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APPARATUS FOR IMPACT PULVERIZING

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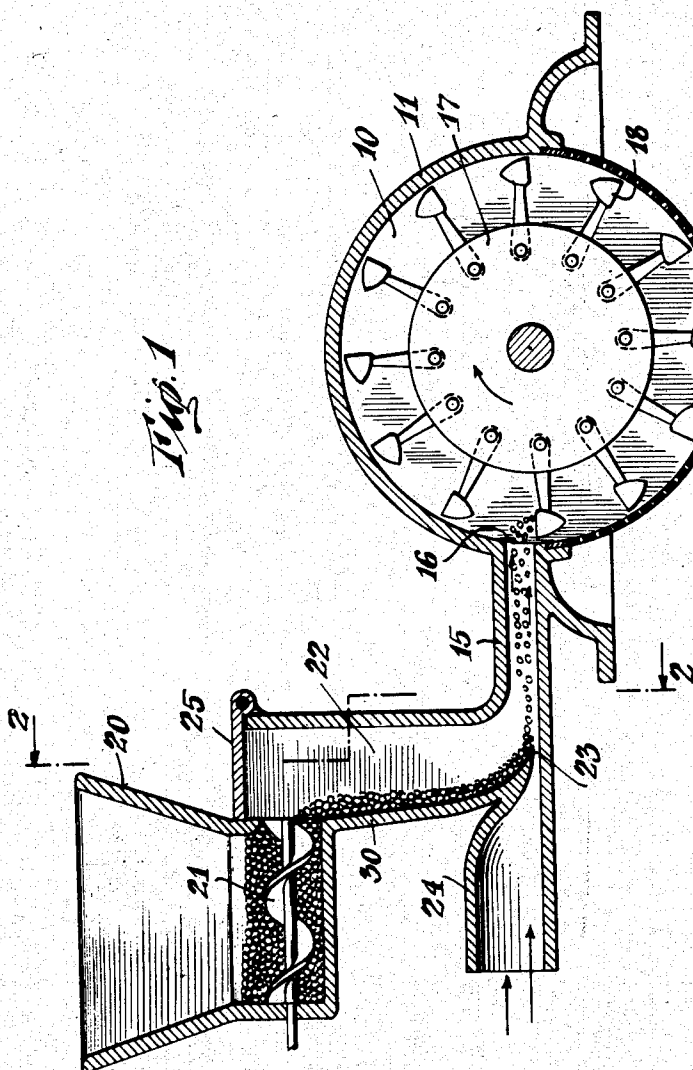
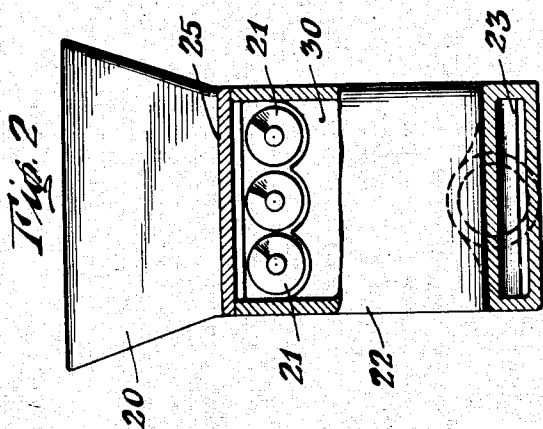
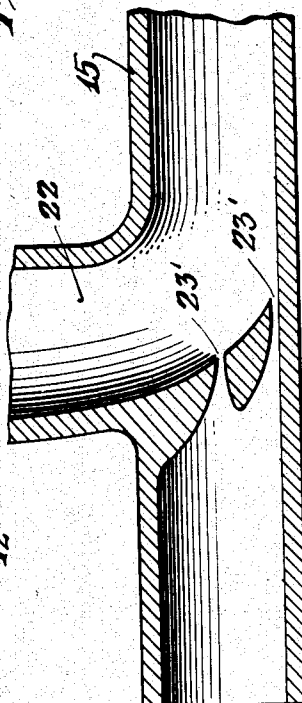


*Fig. 3*



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## APPARATUS FOR IMPACT PULVERIZING

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5 Claims. (Cl. 83—11)

This invention relates to the pulverization of material in impact pulverizers of the rotary beater, or hammer mill, type. The object of the invention is to increase the efficiency of such impact pulverizers and to avoid to a large degree loss of production capacity and fineness of pulverization from wear on the striking faces of the beaters.

The pulverizing action of impact pulverizers is generally considered to result, at least mostly, from the impact between the rapidly rotating beaters and the material introduced into the mill chamber, and largely by the first impact of the beaters on the material as it is introduced through the feed opening in the side of the peripheral wall of the chamber. The fact is, as I have discovered, that the speed at which the material to be pulverized is customarily moved into the mill chamber is so low as compared to the speed of rotation of the beaters and the resulting extremely small time interval between the passing of successive beaters past the feed opening that the particles of material do not enter completely between successive beaters but are merely struck by the outer edges of the beaters, which thus tend to shear off thin layers from the particles and throw the particles outward against the chamber wall. This means, not only loss of efficiency over what it would be with true impact action on the material, but also that the outer edges of the beaters become quickly dulled, thus greatly reducing the efficiency of the mill; and the result is not only loss of production capacity, but also a general coarsening of the pulverized product.

According to the present invention, the material to be pulverized is injected into the mill chamber and into, and at approximately right angles to, the path of the beaters in suspension in a stream of air or other suitable gas driven at such high velocity that by far the greater part of the material enters between successive beaters so as to be in the path of the striking face of the beaters, successive portions of the material being injected into the successive spaces between the passing beaters. The material is thus very largely pulverized by impact in its first contact with the beaters, with resulting improved efficiency of the mill. Furthermore, there is very little wearing away of the outer edge of the beaters. Such wear as there is on the striking face of the beaters does not appreciably alter their angularity and, therefore, does not cause any appreciable loss in production capacity or in fineness of pulverization of the material, and the necessity of more or less frequent renewal or repair of the beaters is avoided. Also, for some materials, finer screens may be used for discharge of the pulverized material from the mill chamber with less trouble from clogging

than with the customary ways of feeding the material.

The invention is suitable for pulverizing all materials which are more or less disintegratable by impact. It has apparently no advantage on the ground of increased efficiency for pulverizing materials which are so tough or so soft as not to be shatterable by an impact blow. In order to avoid danger of explosion in the mill chamber when pulverizing inflammable materials, such as sulphur and resins, an inert gas such as washed flue gas, carbon dioxide and nitrogen is used as the injecting gas. Most of such materials soften when heated, and to avoid the softening of the material due to heat generated by friction within the mill chamber, the inert gas supplied to the injector is chilled. For materials which soften when heated but are not inflammable, chilled air may be used.

A full understanding of the invention can best be given by a detailed description of a preferred form of apparatus, and such a description will now be given in connection with the accompanying drawing showing a hammer mill of the form now considered best. In said drawing:

Fig. 1 is a sectional view of such a hammer mill in a plane at right angles to the axis of the mill rotor;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1; and

Fig. 3 is a fragmentary sectional view of a modified construction.

Referring to the drawing, Fig. 1 shows a hammer mill of known form having a cylindrical mill chamber 10 formed by a casing having an imperforate upper wall 11 and a perforate lower wall, or screen, 12 for the discharge of the pulverized material. A feed conduit 15 extends from a feed opening 16 in one side of the peripheral wall of the chamber, and a high speed rotor 17 is mounted in the mill chamber, the rotor having the usual pivotally mounted hammers, or beaters, 18. As indicated by the arrow, and most desirably, the rotor is driven in the direction for its beaters to move upward past the feed opening.

The material to be pulverized is fed at a controlled rate from a hopper 20 by means of one or more feed screws 21, usually, and as shown, three such feed screws mounted horizontally side by side. The feed screws are driven in any suitable manner and at a speed to feed the material from the hopper at the desired rate. The material fed from the hopper drops through a chute 22 and through an inlet opening into the feed conduit 15 directly in advance of a restricted air inlet, or nozzle opening, 23 to which air is supplied through a conduit or pipe 24 from any suitable source of air under pressure. The feed conduit 15 extends most desirably radially of the rotor and mill chamber and is oblong in cross-section, being

elongated horizontally, and the inner or discharge end of the conduit, which forms the feed opening, thus extends axially of the chamber and most desirably for substantially the length of the chamber. This transverse width of the conduit and length of the feed opening will depend on the length of the mill chamber, and for a mill having a very short mill chamber the feed opening need not be of oblong form and the feed conduit need not be oblong in cross-section. The feed chute 22 should have a width corresponding to that of the feed conduit, and the number of feed screws, one or more, will be determined by the width of the conduit and chute.

The air supply conduit 24 merges into the restricted air inlet, or nozzle opening, 23 so that as the air flows from the pipe to the nozzle pressure energy of the air is converted into velocity energy with the result that a high velocity stream of air issues from the nozzle opening into the conduit 15 and carries along with it through the conduit material dropping into the conduit from the chute 22. The particles of material become distributed in the air stream and are discharged in suspension in the air stream from the feed opening 16 at high velocity into the path of the beaters. The material struck by each beater as it passes the feed opening is, therefore, spread over the striking face of the beater instead of being struck only by the edge of the beater as in hammer mills in which the material is fed into the mill chamber in the heretofore customary way. Most desirably, the far wall 30 of the chute extending downward from the discharge opening of the hopper slopes slightly forward and is curved at its lower end so that the material entering the conduit is directed forward in the direction of the air flow, thus lessening the inertia of the particles of material to be overcome by the air stream; and most desirably the curve at the bottom of the wall ends at the air nozzle opening tangent to the issuing air stream or jet. The chute is closed at the top by a hinged cover 25 to prevent the suction in through the chute of air which would lower the velocity of the air stream entering the mill chamber.

The speed at which the material should for best results be injected into the path of the beaters will depend on the time interval at which successive beaters pass the feed opening and the radial width of the striking faces of the beaters; and for a given speed of injection of the material into the path of the beaters, the vertical width of the nozzle opening and the length and vertical dimension, or depth, of the conduit and the pressure under which the air or other gas is supplied to the pipe 24 will vary according to the capacity of the mill per unit of length of the mill chamber, that is, according to the amount of material passing through the conduit per unit of time in each unit of transverse, or axial, width of the conduit and of the feed opening 16.

The material should be injected through the feed opening and into the path of the beaters at a speed such that the particles move in the time interval between the passing of successive beaters a substantial part of an inch, which will be more or less according to the radial width of the striking faces of the beaters or such part of the forward facing faces of the beaters as it is desired to have serve as the striking faces. Beaters having striking faces a half inch in radial width are commonly used in hammer mills, and for such mills the material is most desirably injected into the path of the beaters at a speed such that the

particles move substantially  $\frac{1}{2}$  inch radially of the rotor in the time interval between the passing of successive beaters. In other words, the material is most desirably injected into the path of the beaters at a speed measured in inches per second substantially equal to the inch measurement of the width of the beater faces times the number of beater passings per second. This speed is ordinarily a speed of several hundred inches per second.

For a hammer mill such as shown in Fig. 1, having a cylindrical mill chamber of about 12 inches in diameter, and a rotor having, as shown, twelve rows of beaters equally spaced circumferentially and extending close to the peripheral wall of the chamber and driven to revolve at 6000 R. P. M., the beaters will pass the feed opening 16 at the rate of 1200 per second, the time interval between the passing of successive beaters being  $\frac{1}{1200}$  of a second. If the beaters have striking faces  $\frac{1}{2}$  inch wide radially, then the speed at which the material is fed radially into the path of the beaters should for best results be theoretically 600 inches per second. This speed of injection of the material of 600 inches per second, or approximately that, is obtained with material feeding means such as shown in which the feed inlet 16 measures  $6\frac{1}{2}$  inches axially of the mill chamber and 1 inch circumferentially thereof, the feed conduit 15 is about 5 inches long and  $6\frac{1}{2}$  inches in horizontal width and 1 inch in vertical width, the nozzle opening 23 is  $6\frac{1}{2}$  inches long and  $\frac{1}{8}$  inch in vertical width, and the air pipe 24 is 3 inches in diameter, and with the material being supplied to the feed conduit at a rate of from 600 to 900 pounds per hour according to the density of the material.

The mill above referred to has in the pulverization of various materials shown a marked increase in efficiency as compared to that obtained with a similar hammer mill in which the material to be pulverized is fed directly to the feed opening and into the mill chamber by the commonly used screw feed. For example, the following comparative results have been obtained, A indicating a mill having direct screw feed, and B indicating the same mill having the material fed to the mill chamber by air injection according to the invention:

#### Granulated cane sugar

|                       | A            | B            |
|-----------------------|--------------|--------------|
| Capacity.....         | 800 lbs./hr. | 900 lbs./hr. |
| H. P. ....            | 8.2          | 7.5          |
| Through 70 mesh.....  | St. Tr. On   | 100.0        |
| Through 100 mesh..... | 99.94%       | St. Tr. On.  |
| Through 200 mesh..... | 93.97%       | 96.25%       |

#### Dental soap

|                       | A            | B            |
|-----------------------|--------------|--------------|
| Capacity.....         | 800 lbs./hr. | 800 lbs./hr. |
| H. P. ....            | 7.5          | 7.5          |
| Through 40 mesh.....  | 100.0%       | 100.0%       |
| Through 60 mesh.....  | 96.5%        | 99.9%        |
| Through 100 mesh..... | 80.5%        | 96.0%        |

#### 11% butterfat cocoa

|                       | A            | B            |
|-----------------------|--------------|--------------|
| Capacity.....         | 400 lbs./hr. | 570 lbs./hr. |
| H. P. ....            | 7.5          | 7.5          |
| Through 150 mesh..... | 98.0%        | 97.7%        |
| Through 200 mesh..... | 96.8%        | 95.1%        |

For hammer mills of substantially larger size and greater capacity, the feed conduit and feed opening should be of correspondingly greater vertical width, and the injecting air is most desirably supplied in two streams through two vertically spaced nozzle openings 23' as shown in Fig. 3.

The physical character and condition of the material to be pulverized is not of particular moment except that it should be in the form of particles not too large to pass freely through the feed or mixing conduit, and that, as stated, the material should be more or less disintegratable by impact.

What is claimed is:

1. An impact pulverizer, comprising a cylindrical chamber having a feed opening in one side of the peripheral wall thereof and the lower portion of its peripheral wall being perforate for the discharge of pulverized material, a rotor mounted within said chamber having a plurality of circumferentially spaced beaters the outer edges of which move close to the chamber wall in passing the feed opening, means for driving the rotor at high speed in the direction to cause its beaters to move upward past the feed opening, a closed feed conduit extending to the feed opening and means for injecting the material to be pulverized through the feed conduit and through the feed opening into the path of the beaters suspended in, and moving at approximately the same speed as, a current of gas moving at approximately right angles to the direction of movement of the beaters with a speed of several hundred inches per second.

2. An impact pulverizer, comprising a cylindrical chamber having a feed opening in one side of the peripheral wall thereof and the lower portion of its peripheral wall being perforate for the discharge of pulverized material, a rotor mounted within said chamber having a plurality of circumferentially spaced beaters the outer edges of which move close to the chamber wall in passing the feed opening, means for driving the rotor at high speed in the direction to cause its beaters to move upward past the feed opening, a closed feed conduit extending to the feed opening a gas injector which discharges through the feed conduit and through the feed opening into the path of the beaters a high velocity stream of gas moving at approximately right angles to the direction of movement of the beaters with a speed of several hundred inches per second, and means for supplying the material to be pulverized to the mixing tube of said injector to be carried by the gas stream at high velocity through the feed opening and into the path of the beaters.

3. An impact pulverizer, comprising a cylindrical chamber having a feed opening in the peripheral wall thereof and the lower portion of

its peripheral wall being perforate for the discharge of pulverized material, a high speed rotor mounted within said chamber having a plurality of circumferentially spaced beaters the outer edges of which move close to the chamber wall in passing the feed opening, a closed feed conduit extending to said feed opening at approximately right angles to the direction in which the beaters move past the feed opening, means for discharging a high speed jet of gas into the outer end of said conduit, a material feed inlet opening into said conduit near its outer end, a feed hopper, a closed chute extending from the outlet of said hopper down to said feed inlet opening, and a feed screw for feeding material to be pulverized from said hopper to drop through said chute to the feed inlet opening into said conduit.

4. An impact pulverizer, comprising a cylindrical chamber having in one side of the peripheral wall thereof a feed opening elongated in the direction parallel to the axis of the chamber, the lower portion of the peripheral wall of the chamber being perforate for the discharge of pulverized material, a rotor mounted within said chamber having a plurality of circumferentially spaced beaters the outer edges of which move close to the chamber wall in passing the feed opening, means for driving the rotor at high speed in the direction to cause its beaters to move upward past the feed opening, a closed feed conduit extending to said feed opening at approximately right angles to the direction in which the beaters pass the opening, said conduit being oblong in cross-section to correspond to the feed opening and having a restricted air inlet slot at its outer end, means for supplying gas under pressure to said inlet slot, an elongated material feed inlet opening into said conduit adjacent the gas inlet slot and between it and the feed opening to the mill chamber, a feed hopper, and a plurality of feed screws located side by side for feeding material to be pulverized from said hopper to drop through the feed inlet opening into said conduit.

5. An impact pulverizer, comprising a cylindrical chamber having a feed opening and the lower portion of its peripheral wall being perforated for the discharge of pulverized material, a high speed rotor mounted within said chamber having a plurality of circumferentially spaced beaters the outer edges of which move close to the chamber wall in passing the feed opening, a closed feed conduit extending to said feed opening, and means for injecting the material to be pulverized through the feed conduit and through the feed opening into, and at approximately right angles to, the path of the beaters suspended in, and moving at approximately the same speed as, a high velocity stream of gas moving at a speed of several hundred inches per second.

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