

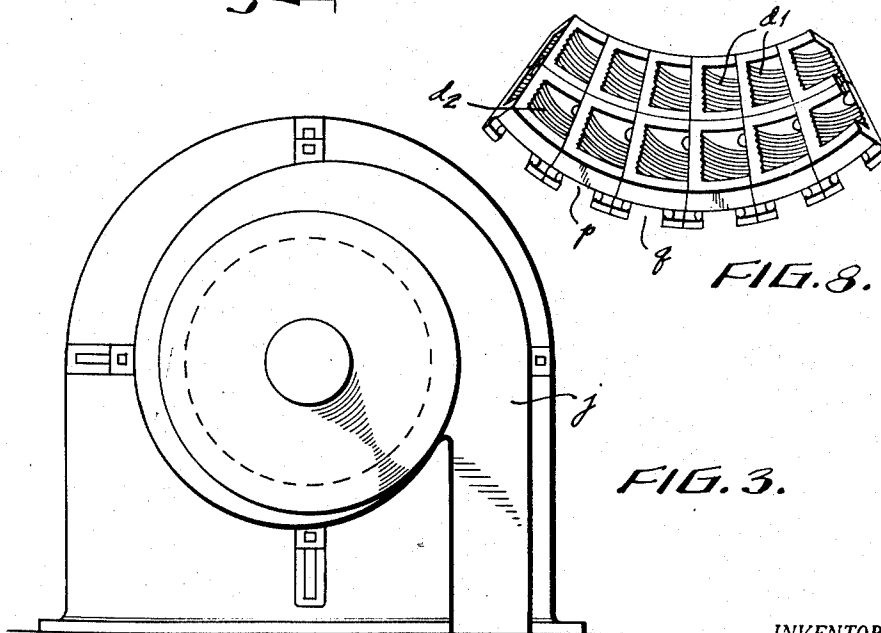
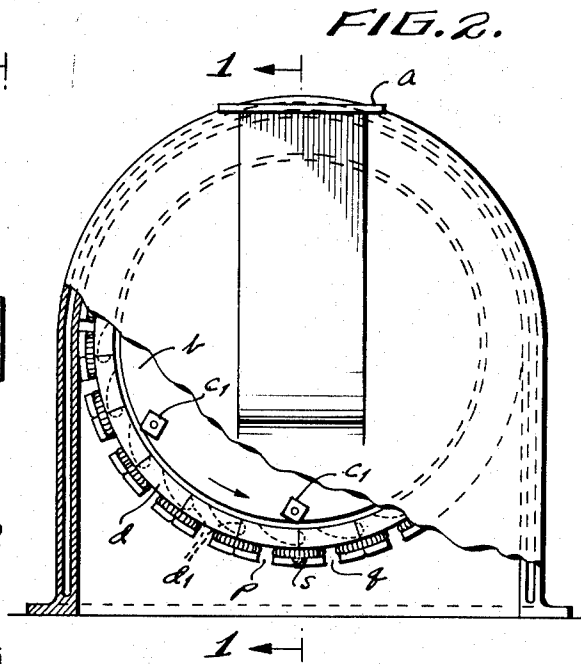
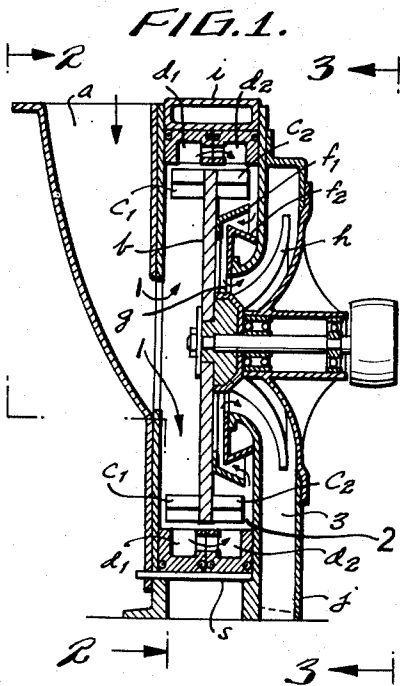
Sept. 9, 1952

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CENTRIFUGAL MILL

2,609,995

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2 SHEETS—SHEET 1



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2 SHEETS—SHEET 2

FIG. 4.

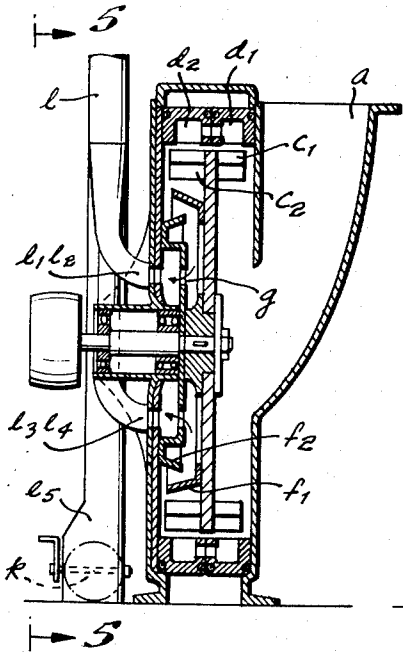


FIG. 5.

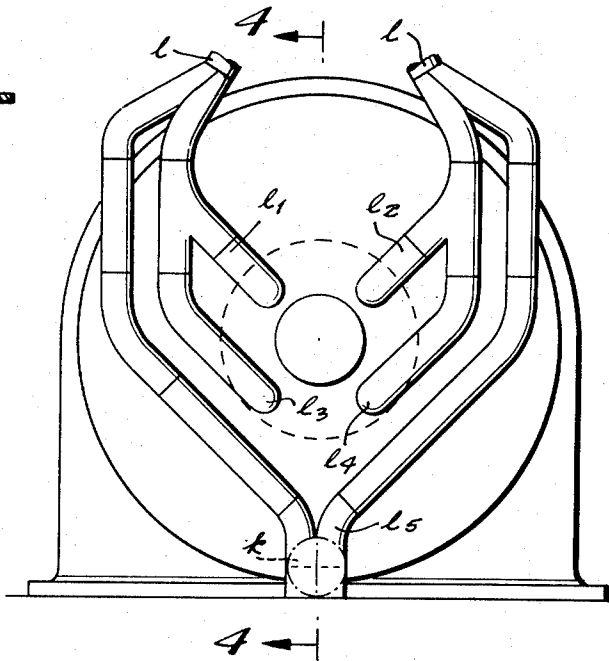


FIG. 6.

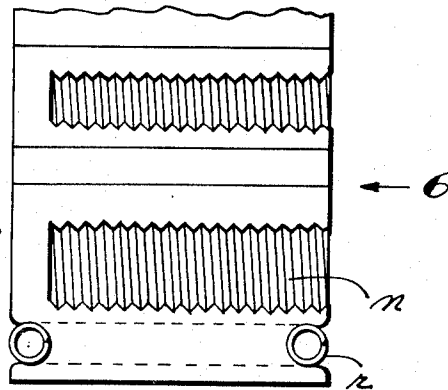
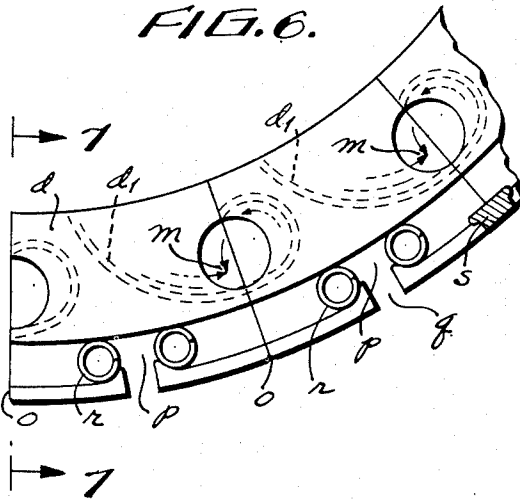


FIG. 7.

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CENTRIFUGAL MILL

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5 Claims. (Cl. 241—154)

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The present invention relates to a centrifugal mill, and more particularly to a mill for the disintegration of materials, and is of the type in which the grinding action is performed by movable impact members in cooperation with a stationary grinding unit arranged at the periphery of the mill casing.

Centrifugal mills of the above indicated type are known into which goods to be ground are fed to the center of the mill and are thrown by beaters or thrust members mounted on a disc for high-speed rotation against a plurality of chambers of circular or oval cross section, the chambers forming a stationary ring-unit arranged at the periphery of the mill casing. The shape and depth of the chambers largely affects the grinding action, since the mixture of material and air thrown into the chambers by the thrust members will, upon discharge from the chambers, form loops intersecting or more or less opposing the main current which circulates in the sense of rotation. In addition, the disintegrating effect is to a high degree dependent on the velocity and the angle of attack of the mixtures of material and air opposing one another and is caused by the mutual friction of the particles of the goods to be ground, with the grinding action occurring at the point of intersection of the above mentioned loops, thus outside of the chambers.

It is a drawback of the aforementioned devices that the thrusting members which pass through the points of intersection are very much exposed to wear in the disintegration of hard materials, since the velocities at these points are very high and the grinding action is by far greater than that of a sand-blasting device. In the disintegration of tough materials or materials resistant to grinding, it is a further inconvenience that a large percentage of unground goods is taken along by the air current and reaches the open air through the grate, so that the ground products have to be sifted afterwards and coarse parts have to be re-ground. However, the most important disadvantage, when grinding occurs outside of the chambers, is caused by the fact that there is a limit to the extent of disintegration, since at a certain grain size a further disintegration by mutual friction of the particles is no longer possible. This is a consequence of the small mass of the particles and the low kinetic energy imparted thereto by the thrust members which is insufficient to overcome the air resistance and effect an impact of the particles upon each other which would cause further disintegration.

It is an object of the present invention to over-

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come the above mentioned drawbacks and to provide a centrifugal mill of improved disintegrating power which permits the grinding of materials down to small particle size.

It is a further object of the present invention to provide a centrifugal mill in which the wear of the milling device and of its active parts is considerably reduced.

It is still another object of the present invention to provide a centrifugal mill equipped with air circulating means and control means therefor for regulating the withdrawal of ground materials from the mill.

It is yet a further object of the invention to provide arrangements for simplifying the mounting, disassembling, and cleaning of the centrifugal mill according to the invention.

It is another object of the invention to provide a centrifugal mill of the type described which is not only simple in construction, but also reliable in operation.

With the above objects in view, a preferred embodiment of the centrifugal mill according to the invention, comprises in combination, a casing, a ring member including a plurality of stationary chambers arranged peripherally in said casing, and being open toward the interior of the mill, feed means for introducing said materials at the center of said mill, thrust means for throwing said materials against the inner walls of said chambers, and an air circulating device capable of cooperating with said thrust means in the disintegrating action, said chambers having a substantially spiral-shaped cross section capable of causing the impinging particles of material to take a return course so as to intersect with and hit the particles introduced with the main current in the interior of said chambers. Since the inner wall of each chamber is designed to follow substantially the line of an Archimedean spiral, the mixture of material and air thrown into the chambers is twisted to such a degree that it intersects the main current within the chamber. This prevents the thrust members from passing the zone of strongest milling and grinding action. New material is being constantly thrust into the chambers by the current of material and air and prevents the goods being ground from leaving the chambers prematurely.

In addition to the grinding action that takes place at the intersection of currents by the impact of particles of material hitting each other, another disintegrating action is performed by the friction of material at the chamber walls, which causes disintegration to fine particle size due to

the velocities and pressure prevailing in the chambers in case the grinding action by the mutual friction of particles would be insufficient because of an opposing air resistance.

The objection that the chamber walls may with this arrangement undergo too heavy a strain is defeated by the fact that in the existing apparatus the thrust members are subjected to greater wear than the chambers, because only 4-8 thrust members are arranged at the circumference as compared to 20-40 chambers, so that the thrust members have to stand a much higher strain upon each rotation than the chambers. This is particularly true in the case of chambers having circular or oval cross section, since the thrust members have then to pass at each chamber the point of heaviest strain.

When spiral chambers are used, wear is about equal for thrust members and chambers and for both reduced to an extent which is acceptable for practical purposes.

The goods circulating within the chambers are carried out of the mill by an accurately controlled air current, transportation being enhanced by one or several helical grooves in the inner chamber walls. Since the mill comprises two or more sections through which the goods pass while being ground, it is in some cases desirable to replace the chambers in the last section by a grate or perforated sheet, through which the ground product leaves the mill. In case it is desired to have a finished product of very fine grain, a fan is connected to the last section and the goods are centrally withdrawn by suction. The suction opening is preferably adjustable so that suction may be accurately controlled. The ground dust may be collected in a dust collector or separator. Conically or cylindrically shaped baffle plates may be provided so as to form a labyrinth at the outlet of the last grinding section thereby preventing coarse parts from entering the fan.

In another embodiment of the invention, the fan is arranged outside the mill and connected to the suction opening of the last grinding section by means of a suction pipe system arranged at the rear wall of the mill casing. This arrangement has the advantage that the mill may be used alternatively for coarse grinding or fine grinding; if the chambers in the last grinding section are replaced by a grate or perforated sheet, as described above, the suction pipe can be connected to the collecting bin and suction is then applied to that bin by opening a valve provided in the pipe for that purpose and closing the opening connecting the pipe system with the mill.

The novel features which I consider as characteristic for my invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a section along the axis of the centrifugal mill according to the invention with fan;

Fig. 2 is a front view with a part of the front wall broken away;

Fig. 3 is a rear view showing the casing with fan;

Fig. 4 is a section along the axis of a mill without fan;

Fig. 5 is a rear view of that embodiment of the mill with suction pipes;

Fig. 6 is a fragmentary section through compartments of grinding ring; and

Fig. 7 shows the structure of Fig. 6 as viewed from the left end of Fig. 6 and showing the helical grooves in the chamber walls.

Fig. 8 is a perspective view of a part of the grinding rings of the structure of the present invention.

In the drawing, *a* designates the feed hopper of the mill, *b* a rotor, *c* the members for thrusting the goods to be ground, *d* the chambers for receiving the goods, *f*₁ and *f*₂ baffle plates arranged to form a labyrinth, *g* a suction opening, *h* a fan, and *i* a cooling water jacket. The first and second grinding sections of the mill are designated by numerals 1 and 2, the fan section by 3.

As shown in Figs. 1 and 2, the goods to be ground are introduced centrally through the feed hopper *a* into the first grinding section 1 and are thrust into substantially spiral-shaped chambers *d*₁ by means of members *c*, secured to the rotor *b*.

From chambers *d*₁ of section 1, the goods pass through an opening formed in adjacent chamber walls and through a narrow gap between the rotor *b* and the walls between compartments of the ring unit into the chambers *d*₂ of section 2, in which further comminution of the goods is effected by members *c*₂.

While in the drawing only two grinding sections have been illustrated, it should be understood that three or more grinding sections could be provided in series in a mill according to my invention.

The fan *h* housed in section 3 has a suction opening *g* centrally arranged in section 2. In order to prevent coarse particles of ground material from entering the fan with the current of air passing through the chambers, conical or cylindrical baffle plates *f*₁ and *f*₂ are arranged on the rotor and fan wall, respectively, to form a labyrinth, baffle *f*₁ rotating and baffle *f*₂ being stationary.

Fig. 3 shows the fan housing arranged at the rear wall, the housing being arranged for rotation in any direction depending on where or by what means it is desired to collect the finished products, for instance in a collecting bin, or similar receptacles, a dust separator, a screening or filtering device etc.

The housing may be provided as mentioned above, with a jacket *i* for water cooling.

Fig. 4 illustrates the mill with the two grinding sections as above, but without fan, which is in this embodiment arranged outside the mill. A suction pipe arrangement opens into the second grinding section with a suction aperture *g*. Conically shaped baffles *f*₁, *f*₂ serve for preventing coarse particles of ground goods from entering suction pipes *l*₁, *l*₂, *l*₃, *l*₄, which are arranged at the rear wall of the mill and lead to the suction pipes *l* capable of being connected at the bottom by means of a suction pipe *l*₅ and flap *k* to the collecting bin (see also Fig. 5).

Fig. 6 shows, on a larger scale, several chambers having a scroll-shaped inner wall *d*₁, the paths of the catapulted and twisted currents of air and material being indicated by arrows. The points of intersection *m* of the two currents, where grinding occurs due to the mutual friction of the particles of the goods, is disposed within the grinding chambers, thus the thrusting members *c* are outside of the strongest grinding and milling action.

Fig. 7 shows the chambers in side view with the screw thread-like grooves n at the inner wall of the chambers.

Fig. 8 shows a part of the rings formed by the chambers d_1 and d_2 , these chambers being placed in end to end relation to form a pair of continuous grinding rings.

In order to simplify mounting and cleaning, the ring-shaped grinding unit may be formed of individual segments jointed at o the narrowest spot of the chamber, in the manner of a vault. For preventing the ring unit from coming apart when disassembled, the segments are provided with recesses p at their points of contact with the casing and ring-shaped helical springs r are inserted into said recesses through slots q . The springs hold the system in assembled position when after removal of a key s the ring unit is taken out of the mill. If the chambers need cleaning in case clogging occurs, they may be tilted on the rounded edges at o and the ring can then be opened without removal of the springs. As is apparent from Fig. 1, the key s may be removed by being pulled to the left, as viewed in Fig. 1.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of centrifugal mills differing from the types described above.

While I have illustrated and described the invention as embodied in centrifugal mills, more particularly in combination with a fan and suction pipe system for withdrawal of the ground product, and similar purposes, I do not intend to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of my invention.

Without further analysis, the foregoing will so fully reveal the gist of my invention that others may by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What I claim as new and desire to secure by Letters Patent is:

1. A centrifugal mill comprising, in combination, a casing having a central portion and inner peripheral wall; means for supplying the material to be milled to said central portion of said casing; thrust means rotatably mounted in said casing for hurling said material to be milled from said central portion of said casing toward said inner peripheral wall of said casing; and a plurality of chambers fixedly mounted on said inner peripheral wall of said casing, said chambers being formed with entrance openings which open toward said central portion of said casing so as to receive the material to be milled from said thrust means, said chambers having a substantially spiral inner wall with helical grooves formed therein, said wall forming a bottom for said entrance opening and forming an extension of said bottom of said entrance opening, a portion of said wall adjacent to said extension being curved so as to overlie said extension of said bottom of said entrance opening.

2. A centrifugal mill comprising, in combina-

tion, a casing having a central portion and inner peripheral wall; means for supplying the material to be milled to said central portion of said casing; thrust means rotatably mounted in said casing for hurling said material to be milled from said central portion of said casing toward said inner peripheral wall of said casing; and a plurality of chambers fixedly mounted on said inner peripheral wall of said casing, said chambers being formed with entrance openings which open toward said central portion of said casing so as to receive the material to be milled from said thrust means, said chambers having a substantially spiral inner wall with helical grooves formed therein, said wall forming a bottom for said entrance opening and forming an extension of said bottom of said entrance opening, a portion of said wall adjacent to said extension being curved so as to overlie said extension of said bottom of said entrance opening, said chambers being arranged in a series of at least two rings arranged adjacent to each other with one of said two rings of chambers being located adjacent to said supply means.

3. A centrifugal mill comprising, in combination, a casing having a central portion and inner peripheral wall; means for supplying the material to be milled to said central portion of said casing; thrust means rotatably mounted in said casing for hurling said material to be milled from said central portion of said casing toward said inner peripheral wall of said casing; and a plurality of chambers fixedly mounted on said inner peripheral wall of said casing, said chambers being formed with entrance openings which open toward said central portion of said casing so as to receive the material to be milled from said thrust means, said chambers having a substantially spiral inner wall with helical grooves formed therein, said wall forming a bottom for said entrance opening and forming an extension of said bottom of said entrance opening, a portion of said wall adjacent to said extension being curved so as to overlie said extension of said bottom of said entrance opening, said chambers being arranged in a series of at least two rings arranged adjacent to each other with one of said two rings of chambers being located adjacent to said supply means and said chambers of said two rings each having adjacent side walls abutting against each other, the said side walls of each of said chambers of said rings being formed with openings passing therethrough.

4. A centrifugal mill disintegrator chamber having top, bottom, and side walls, said top wall having an entrance opening formed therein so that the material to be milled may enter said chamber through said entrance opening, said bottom wall being curved and forming a bottom surface for said entrance opening, said top wall having a lower surface located within said chamber and overlying a portion of said bottom wall, whereby said lower surface of said top wall substantially prevents the material to be milled from falling out of said chamber but permits the milled material to be drawn from said chamber, said bottom wall and lower surface of said top wall of said chamber having helical grooves formed therein so that the material to be milled which enters said chamber is transported by said grooves from one of said side walls of said chamber to the other of said side walls of said chamber.

5. A centrifugal mill disintegrator chamber having top, bottom, and side walls, said top wall

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having an entrance opening formed therein so that the material to be milled may enter said chamber through said entrance opening, said bottom wall being curved and forming a bottom surface for said entrance opening, said top wall 5 having a lower surface located within said chamber and overlying a portion of said bottom wall, whereby said lower surface of said top wall substantially prevents the material to be milled from falling out of said chamber but permits the 10 milled material to be drawn from said chamber, said bottom wall and lower surface of said top wall of said chamber having helical grooves formed therein so that the material to be milled which enters said chamber is transported by said 15 grooves from one of said side walls of said chamber to the other of said side walls of said chamber, and at least one of said side walls of said chamber having an opening formed therein and passing therethrough so that the material being 20 milled in said chamber may leave said chamber through said opening.

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