Dec. 30, 1952 R. P. SCHERER 2,623,700

DISINTEGRATING DEVICE

Filed Feb. 21, 1949

Fig. 1.

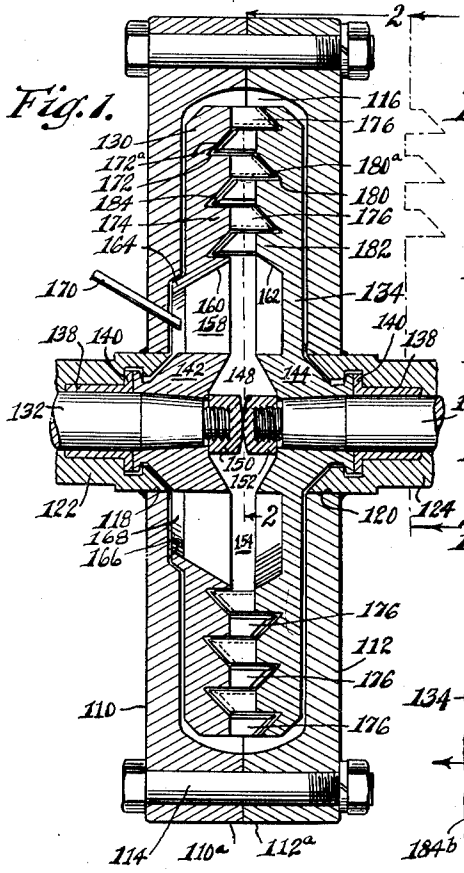
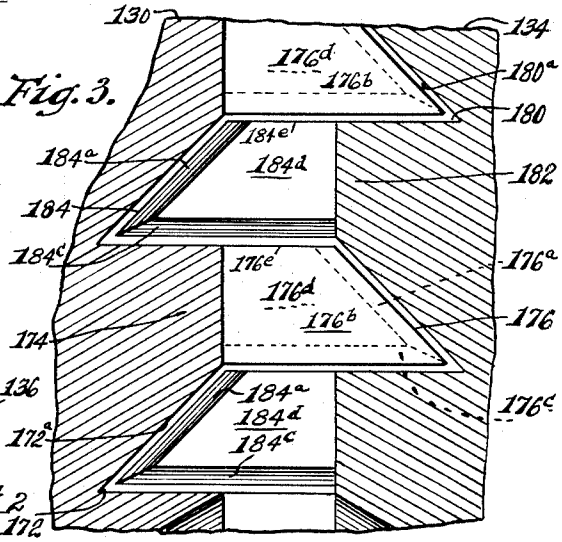


Fig. 3.



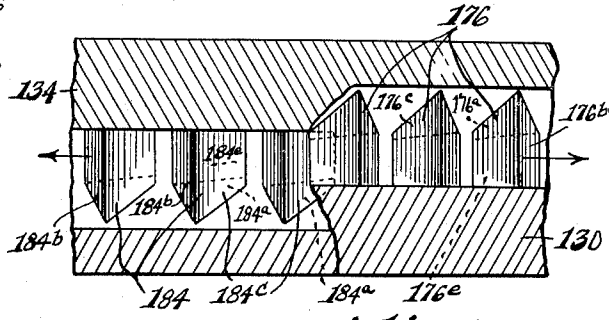
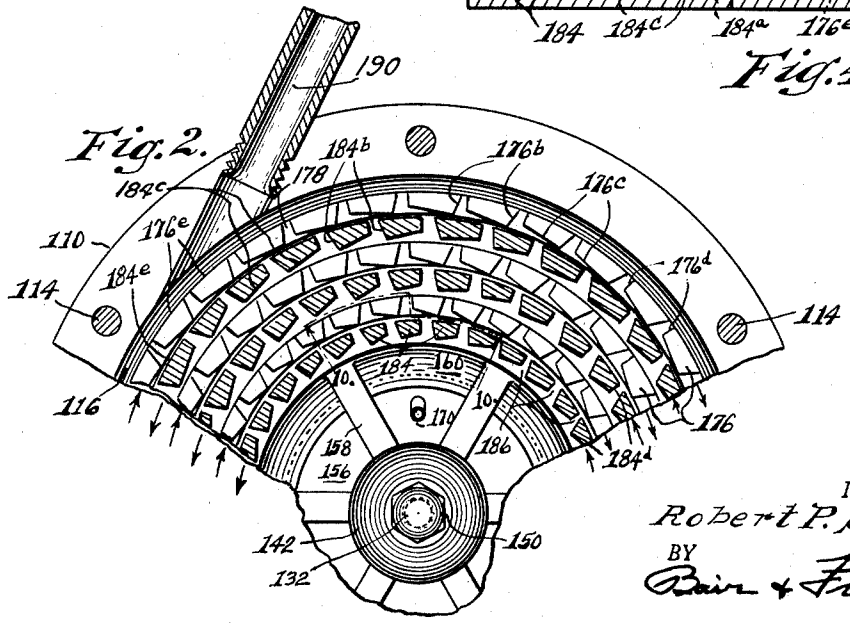


Fig. 4.

Fig. 2.



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DISINTEGRATING DEVICE

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1 Claim. (Cl. 241—188)

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This invention relates to method and apparatus for the disintegration of granular solid material. More particularly, the invention relates to means and methods in which moving granular solid material is shattered or disintegrated by being subjected to sudden reversals in direction of movement, as by repeated violent impacts against a hard surface or even against a gaseous cushion.

In the past, impact mills such as hammer mills have been employed to reduce granular or pulverulent material to finer particle size. Mills of this general type operate basically by hurling the material being ground back and forth between a rapidly rotating set of strikers and a stationary set of strikers. The ability of mills of this type to reduce solid material to smaller particle size is limited by the rate at which the rotating strikers can be revolved which is determined by factors such as strength of materials of construction, speeds tolerated by bearings, and the like.

I have now provided a disintegration device having twice the efficiency of hammer mills or like mills having one moving and one stationary set of strikers. My novel device reaches this high efficiency without increase in rotational speed, for my device includes two counter-rotating sets of strikers so that the relative velocity of these two sets of strikers with respect to each other is equal to the sum of the actual velocities of the two sets of strikers. Further, my novel disintegration device meets all other requirements for a practically satisfactory mill with respect to points such as methods of feeding material to be ground into the mill, method of discharging ground material from the mill, method for effecting repeated impacts on a single particle, method of adjustment or modification to determine the extent of disintegration, simplicity of construction, and the like.

My novel disintegration device comprises two facing discs rotatable in opposite directions on a common axis. The opposed cooperating faces of the two discs are each provided with one or more rings of axially projecting vanes so spaced radially that the innermost ring of one disc is closely surrounded by a ring of the other disc which again is closely surrounded by a ring of vanes on the first disc, and so on so that a suitable number of rings, say, three rings, are arranged on the faces of the two discs in the indicated overlapping and closely spaced relationship. The two opposed faces of the two discs are closely spaced so that a plane normal to the axis of rotation at

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the mid-point between the two disc faces will substantially bisect all the vanes of both discs. This plane will represent the median plane along which the particles being disintegrated will travel.

The material to be disintegrated may be fed into the central region between the two discs according to several methods. Thus, one or both of the shafts on which the two discs rotate may be hollow. Or, one disc may be apertured near its shaft at a plurality of locations (to define short spokes in the disc), and the outside of the disc may be flanged around the apertured area to define a region into which the material to be ground may be fed. In either construction, the material to be ground can be fed into a region from which the material thereafter passes between the vanes in a manner disclosed hereinbelow. Most suitably, the material to be ground is suspended in air or other gas flowing into the mill and thereby carried through the feed passage (the hollow shaft or disc apertures and the space immediately outside thereof) into the space between the two discs inside the innermost ring of vanes. From this space the particles move into the slots between the innermost ring of vanes under the influence of gravity and/or centrifugal force. When the particles have moved into these slots, the particles are carried along by the vanes and thereby accelerated to the rotative velocity of the innermost ring of vanes. Under the influence of centrifugal force, the particles will then migrate radially outwardly along the leading faces of the vanes until the particles reach the outer ends of the vanes when the particles are thrown off tangentially into the narrow clearance space between the two innermost rings of vanes of the two discs. Since these two rings of vanes rotate in opposite directions, the result is a violent reversal in the direction of movement of the particle with consequent fragmentation of the particle. This process is repeated at each interface or clearance space between counter-rotating rings of vanes and becomes progressively more violent because the lineal velocity of succeeding rings increases as the diameters of the rings increase.

The particles are finally thrown clear of the vane system at the periphery of the outermost ring of vanes. The particles are then either swept out by way of a scroll and tangential discharge opening or are discharged directly into a plenum chamber from which they are later recovered or are discharged otherwise.

The clearance between the overlapping

counter-rotating rings of vanes should preferably be kept at a minimum, to reduce the length of the tangent particle path from one ring to another whereby violence of reversal and resultant impact are increased. However, the clearance should be at least three or four times the diameter of the particles traversing the clearance to prevent packing or jamming with material being ground.

The vanes are preferably shaped to present edges to the surfaces over which the vanes sweep. Surfaces against which centrifugal force urges material being ground are preferably inclined radially outwardly. Thus lodging or packing of material being ground is reduced or eliminated.

The above described device is characterized by an air pumping action when operated. Thus, an air-sweep is automatically provided for feeding the solid material into and through the device. To reduce the power consumption due to this pumping action, a vacuum may be applied to the device to reduce the amount of air present therein. Operation under partial vacuum not only reduces power consumption but also lessens the cushioning effect of the air on particle impact and therefore brings about finer disintegration.

It is, therefore, an important object of the present invention to provide means and methods for fine disintegration of granular solid material involving radial migration of solid granules from a central point along a path in which the material is repeatedly subjected to violent impacts against radially spaced annular series of vanes projecting into said path from closely spaced counter-rotating discs.

Other and further objects and features will become apparent from the following description and appended claim and from the accompanying drawings which show, diagrammatically and by way of example, a disintegration device according to the present invention together with modifications thereof. More particularly:

Figure 1 is a fragmentary longitudinal vertical cross-sectional view, with parts shown in elevation, of a disintegrating device according to the present invention;

Figure 2 is a fragmentary cross-sectional view taken along the line 2—2 of Figure 1;

Figure 3 is an enlarged fragmentary view similar to Figure 1; and

Figure 4 is an enlarged fragmentary view taken along the line 4—4 of Figure 2.

The device shown in Figures 1 through 4 includes a housing comprising a left half 110 and a right half 112, each flanged, as at 110*a* and 112*a* and held together by bolts 114. The two housing halves define an inner chamber 116 accessible through a central aperture 118 in the left housing half 110 and a central aperture 120 in the right housing half 112. A tubular sleeve 122 is seated in the aperture 118 while another tubular sleeve 124 is seated in the aperture 120.

Within the chamber 116 are disposed a left disc 130 seated on the free end of a solid shaft 132 projecting into the chamber 116 from the sleeve 122 as well as a right disc 134 seated on a solid shaft 136 projecting from the sleeve 124 into the chamber 116. For journalling the shafts 132 and 136, bearings 138 may be provided at the inner ends of the sleeves 122 and 124 that may be suitably countersunk for this purpose. The bearings 138 may have inner flanges 140 providing thrust surfaces over which move the terminal surfaces of a hub 142 of the disc 130 and a hub 144 of the disc 134. Thus, relative displacement from one another of the two discs 130 and 134 is prevented.

The two discs 130 and 134 are centrally recessed to define therebetween a central chamber 146. The ends of the two shafts 132 and 136 may be threaded and may project into the central chamber 146. Nuts 150 and 152 may be threaded, respectively, over the threaded ends of the shafts 132 and 136. The opposed faces of the two nuts 150 and 152 may be spaced very closely or may even contact each other over a limited area, to prevent or limit displacement of the discs 130 and 134 toward each other.

The opposed faces of the two discs 130 and 134, outside the central recesses therein, may be recessed to define therebetween an annular space 154 communicating with the chamber 116 through slots 156 formed in the disc 130 and defining spokes 158 in the latter extending from the hub 142. The space 154 is limited peripherally by convergent radially outwardly sloping walls 160 and 162 formed, respectively, in the discs 130 and 134. Further, the outside of the disc 130 is formed with an annular flange 164 aligned with the wall 160 so that the radially inner wall of the flange is flush with the wall 160. The inside of the housing 110 is annularly recessed, as at 166, to clear the end of the flange 164 and to define an annular space 168 limited peripherally by the flange 164 and inwardly by the hub 142. The space 168 thus extends between the bottom of the recess 166 and the outsides of the spokes 158. A tube 170 pierces the bottom of the recess 166 and projects past the outer edge of the flange 164. The tube 170 serves to feed into the space 168 material to be disintegrated.

Outside the wall 160, the disc 130 is formed with three radially spaced annular grooves 172 and with three radially spaced annular ribs 174 each arranged radially outside one of the grooves 172. Vanes 176 project from each of the ribs 174 and define slots 178 therebetween. The radially outside walls 172*a* of each groove 172 slope radially inwardly and axially outwardly, as shown in Figures 1 and 3. The right disc 134 is formed with three radially spaced annular grooves 180 opposed to the ribs 174 and with three radially spaced annular ribs 182 opposed to the grooves 172. Vanes 184 project from each of the ribs 182 and define slots 186 therebetween. The radially outside walls 182*a* of each groove 180 slope radially inwardly and axially outwardly, as shown in Figures 1 and 3.

The disc 130 is rotated clockwise, while the disc 134 rotates counterclockwise. The vanes 176 project past the ribs 182 into the grooves 180 and the vanes 184 project past the ribs 174 into the grooves 172. The leading edges of the vanes 176 conform to the generally V-shaped contour of the grooves 180 and the leading edges of the vanes 184 similarly conform to the generally V-shaped contour of the grooves 172. Thus, the leading edges of the end surface 176*a* of the vanes 176 extend parallel to and closely spaced from the sloping groove walls 180*a*, while the leading edges of the end surfaces 178*a* of the vanes 184 extend parallel to and closely spaced from the sloping groove walls 172*a*. Further, said vane end surfaces 176 and 184*a* slope both away from their leading edges and from the opposed groove walls 180*a* and 172*a*, so that said leading edges may be compared to knife edges sweeping the sloping wall surfaces 180*a* and 172*a*. In other words, while the vanes 176

and 184 overlap each other, the terminal vane portions outside the overlap project into the grooves 180 and 172, respectively, and are characterized by leading edges conforming closely to the shapes of said grooves. Thus, the grooves 172 and 180 are continuously swept clean on rotation of the discs 130 and 134.

The leading surfaces 176*b* and 184*b* of the vanes 176 and 184 are raked backwardly. In other words, these surfaces slope away from the leading edges thereof, the direction of slope being the opposite to the direction of rotation, and the radially outermost edges of the leading surfaces 176*b* and 184*b* being considered as the leading edges thereof. Further, the inside surfaces 176*c* and 184*c* slope away radially outwardly from their leading edges. The trailing surfaces 176*d* and 184*d* extend at a diverging angle from the opposed, leading surfaces 176*b* and 184*b* so that the slots 178 and 186 will taper radially outwardly. As a result, any particles traversing the gaps between the rings of vanes 176 and 184 will be subject to direct impact with the leading surfaces of each vane with a minimum impacting against the inner vane surfaces and entry of the particles into the slots between the vanes will be facilitated.

Only the outsides 176*e* and 184*e* of the vanes 176 and 184 extend in concentric relationship in parallelism with the axes of the discs 130 and 134.

The above described slope of the walls 160 and 162 and of the groove walls 172*a* and 180*a* aids in preventing packing material being comminuted against the walls in question, for the said slope permits centrifugal force to contribute its influence toward radially outward movement of the material passing from the tube 170 into and through the space 168, through the slots 156, through the space 154 and between the vanes 176 and 184 and out through a tangential discharge conduit 190.

It should be understood that different numbers of vane series and grooves may be provided in each disc and that the number of vanes in each series may be varied. Further, the number of rings of vanes in the two discs need not be the same. Resonance can be effected when the two rotors have each the same number of rings of vanes.

The following discussion will clarify the action of the devices above described. When material to be disintegrated is introduced into the central chamber 148, the individual particles will come under the influence of the centrifugal forces generated by the two discs 130 and 134 and will migrate radially outwardly until the particles enter the slots 186 between the first ring of vanes 184. The particles are then forced to rotate with this ring of vanes. The centrifugal force will now move the particles radially outward through the slots 186, and thereafter the particles will be thrown off tangentially from the ring of vanes 184 and enter the slots 178 between the next ring of vanes 176 which is rotating in reverse direction. Thus, the particles will be forced to reverse their direction of movement very suddenly. Such a reversal is repeated as many times as there are gaps bounded by counter-rotating rings of vanes 184 and 176. The centrifugal force generated by the two rotating discs causes the particles to migrate continuously through the whole system of counter-rotating vanes, discharging the disintegrated particles at the periphery of the two discs. The effectiveness of the device may be increased by partially or completely evacuating the interior of the device, as through the conduit 190. Such evacuation reduces power consumption and heat generation caused by churning of the enclosed air, and further serves to reduce or eliminate the cushioning effect of the air layers moving with the counter-rotating annular series of vanes as well as to prevent accumulation of material within the housing. Thus, the particles will impinge more sharply on the vanes with resultant improved disintegration.

The force exerted on the individual particles passing through this device may be computed. By way of example, I give hereinbelow such a computation. Let us assume, for instance, that the two discs 130 and 134 each have a diameter of 4 inches; that each disc rotates at 12,000 R. P. M.; that the vanes of each ring have a radial depth of ¼ inch; that each disc has three rings of vanes; and that the central chamber 148 has a diameter of 1 inch. Then five gaps will be defined between the vane series, and these gaps will have the following diameters: 3½, 3, 2½, 2 and 1½ inches. The radial clearance between the counter-rotating rings of vanes may be assumed to be 0.020 inch. It will further assume the most unfavorable operating conditions by considering the particles as being completely decelerated but not accelerated by air friction as the particles leave the outer end of one ring of vanes, so that the particles will have zero speed in the middle of the gaps between the rings. Then the particles are accelerated in the opposite direction from zero speed as the particles enter the next outer ring of vanes. On the previous assumptions, a computation of the resulting forces gives the values tabulated as follows:

Radius to interface in inches

	0.75	1.00	1.25	1.50	1.75
Lineal Speed of One Disc at Interface in Feet/Second	78.5	104.7	132	157	183
Length of Tangent Traversing 0.020" radial Clearance in Inches	0.175	0.201	0.224	0.2466	0.265
½ Tangent Length, in Inches	0.087	0.1005	0.112	0.123	0.133
½ Tangent Length, in Feet	0.00725	0.0084	0.009	0.010	0.011
Stopping Time in Seconds	0.000184	0.000161	0.00137	0.000130	0.00012
Acceleration in Feet/Second	426,000	652,000	965,000	1,210,000	1,525,000
Acceleration in Terms of Gravity	13,250	20,300	30,000	37,600	47,500

These figures show that even when it is assumed that the particle is decelerated to zero velocity by the air at the exact middle of the gaps between the counter-rotating rings or series of vanes, there is nevertheless generated at the outermost interface between the counter-rotating rings of vanes, a condition of acceleration or deceleration comparable to that generated when a 0.22 caliber short rifle bullet strikes a steel plate. As is well known, the muzzle velocity of a rifle bullet ¼ inch long is approximately 900 feet per second. The stopping distance is therefore ¼ inch, resulting in a spattering of the ball upon striking the steel plate.

If the device is operated in vacuum so that the particles are not completely checked, and reversed by air friction, the particles impinge on the next outer vanes with a force greater than that indicated hereinabove. Further, if air friction checks and reverses the particles more quickly than assumed, the particles are subjected to forces greater than those indicated. Actually, when the above disclosed apparatus is operated under vacuum, and when 1-lb. per minute of material capable of clearing the 0.020" gaps is passed through the device, the total power required for rotating both discs amounts to about ⅕ H. P.

Many details of construction and operation may be varied within a wide range without departing from the principles of this invention and it is therefore not my purpose to limit the patent on this invention otherwise than necessitated by the scope of the appended claim.

I claim as my invention:

A device for disintegrating granular solid material comprising two spaced opposed discs each formed with radially spaced annular generally wedge-shaped grooves each having an inner wall parallel to the axes of said discs and an outer wall inclined with respect to said inner wall, said discs being further formed with radially spaced annular ribs alternating with said grooves, the ribs of one disc being opposed to the grooves of the other disc and said ribs having vanes projecting therefrom, the ends of said vanes being bounded by planar surfaces and extending within said grooves, said vane ends each being formed with an outside surface opposed to said inclined outer groove surfaces and having a leading edge inclined to conform with the inclination of said outside walls of said grooves, said outside vane surface sloping from its leading edge so as to diverge from said outside groove walls, said vane ends further each being formed with an inside surface opposed to said inner groove walls and

having a leading edge parallel with the axes of said discs, said inside vane surface sloping away from its leading edge so as to diverge from said inside groove walls, said outside and inside vane end surfaces of each vane intersecting to define an edge having a leading point located in close proximity to the thereto opposed groove bottom, said edge sloping away from its leading point to diverge from said groove bottom.

ROBERT PAULI SCHERER.

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