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METHOD AND APPARATUS FOR TREATING MICA

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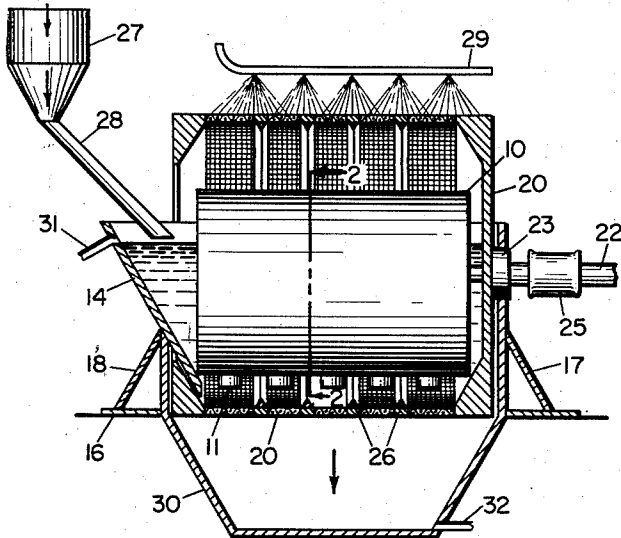


FIG. 1

FIG. 2

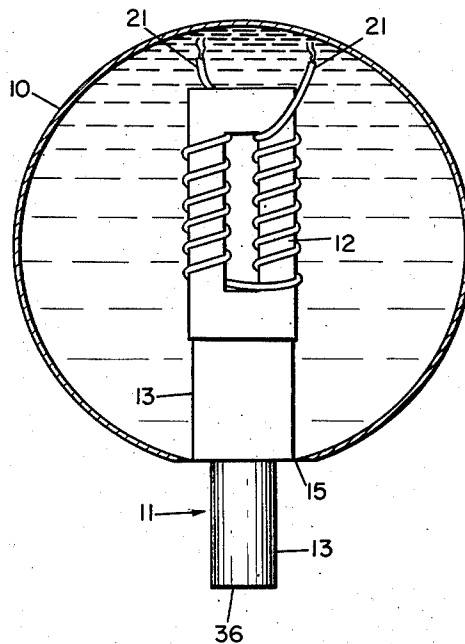
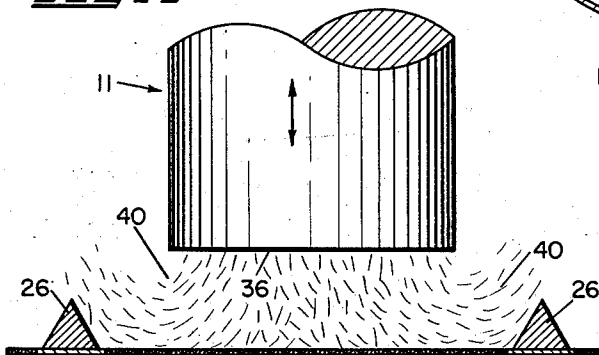


FIG. 3



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METHOD AND APPARATUS FOR TREATING MICA

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6 Claims. (Cl. 241—1)

This invention relates to methods and apparatus for reducing the particle size of mica and for delaminating mica. More particularly, the invention relates to methods and apparatus for effecting particle size reduction and delamination of mica by the application of ultrasonics.

Mica in either sheet or ground form has many uses. For example, sheet mica is useful for electrical insulation, goggles, screens, various types of diaphragms, etc. In the ground form mica is widely used to lend decorative features to paint, wall paper, tile, etc. There are many other uses for both the ground and the sheet form. Since the material does not occur naturally in either sheet or finely ground form, it must be processed before it is suitable for any of the many applications to which it may be put.

In the past, delamination of mica has generally been accomplished by hand operations. There have been attempts at mechanical delamination but these have invariably been inefficient and have produced too much scrap in proportion to the amount of material obtained in useful sheet form. Grinding operations in the past have usually comprised wet grinding processes utilizing chaser mills of annular steel or wooden pans up to as much as 10 feet in diameter, and 40 inches in depth. In these processes the water/mica ratio is very critical. The mills are ordinarily provided with two, three, or four rollers operating at 20 to 40 R. P. M. Complete grinding of a one-ton charge requires 4 to 8 hours. There are also dry grinding methods, usually with a hammer mill, but these require that the mica to be ground be thoroughly washed before grinding. This washing is usually accomplished by stirring and settling procedures involving a series of tanks. The clean wet bulk must then be dried before being subjected to the grinding operation.

It is, therefore, an object of this invention to provide new methods and apparatus for delamination or wet grinding of mica and scrap mica.

It is another object of this invention to provide such methods and apparatus whereby the processing of mica can be accomplished more efficiently in respect to space requirements and time of treatment.

Still another object of the invention is to provide wet grinding methods and apparatus wherein water/mica ratios are not limiting and critical.

Other objects and advantages of the present invention will be apparent from the following detailed description thereof, especially when read in conjunction with the attached drawings wherein,

Fig. 1 is a partly sectioned, partly schematic drawing of an apparatus of the present invention;

Fig. 2 is a section on line 2—2 of Fig. 1; and

Fig. 3 shows schematically the manner in which the mica is processed according to the present invention.

In general, the invention comprises a method of delaminating mica or reducing the particle size of mica by subjecting the mica to ultrasonic vibrations. The invention also contemplates apparatus comprising a transducer element, a rotating screen, and suitable means for feed-

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ing in the raw material and removing the treated material.

Referring now more particularly to the drawings, it will be seen in Fig. 1 that the apparatus of this invention may comprise a housing 10 within which are positioned a plurality of transducer elements 11—11. A collector or material-retaining reservoir 14 may be provided around the housing 10 and one side of said housing 10 may conveniently be supported on such collector element 14, as is illustrated in Fig. 1. A screen element 20 having its horizontal axis parallel to that of housing 10 is located so as to encompass housing 10 within its perimeter. It should be noted that collector element 14 has no bottom so that material charged into this retaining reservoir rests on screen member 20, while retaining collector 14 serves only to regulate the depth of the material so supported. In this connection, an overflow 31 is provided in collector 14. Rib elements 26 are provided along the inside perimeter of screen element 20, each pair of rib elements 26 cooperating to form a channel, as is best seen by reference to Fig. 3. The entire screen and rib assembly is arranged to rotate around housing 10, said screen assembly rotating on a hollow shaft 22, which projects through bearing 23. Brace members 17 and 18 may be provided to support and position collector 14. Such brace members 17 and 18 may be suitably fastened to a base member 16, which may be a floor at the operating level for the device, or may be any suitable base. A support member (not shown) for the other side of housing 10 may project through hollow shaft 22 into a suitable support. Shaft 22 for rotating screen 20 is driven through pulley 25 by driving means such as a belt and electric motor combination, not shown. A material feeding means, for example, comprising a hopper 27 and feeding chute 28, may be provided. A source of water, for example, water spray means 29, may be provided above screen assembly 20. A reservoir 30 for receiving treated material is provided beneath the screen assembly as shown in Fig. 1. A suitable drain 32 is provided for tapping off treated material from reservoir 30.

Fig. 2 is a section on line 2—2 of Fig. 1 and serves to show one of the transducer elements 11 in more detail. The transducer assembly 11 comprises a laminated section 12 and a mechanical amplifying or energy transforming element 13. The transducer 11 is supported by housing 10 at a nodal point 15. Suitable electric power leads 21—21 are wound around laminated core section 12. A cooling fluid may be circulated around transducer 11 and inside housing 10. Inlet and outlet means for the cooling fluid, as well as the necessary power leads may be led into housing 10 from the exterior through hollow shaft 22. As is well known in the design of transducer elements (such as element 13), vibration of an energized transducer will create cavitation and high stress in the fluid in the area beneath radiating face 36. This area is hereinafter referred to as the "reaction area."

Fig. 3 is a view showing the reaction area in more detail. The direction of vibration of transducer element 11 is indicated by the double arrow. Untreated mica particles 40 in suspension in a supporting fluid and positioned in a channel formed by ribs 26—26, are subjected to stresses as they pass under radiating face 36. Particles not in suspension are supported on screen 20 until they have been sufficiently treated to pass through the openings in the screen. The rotation of screen 20 serves to constantly agitate these particles and bring them into suspension.

The method and apparatus of the present invention function as follows:

Mica 40 to be treated is fed from hopper or storage tank 27 through chute 28 onto revolving screen 20. Water is added from spray 29 and passes through screen 20 into reservoir 30 carrying with it mica particles which

are small enough to pass through screen 20. After the mica has been passed through a separator (not shown) the clear water may be recirculated and introduced into the cycle again through spray 29. Meanwhile, the larger particles of mica 40 are brought into the reaction zone through the combined functioning of screen 20 and ribs 26, which latter tend to concentrate the mica particles on that portion of screen 20 which passes directly under the radiating face 36 of a transducer element 11. As these particles pass under the radiating face they are split or fractured due to the severe stresses caused by cavitation of the suspending medium (water) and by stresses due to highly accelerating and decelerating particles in the fluids. The slowly moving screen keeps the mica in suspension until it can be fully treated. The water spray serves the additional function of removing any mica particles which may tend to adhere to the screen. This action, together with the movement of the screen, prevents the particles from packing—a condition which would reduce the effectiveness of the ultrasonic energy in delaminating the mica or reducing its particle size. The screen movement also insures that all particles can and will be brought into the region of maximum energy intensity.

From time to time, the apparatus may be shut down and the heavier mica particles permitted to settle for a few seconds. The collector may then be filled to overflow, the overflow carrying off the very fine particles which might otherwise require considerable time for settling. Except for such periods, operation may be continuous with the rate of raw material input being roughly synchronized with the rate of treated material output. This coordination need not be critically controlled since the present method is operable over a wide range of water/mica ratios so that no critical relation between the quantity of water and the mica content need be maintained.

The transducer elements used may be conventional devices designed to operate in the frequency range from about 15 kilocycles per second to about 1 megacycle per second. The frequency of operation is not critical although higher intensities are required for the lower frequencies. Preferred operating frequencies are in the range from 15 kilocycles per second to about 35 kilocycles per second. A good practical operating frequency is 20 kilocycles per second.

Example

As an illustration of the effectiveness of the present method and device in treating mica, a sample of run-of-the-mine scrap mica was treated according to the present invention. The product was then compared with a commercially available treated mica of the grade ordinarily used for paint.

Prior to treatment, the test sample averaged slightly more than 10 microns in thickness and consisted of both plate-like and fibrous material, the fibers being attached to the edges of the plates. The sample was treated (according to the process described above and in the apparatus illustrated in the attached drawings), the magnetostrictive transducer being excited at 20 kilocycles. After this treatment, the treated mica was found to be about 80 percent plate-like material and about 20 percent fibrous material. The plates and fibers were separated from each other in the treated product. The average size of the components after treatment was as follows:

Fibers—2.6 microns by 30 microns
Plates—21 microns by 40 microns.

The commercial sample consisted of about 10 percent fibrous and 90 percent plate-like material. The average size of the components of this product was:

Fibers—5 microns by 30 microns
Plates—10 microns by 30 microns.

It is thus apparent that the present method and apparatus can provide a product which is comparable to commercially available products prepared by prior art methods and apparatus.

An outstanding advantage of the present invention is that it eliminates the critical prior art requirement as to water/mica ratio. In previous wet grinding operations it was found that too much water prevented proper grinding, while too little water resulted in a burned mica product. In the method and apparatus of the present invention, the water/mica ratio is not at all critical. Efficient operation with a clean, unburned mica product has been carried out with water/mica ratios varying from as low as 1:1 to ratios as high as 10:1. This characteristic in itself represents a distinct improvement over the prior art.

Other advantages of the invention include the fact that the danger of burning the mica is eliminated, and the fact that a very clean product is obtained. Space requirements compare favorably with those of prior art processes and apparatus. The economics of the present method and apparatus are particularly favorable. Prior art methods and devices require as many as eight operators to handle an amount of mica which may conveniently be taken care of by two operators, in the same amount of time, using the present method and apparatus. In addition the present method and apparatus require less power than prior art operations so that a savings is effected in that regard.

It will be understood that the particular structure shown in the drawings and described in this specification is illustrative only and should not be considered as limiting. Many variations in the particular structure shown may be made without departing from the scope of the invention. For example, the hopper represents only one possible storage and feed device. Many other equivalent devices and structures would serve as well. Indeed the material could be injected into the operation by a hand process, such as by shoveling. The mesh size of the rotating screen is not critical but will vary according to the size of product desired. For most applications a mesh size of 60–80 mesh is satisfactory. As has been mentioned previously, the transducer element itself may be any conventional transducer. A laminated nickel transducer operating as a magnetostrictive device makes an entirely satisfactory transducer element. Such devices are excited by means of an internal magnetic field induced by passing an alternating current of the proper magnitude and frequency through the coil which surrounds the laminated stack. The size and shape of the various elements of the apparatus may be varied over a wide range, depending upon the magnitude of the operation.

Although the particular operation described above is a continuous-type operation, the method and apparatus of this invention are readily adapted to batch-type operation. This could also involve a stationary unit utilizing a mechanical stirrer. In this case, a reservoir containing the mica charge suspended in water would be arranged so that the charge could be kept in constant motion along or around the reservoir (by means of the mechanical stirrer). A transducer, or array of transducers, could then be arranged above and along the reservoir, so that the mica charge would be subject to the ultrasonic vibrations and resultant stresses. Separation of the mica particles would be done following the treatment under the transducer. Particles not sufficiently reduced or delaminated could be recharged into a succeeding batch operation.

It will be apparent that new and useful apparatus and methods for delaminating mica and reducing mica particle size have been disclosed, wherefore it is desired to further describe the invention in the following claims.

What is claimed is:

1. A method of delaminating and reducing the particle

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size of mica comprising the steps of suspending the mica particles in water, maintaining the water/mica ratio in the range from 1:1 to 10:1, subjecting the suspension to ultrasonic vibrations in the range from 15 kilocycles to 1 megacycle per second while maintaining the particles in suspension on a screen of mesh size corresponding to the largest desired product particle size, rotating the supporting screen during the operation, and collecting the particles as they pass through the rotating screen.

2. A continuous method of reducing the particle size of mica comprising the steps of charging the particles onto a screen, adding water to suspend the particles, rotating the screen thereby bringing the particles into a reaction area beneath the face of an ultrasonic transducer, energizing the transducer, thereby subjecting the particles to ultrasonic vibrations and stresses, collecting treated particles as they pass through the rotating screen, and coordinating the rate of charging of raw mica with the rate of withdrawal of treated mica.

3. The method of reducing the particle size of mica particles comprising the steps of charging the mica particles onto a screen of mesh size corresponding to the largest desired particle size, adding water in sufficient quantity to suspend the mica, rotating the screen thereby bringing the particles into the reaction area created by an ultrasonic transducer, subjecting the particles to ultrasonic vibrations in said area thereby reducing the particle size, and passing the reduced particles through said screen into a container.

4. Apparatus for reducing the particle size of mica particles comprising a mica storage and feed means, a revolving screen mesh size corresponding to the largest desired product particle size, and upon which particles to be treated are deposited from said feed means, water supply means for adding water through said screen thereby putting the mica particles in suspension, a transducer housing positioned inside the circumference of the rotating screen, transducer elements positioned within said housing each having a radiating face projecting through said housing, and designed to operate in the ultrasonic frequency range and positioned so as to create a reaction area through which particles are carried by the rotating screen.

5. Apparatus for reducing the particle size of mica

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particles comprising mica storage means, a screen of mesh size corresponding to the largest desired particle size, means for rotating said screen, a feed means for depositing mica particles from said storage means on said screen, a housing positioned inside the circumference of said screen, a plurality of transducer elements designed to operate in the frequency range from 15 kilocycles to 1 megacycle, and positioned in said housing so as to have radiating face projecting through said housing, water-supplying means positioned above said rotating screen, a collector device positioned partially around the base of said housing, an overflow means in said collector, and a reservoir positioned below the rotating screen wherein treated particles passing through said screen may be collected.

6. Apparatus for delaminating mica comprising a housing, magnetostrictive transducer devices designed to operate in the frequency range of from 15 kilocycles to 1 megacycle and mounted within said housing and each having an energy-radiating face projecting from said housing, a screen of mesh size corresponding to the largest desired product particle size, said screen being spaced from said housing and surrounding said housing, means for charging mica onto said screen, means for introducing water through said screen to provide a water suspension of said mica, means for rotating said mica-laden screen so as to successively present the water-suspended mica into the energy field beneath said radiating face, and means for energizing said magnetostrictive devices while said mica is in said energy field.

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