamber and a fluid driving nozzle associated with the feed chamber for driving a mixture of fluid and particulate feed tangentially into the grinding chamber; the fluid exit tube being of substantially less diameter than that of the product exit tube and being positioned to permit adjustable insertion into said product exit tube for a relatively short distance.

2. A fluid energy grinder according to claim 1 in which the said product exit tube has an adjustable sleeve in slidable relationship thereon.

3. A fluid energy grinder according to claim 1 in which the feed chamber and fluid driving nozzle are attached to the grinding chamber at a sufficient distance from the bottom closure plate to establish a layer of moving material on said plate.

4. A fluid energy grinder according to claim 1 in which the feed chamber has a linear conduit attached thereto, said conduit being disposed in a downward position to receive feed material by suction flow.

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