June 5, 1945. R. C. HOPKINS 2,377,496

TWO STAGE ROTARY MILL

Filed Nov. 5, 1942 3 Sheets-Sheet 1

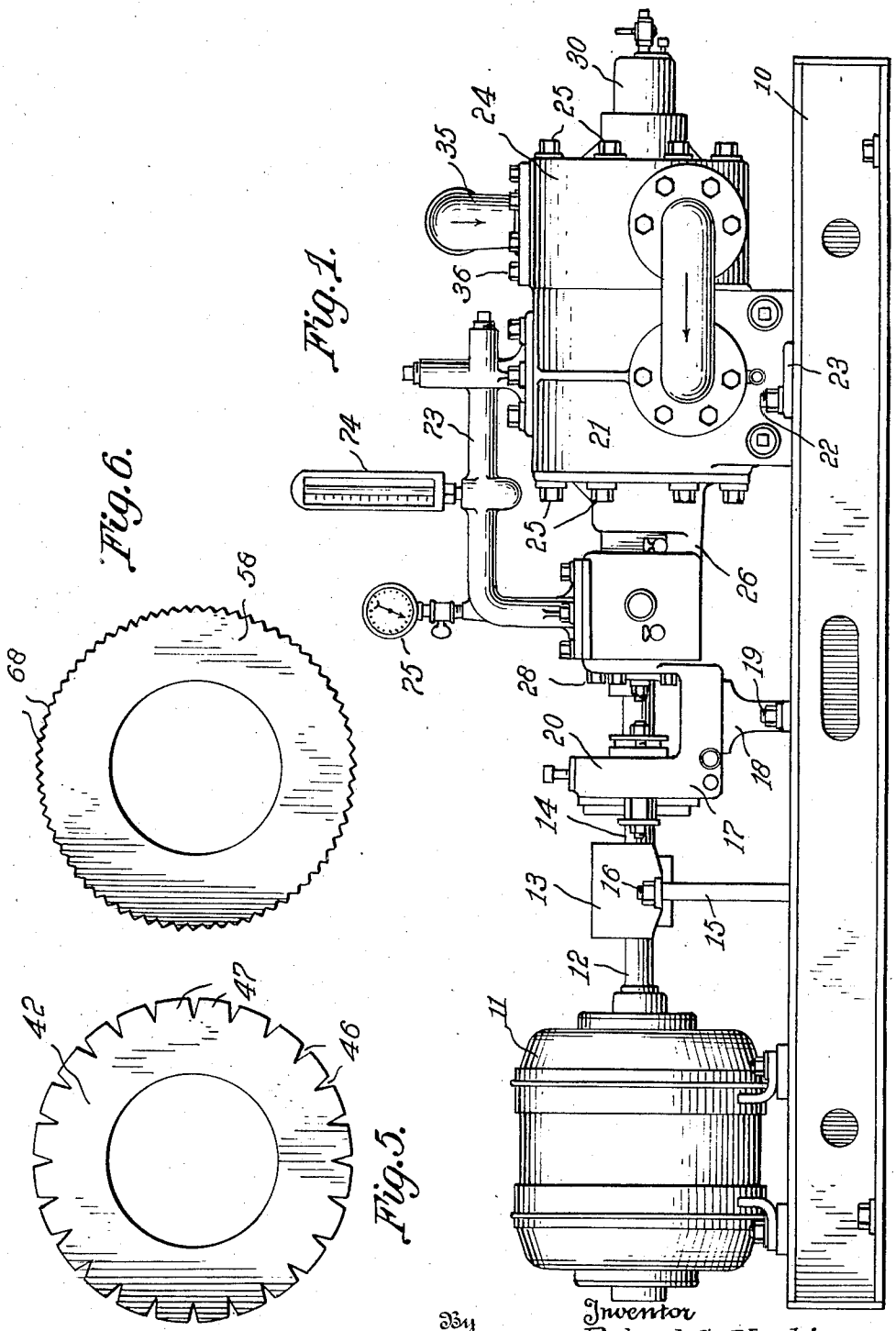


Fig. 1.

Fig. 6.

Fig. 5.

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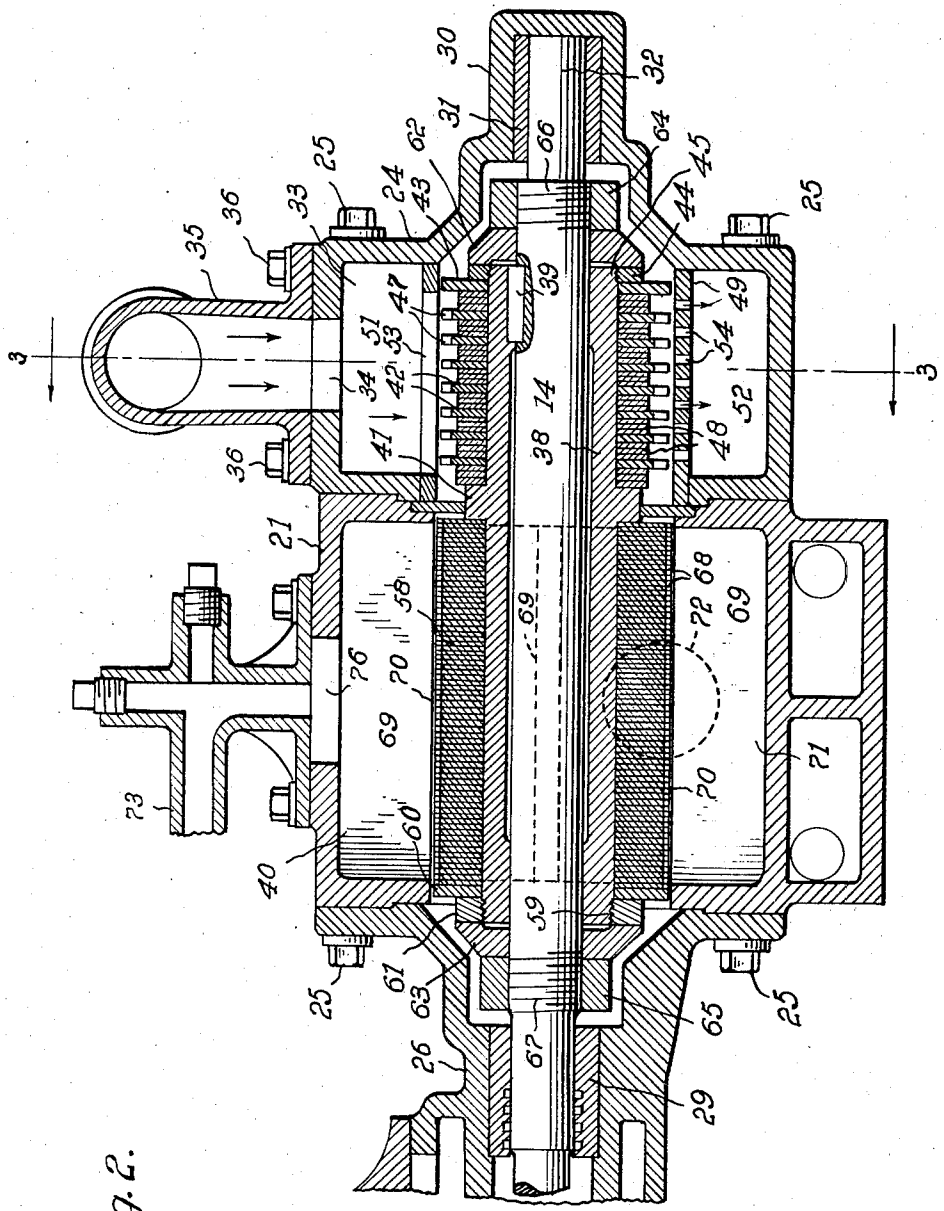


Fig. 2.

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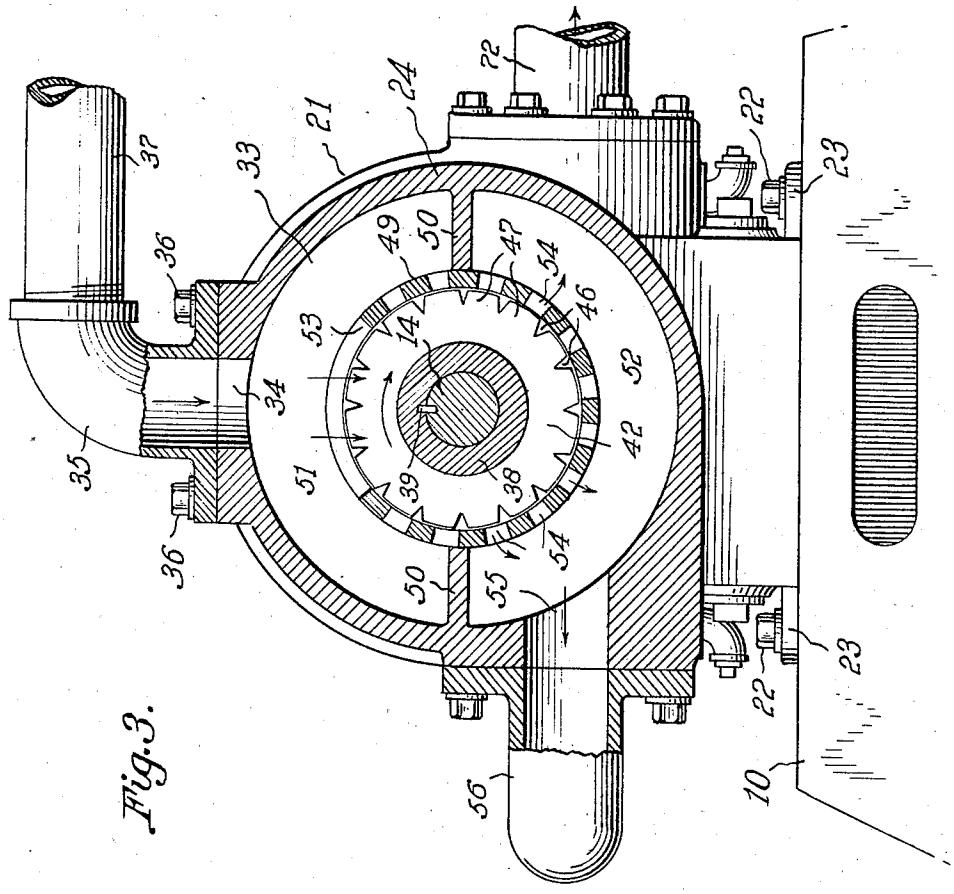


Fig. 3.

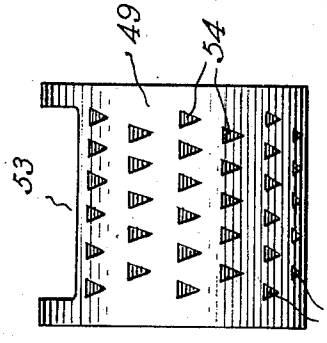


Fig. 4.

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UNITED STATES PATENT OFFICE

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TWO STAGE ROTARY MILL

Robert C. Hopkins, Alliance, Ohio

Application November 5, 1942, Serial No. 464,563

6 Claims. (Cl. 241—88)

The invention relates to rotary mills for cutting, mixing and attrition of the heavy particles of oils, synthetic rubber constituents, paints, pigments and other mineral, vegetable and animal matter in fluid state, or capable of flowing and being ground and mixed with other liquid or plastic substances, and more particularly to a two stage mill of this character.

An object of the invention is the provision of a two stage rotary mill having a primary milling chamber in which the first stage of reduction is accomplished somewhat on the principle of a hammer mill, in which the larger particles are milled down to a finer grain or particle size and blended, and a secondary milling chamber in which the first reduction or first pass material is subjected to further cutting, grinding, attrition and mixing to such an extent that it is completely pulverized and reduced to a uniform consistency and thoroughly mixed.

A further object of the invention is to provide a mill of this character having a primary chamber in which is located a rotary gang of disks having spaced notches in their peripheral portions, forming wide, heavy teeth for breaking up the larger size particles to a finer grain size.

A still further object is the provision of a rotary mill in which a perforate, cylindrical screen surrounds the rotary gang of disks, the peripheral toothed portions of the disks being located in close proximity to the screen.

Another object of the invention is to provide a rotary mill of this character in which the perforations of the screen are triangular, or V-shape, with their apices disposed in the direction of rotation of the rotary gang of disks.

Still another object is the provision of a rotary mill of the character referred to in which the primary chamber is divided into two compartments, the inlet to the chamber communicating with one compartment and the outlet communicating with the other compartment, the cylindric screen having an inlet opening within the inlet compartment, whereby all of the material entering the primary chamber must pass through the cylindric screen and be milled by the rotary disks before it passes to the outlet compartment and is discharged from the chamber.

A further object is the provision in such a mill of a secondary chamber divided into a plurality of attrition chambers by means of radial partition walls having cutting edges in close proximity to the peripheral portions of the gang of rotary blades in the the secondary chamber.

A still further object of the invention is to provide a rotary two stage mill of this character in which the primary chamber is provided with a rotary gang of disks having wide, heavy teeth around their peripheral portions, and the secondary chamber is provided with a rotary gang of disks having smaller, saw teeth around their peripheral portions.

Another object is to provide such a two stage mill in which the primary and secondary chambers are located in axial alignment and a single drive shaft is journalled longitudinally through both chambers and has the rotary gangs of disks mounted thereon, the outlet of the primary chamber communicating with the inlet of the secondary chamber.

A further object of the invention is to provide a rotary mill of this character in which the toothed disks in the primary chamber are spaced apart a distance considerably greater than the thickness of the disks.

The above objects together with others which will be apparent from the accompanying drawings and the following description, or which may be later referred to, may be attained by constructing the improved rotary two stage mill in the manner illustrated in the drawings, in which—

Figure 1 is a side elevation of the two stage mill to which the invention pertains, showing the same mounted with a motor as a complete unit;

Fig. 2, an enlarged, longitudinal sectional view through the primary and secondary chambers;

Fig. 3, a transverse sectional view through the primary chamber, taken as on the line 3—3, Fig. 2;

Fig. 4, a detached side elevation of the cylindric screen which surrounds the disks in the primary chamber;

Fig. 5, a detached elevation of one of the disks from the primary chamber; and

Fig. 6, a similar view of one of the disks from the secondary chamber.

Similar numerals refer to similar parts throughout the drawings.

The mill and its driving means may be mounted as a unit upon a base 10, an electric motor 11 being preferably provided for driving the mill and being mounted upon one end portion of the base as shown in Figure 1.

The shaft 12 of the motor may be axially connected, by a coupling or clutch located within the guard 13, to the drive shaft 14 of the mill. This coupling guard may be supported upon the base 10 as by the upright 15 to which the guard

may be detachably connected as by one or more bolts 16.

A bearing bracket 17 may be mounted upon the base 10 adjacent to the coupling guard as by the feet 18 which are secured to the base as by bolts 19. This bracket is provided with a bearing portion 20 within which may be housed any suitable antifriction bearing within which is journalled the end portion of the drive shaft 14 adjacent to the coupling.

The rotary mill proper includes the secondary housing 21 which is mounted directly upon the base 10 and connected thereto as by the bolts 22 located through flanges 23 upon the housing, and the primary housing 24 which is mounted upon one side of the secondary housing and secured thereto as by bolts 25.

A bearing bracket 26 may be attached to the opposite side of the secondary stage housing as by bolts 25 and to the bearing bracket 17 as by bolts 28 for supporting a bearing 29 through which the intermediate portion of the drive shaft 14 may be journalled, and a bearing portion 30 may be formed upon the outer side of the primary housing 24 for housing a bearing 31 in which the reduced outer end portion 32 of the drive shaft 14 may be journalled.

A cylindric chamber 33 is formed within the primary housing 24 and provided at its top with an inlet opening 34 having a flanged coupling 35 attached thereto as by the screws 36 for connecting a feed pipe 37 which may lead from any suitable source of supply of the oil or other substance to be milled.

The drive shaft 14 extends axially through the cylindric primary chamber 33 and the hub 38 may be fixed upon the shaft by any usual and well known means such as the key 39. This hub may extend entirely through the secondary chamber 40, within the secondary housing 21, and is provided with the annular shoulder 41 intermediate the two chambers.

A plurality of cutting disks 42 is mounted upon the hub 38 within the primary chamber 33 and extends from the shoulder 41 to a point near the end of the hub, at which point a ring flange 43 may be located around the hub and clamped against the adjacent end of the gang of the cutting disks as by a nut 44 threaded upon the adjacent screw threaded end portion 45 of the hub, thus clamping the gang of disks tightly between the shoulder 41 and the ring flange 43.

Each of the disks 42 is provided around its periphery with spaced V-shape notches 46 forming the wide, slightly tapered teeth 47 around the periphery of each disk.

As shown in Fig. 2 a plurality of spacers 48 may be placed between each adjacent pair of cutting disks 42 so as to space the disks widely apart, or if desired the spacers may be eliminated and the cutting disks may be placed side by side upon the hub throughout the entire length of the primary chamber.

A hollow cylinder 49 surrounds the cutting disks 42 in the primary chamber and is located in close proximity to the peripheries of these cutting disks so that the disks have substantially a running fit within the hollow cylinder.

Radial partition walls 50, upon the interior of the primary housing, extend inwardly toward each other and contact the outer surface of the cylinder 49 dividing the primary chamber 33 into an upper or inlet compartment 51 and a lower or discharge compartment 52.

An enlarged opening 53 is provided in the upper portion of the cylinder 49 to admit oil or other material to be milled to pass from the inlet compartment 51 to the interior of the cylinder, and the remainder of the cylinder is provided with a multiplicity of smaller outlet orifices 54 of such size as is required in the first reduction of semi-solid material or heavy particles of sludge or the like.

Although these outlet orifices may be of circular or other shape they are preferably triangular or V-shape as shown in Fig. 4 and are so positioned that their apices are disposed in the direction of rotation of the cutting disks 42, whereby the large particles or semi-solids may be reduced in size as they are wedged into these reduced angular portions of these outlet orifices as they are discharged therethrough by the rotation of the cutting disks.

It will be seen that all of the material entering the primary chamber through the inlet 34 must pass from the inlet compartment 51 into the cylindric screen 49 where it is acted upon by the rotary cutting disks and the heavy particles thereof are broken up, blended and screened and discharged through the outlet orifices 54 of the screen into the outlet compartment from which the material is discharged through the discharge outlet 55 and passes through the pipe 56 into the bottom of the secondary chamber 40 located within the secondary housing 21.

The drive shaft 14 extends axially through this chamber also and is surrounded throughout the length of the secondary chamber with the hub 45.

Cutting disks 58 are located upon the hub extending from the shoulder 41 to a point near the screw threaded end 59 of the hub, at which point a ring flange 60 may be located around the hub and clamped against the adjacent end of the gang of cutting disks as by a nut 61, threaded upon the end portion 59 of the hub, thus tightly clamping the gang of disks between the shoulder 41 and the ring flange 61.

If desired, rings 62 and 63 may be mounted upon the shaft and clamped into engagement with the nuts 44 and 61 respectively, as by the large nuts 64 and 65 mounted upon the screw threaded portions 66 and 67 respectively of the shaft 14, thus tending to lock the nuts 44 and 61 in adjusted position.

The disks 58 may be of lighter gauge than the disks 42 in the primary chamber and are preferably provided around their peripheral portions with relatively small V-shape teeth 68, so that these disks are in the nature of circular saw blades.

The secondary chamber 40 is preferably divided into a plurality of attrition compartments by means of the radial partition walls 69 having the cutting edges 70 located substantially in peripheral engagement with the disks 58.

The first reduction or first pass material is admitted from the primary chamber to the lower front compartment indicated at 71 of the secondary chamber, and after passing through the several compartments of the secondary chamber is discharged from the lower rear compartment of the secondary chamber through the discharge outlet 72.

For the purpose of regulating the temperature and pressure of the material being milled a pipe 73 may communicate with the upper portion of the secondary chamber for connection of a thermometer 74 and pressure gauge 75, this pipe communicating with the secondary chamber through the port 76.

In the operation of the mill, oil or other material is admitted through the inlet 34 to the upper or inlet compartment 51 of the primary chamber and then passes through the opening 53 to the interior of the cylindric screen 49 where it is engaged by the rapidly rotating cutting disks 42 which rotate in a clockwise direction as viewed in Fig. 3, the large teeth upon these disks cooperating with the inner surface of the cylinder 49 to cut and break up the semi-solids and large particles or sludge, discharging the milled material through the outlet orifices 54, the direction of rotation of the disks tending to force the material through the tapered ends of the outlet orifices so that the action is to blend as well as to mill down to a finer grain or particle size.

As the material is discharged through the outlet orifices of the screen 49 into the lower or discharge compartment 52 it passes out of the primary chamber through the outlet 55 and pipe 56 to the secondary chamber for final reduction, attrition and blending or mixing.

As the material enters the lower portion of the secondary chamber and passes progressively through the several attrition compartments it is given a violent agitation within each compartment by means of the rotating cutting disks, the material being thoroughly reduced, mixed and blended as it passes from each compartment to the next until it is finely discharged through the outlet pipe 72.

I claim:

1. A rotary mill including a primary chamber and a secondary chamber, means forming a communication between the chambers, an inlet to the primary chamber, an outlet from the secondary chamber, a plurality of closely spaced, revolving, cutting discs throughout the entire length of the primary chamber, said discs having spaced, radial inwardly tapered, V-shape notches entirely around their peripheries forming wide, substantially flat peripheral edged teeth therebetween, the flat peripheral edges of the teeth being considerably wider than the intervening notches and a plurality of closely spaced revolving cutting discs throughout the entire length of the secondary chamber having relatively smaller V-shape teeth entirely around their peripheries, said discs entirely filling said chambers between the inlet and outlet so that all material passing through the chambers will contact the discs.

2. A rotary mill including a primary chamber and a secondary chamber, means forming a communication between the chambers, an inlet to the primary chamber, an outlet from the secondary chamber, a plurality of closely spaced, revolving, cutting discs throughout the entire length of the primary chamber, said discs having spaced, radial, inwardly tapered V-shape notches entirely around their peripheries forming wide, substantially flat, peripheral edged teeth therebetween, the flat peripheral edges of the teeth being considerably wider than the intervening notches, a hollow cylinder surrounding the cutting discs throughout their entire length and in close proximity to the peripheral portions thereof, said cylinder having a multiplicity of closely spaced, relatively small outlet orifices therein throughout the entire area of said cutting discs, and a plurality of closely spaced, revolving, cutting discs throughout the entire length of the secondary chamber having relatively smaller V-shape teeth around their peripheries, said discs entirely filling said chambers between the inlet and outlet so that all material passing through the chambers will contact the discs.

3. A rotary mill including a primary chamber and a secondary chamber, means forming a communication between the chambers, an inlet to the primary chamber, an outlet from the secondary chamber, a plurality of closely spaced, revolving, cutting discs throughout the entire length of the primary chamber, said discs having spaced, radial, inwardly tapered V-shape notches entirely around their peripheries forming wide, substantially flat peripheral edged teeth therebetween, a hollow cylinder surrounding the cutting discs throughout their entire length and in close proximity to the peripheral flat portions of the teeth, said cylinder having throughout its entire area a multiplicity of closely spaced, relatively small, triangular outlet orifices therein, the apices of the triangular orifices being forward relative to the triangle bases with respect to the direction of rotation of the cutting discs, and a plurality of closely spaced, revolving, cutting discs throughout the entire length of the secondary chamber having relatively smaller peripheral teeth entirely around their peripheries, said discs entirely filling said chambers between the inlet and outlet so that all material passing through the chambers will contact the discs.

4. A rotary mill including a chamber, a plurality of revolving cutting discs mounted within and extending throughout the entire length of the chamber and provided entirely around their peripheries with closely spaced, flat peripheral edged teeth, a hollow cylinder surrounding the cutting discs throughout their entire length and in close proximity to the peripheral portions thereof, a multiplicity of closely spaced, relatively smaller, triangular outlet orifices, in said cylinder throughout the entire area of said cutting discs, the apices of the triangular orifices being forward relative to the triangle bases with respect to the direction of rotation of the cutting discs, an inlet to the chamber and an outlet from the chamber, said discs entirely blocking the passage between the inlet and outlet so that all material passing through the chambers will contact the discs.

5. A rotary mill including a chamber, a plurality of closely spaced, revolving, cutting discs mounted within and extending throughout the entire length of the chamber, a multiplicity of wide, outwardly tapered, substantially flat peripheral edged teeth entirely around the peripheral portion of the discs, a hollow cylinder surrounding the discs throughout their entire length and in close proximity to the peripheral portions thereof, partition walls extending from the inner walls of the chamber to the hollow cylinder and dividing the chamber into an inlet compartment and a discharge compartment, an inlet in the top of the cylinder communicating with the inlet compartment, a multiplicity of closely spaced, relatively small, triangular outlet orifices in the cylinder, throughout the entire area of the cutting discs and communicating with the discharge compartment, the apices of the triangular orifices being forward relative to the triangle bases with respect to the direction of rotation of the cutting discs, means for admitting material to the inlet compartment and means for discharging material from the discharge compartment, said discs entirely blocking the passage between the inlet and outlet so that all material passing through the chambers will contact the discs.

6. A rotary mill including a cylindric chamber.

a shaft concentrically journalled through the chamber, means for rotating the shaft, a multiplicity of revolving cutting discs fixed upon the shaft, means spacing the discs apart a slightly greater distance than the thickness of a disc, there being spaced, radial inwardly tapered, V-shaped notches entirely around the peripheral portions of the discs forming relatively wide, outwardly tapered, substantially flat peripheral edged teeth upon the peripheral portions of the discs between said notches, a hollow cylinder surrounding the discs throughout the entire length of the chamber and in close proximity to the peripheral portions of the discs, horizontal partition walls extending from the inner walls of the chamber to the hollow cylinder and dividing the chamber into an upper inlet compartment and a lower discharge compartment, an inlet in the inlet compartment, there being an inlet opening in the top of the cylinder communicating with the inlet compartment, a multiplicity of closely spaced, relatively small, triangular orifices throughout the entire area of the cylinder communicating with the discharge compartment, the apices of the triangular orifices being forward relative to the triangle bases with respect to the direction of rotation of the cutting discs, and an outlet in the discharge compartment, said discs entirely blocking the passage between the inlet and outlet so that all material passing through the chambers will contact the discs.

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