Jan. 5, 1960 | B. J. PARMELE | 2,919,864

CENTRIFUGAL PULVERIZER

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Fig. 1

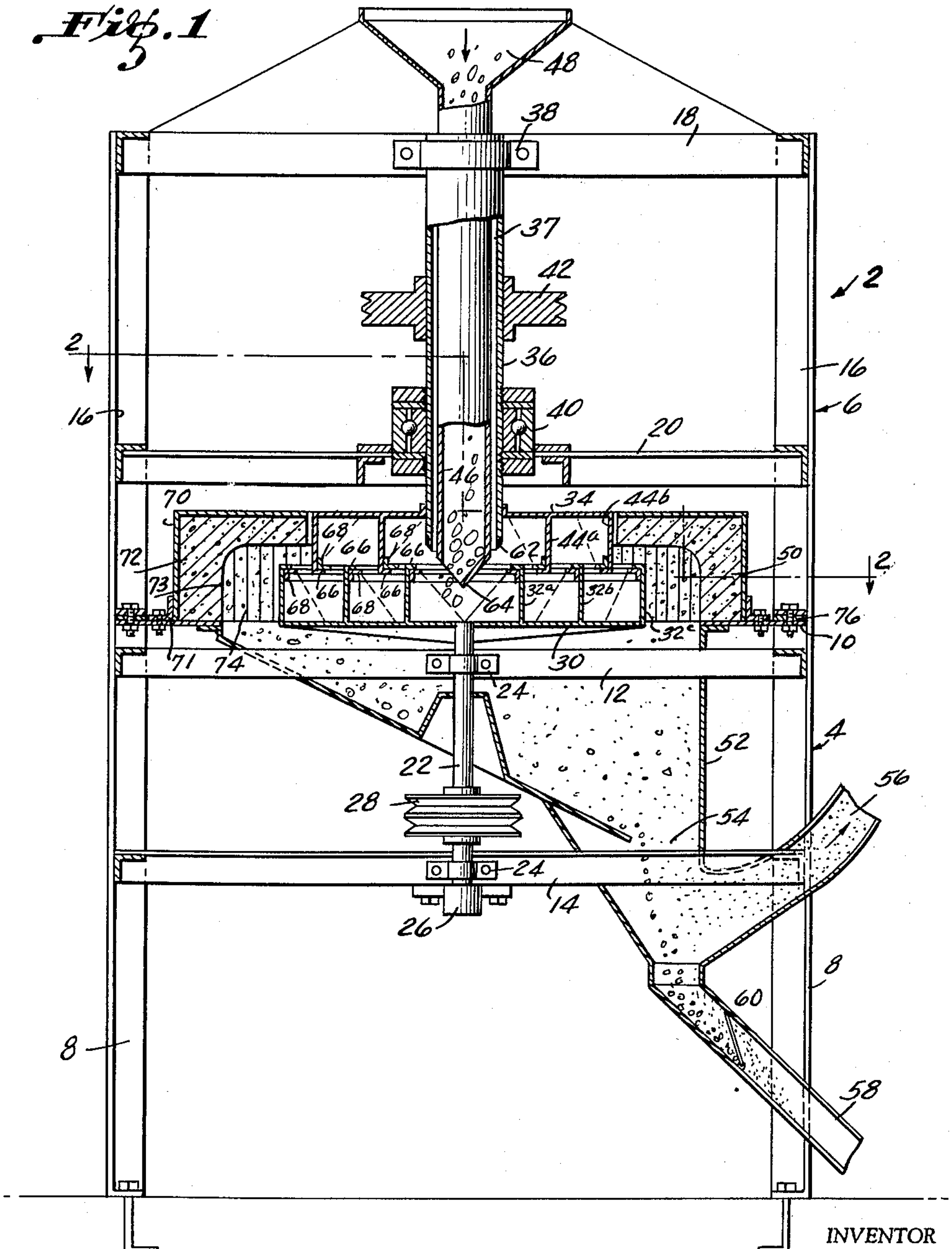

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Fig. 2

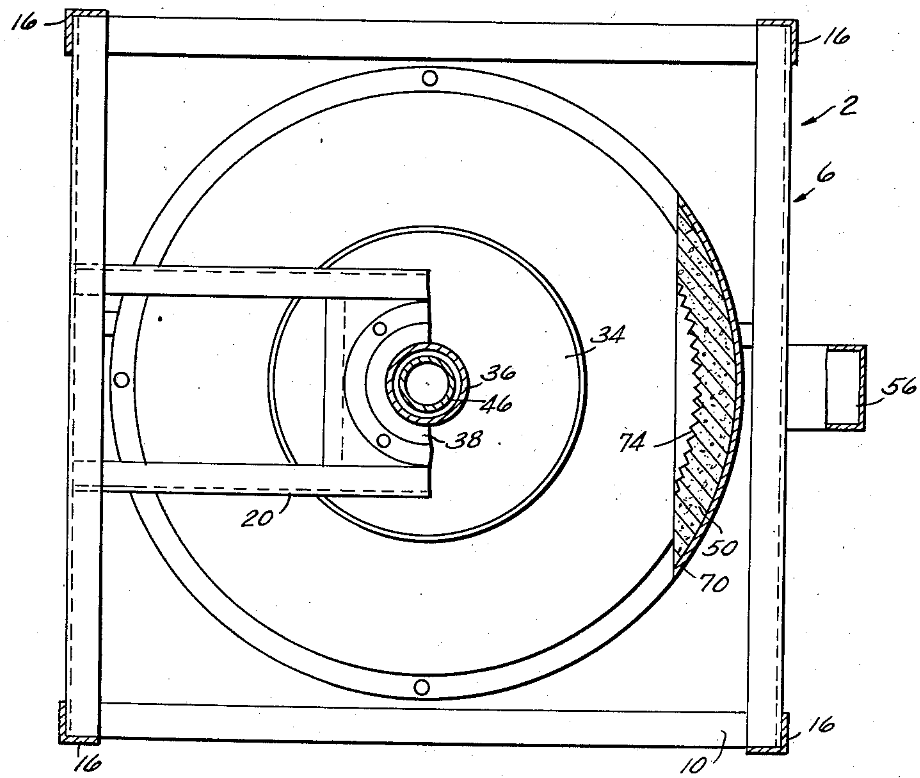

Fig. 3

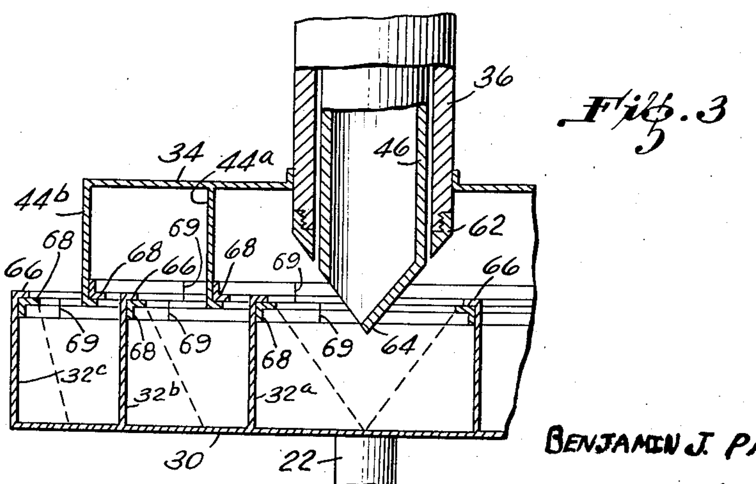

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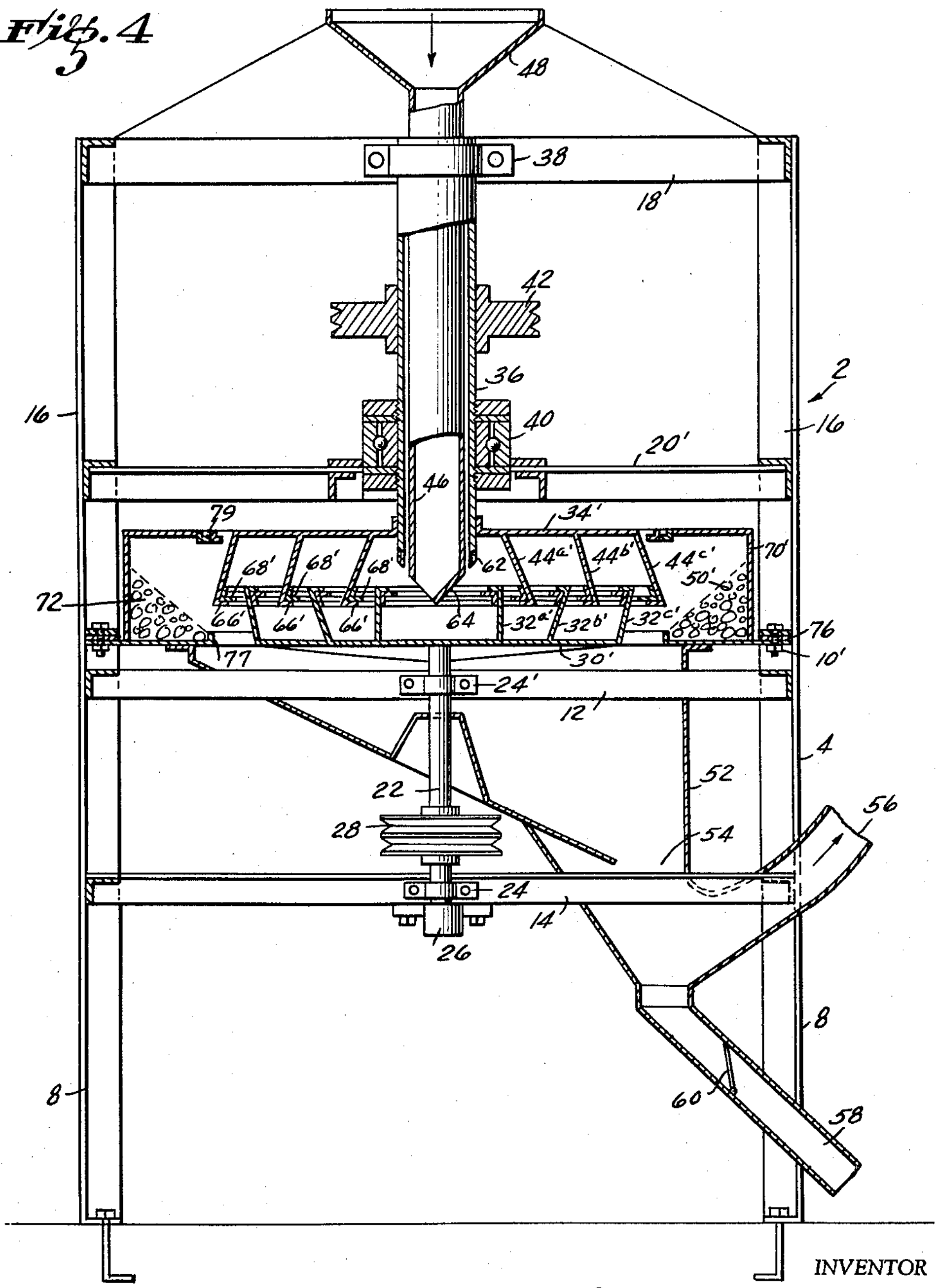
Fig. 5



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CENTRIFUGAL PULVERIZER

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Application December 27, 1956, Serial No. 630,920

5 Claims. (Cl. 241—253)

This invention relates to wet or dry process solid material comminution or disintegration and, more particularly, to pulverizers of the type embodying a pair of counter-rotating coaxial rotors having opposed working faces.

In pulverizers for hard, heavy, gritty, abrasive and sometimes corrosive materials, a major problem has resulted from abrasion of the machine parts with which the materials come into contact. By and large, wear has been dealt with by providing massive slow moving grinders or ball mills, with resultant high capital outlay, high power requirements, and lack of mobility. The purpose of this invention is to provide a comparatively light weight, high speed, low power pulverizer usable either for permanent situation or for preparing materials at or near the site of utilization, and which will be economically feasible for installation at comparatively small mines or mineral deposits.

The general objects are to utilize high-speed impact of particle against particle, and to predetermine the courses and counter-courses of particles through the grinding zones so that millions upon millions of collisions will occur between them while they are flying freely through spaces between the machine parts and when they impinge upon surfaces formed by the material itself. To accomplish this, it is proposed now to provide a pair of coaxial discs mounted for counter-rotation, the discs having opposed working faces spaced from one another, an axial input for material between the center of the discs, a peripheral collecting manifold, and a plurality of concentric, radially spaced baffles upstanding on the faces of the discs. Thus the material flowing under centrifugal force from the input to the collecting manifold not only must zig-zag, as seen in vertical cross-section, but with each change of direction the particles undergo many orbital reverses, as visualized in plan view.

Pulverizers of the general type under consideration have heretofore been proposed, but they have been subject to certain major drawbacks which have now been taken into account and dealt with. According to previous designs, the baffles on the counter-rotating discs are subjected to great erosion, and it was thought that erosion could be reduced by the build-up of material which compacts against the inwardly facing surfaces of the baffles. While this phenomenon alone is advantageous to some extent, the material builds up against a baffle in a generally right-triangular mass, as seen in cross-section, and the free edge of the baffle, being exposed, erodes as the out-flowing material passes over it. Additionally, the material build-up was not sufficiently uniform, resulting in unbalanced heavy loads on the rapidly rotating members. One approach to the solution was to provide, on the free edges of each baffle, an inwardly turned lip so that the material would build up and will be retained against the associated baffle face in predetermined form. However, the greatest wear on the baffle was found to occur at the lip. An object is to form the lips of abrasive and corrosion resistant material, and to mount them removably on the baffles so that they may be easily replaced.

In the preferred form of the invention, the baffles are

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disposed at comparatively small angles to the plane of the inwardly-facing surface of the mass of material which builds up on them, thereby reducing the mass of the built-up material, and also disposing the free edge of the baffle so that the outflowing material flies past the baffle edge, rather than over it. When the baffles are disposed with their inwardly facing surfaces generally parallel to the inwardly-facing surface formed by the material at its angle of repose on the baffles, important results are achieved in addition to the weight-load reduction. First, the size of the mass of deposited material is greatly reduced, thereby leaving much more clear space for the material to travel through and thereby enlarging the free-space working zones for the particles of material to fly freely through. Second, the air-drag load is greatly decreased. Where the baffles on the upper and lower discs are parallel with one another, heavy air drag occurs as the machine comes up to speed with one disc rotating at a high speed in one direction and with the other disc rotating at a similar speed in the opposite direction. The counter currents and eddy currents set up by and between the parallel baffle surfaces are sufficient to require considerable power to turn the machine with no material in it. Where, however, the baffles are inclined outwardly from their points of anchorage to the disc faces, not only are the volumes of the spaces between the baffles much greater, with resultant decrease in air drag, but also one baffle presents to the next a comparatively thin edge, rather than a flat surface.

Other objects of the invention are to protect the input structure against damage from flying material; to provide a deflector for the inflowing material so that it will not pile up unduly in the central region where the centrifugal forces are small, to provide a peripheral collector manifold which will function as an easily replaceable working surface; to shape the inner face of the collector manifold so that the out-flying particles will strike against surfaces generally normal to their direction of travel; to provide for adjustment of the axial spacing of the counter-rotating discs and associated baffles; and to provide for separation of the heavy and light pulverized particles so that the heavy ones may be recirculated.

These and other objects will be apparent from the following specifications and drawings, in which:

Fig. 1 is a side elevation and vertical section of one form of the invention;

Fig. 2 is a horizontal section along the line **2—2** of Fig. 1;

Fig. 3 is an enlarged fragmentary section showing the infeed, discs, baffles, and replaceable wear rings; and

Fig. 4 is a side elevation and vertical section of a second embodiment of the invention.

In the ensuing specification, like references denote similar elements and prime reference numerals denote comparable elements previously designated by whole numbers. Referring first to the embodiments in Figs. 1 to 3 inclusive, the pulverizer **2** has separable lower and upper frames **4** and **6** respectively, with the upper frame stacked on the lower. The lower frame has four vertical corner posts **8**, a top plate **10** and transverse braces **12** and **14**. Upper frame **6** has four vertical corner posts **16**, a transverse brace **18** and transverse frame **20** intermediate the upper and lower ends. Most of the frame parts are heavy angle iron rigidly secured together, as by welding, and suitable braces may be utilized to buttress the frame against heavy loads.

A vertical shaft **22** is rotatably supported centrally in lower frame **4** by radial thrust bearings **24** and an end thrust bearing **26** mounted on transverse braces **12** and **14**. A sheave **28** is provided on shaft **22** for driving the latter from a suitable motor. Affixed on the upper end of shaft 22 is a disc 30 having on its upper working face a plurality of annular baffles 32*a*, 32*b*, 32*c*. In the embodiment of Figs. 1 to 3, the annular baffles are cylindrical and at right angles to the disc on which they are affixed.

Spaced above disc 30 is an upper disc 34 affixed near the lower end of a hollow shaft 36 mounted for rotation about a vertical axis centrally of upper frame 16 by means of bearings 38 and 40 carried by transverse brace 18 and transverse frame 20 respectively. A sheave 42 is affixed on hollow shaft 36 for rotating the latter by drive from a suitable motor independently of the drive for shaft 22 and, ordinarily, hollow shaft 36 and disc 34 affixed thereon are rotated oppositely from shaft 22 and disc 30. Disc 34 has affixed on its lower face a plurality of cylindrical baffles 44*a* and 44*b* disposed, in this form, at right angles to the lower working face of disc 34 and interdigitating between baffles 32*a*, 32*b* and 32*c* on disc 30. A feed pipe 46 extends downwardly from a funnel 48 at its upper end and is coaxially disposed in hollow shaft 36 so as to drop material to be pulverized into the central portion of the zone between lower and upper discs 30 and 34. The pulverized material, after working its way through the labyrinth formed by the interdigitating baffles, is discharged against a manifold 50 surrounding the periphery of discs 30, 34 and, from manifold 50, the pulverized material drops to a collector bin 52 from which it is discharged by gravity through a bottom outlet 54. The finely pulverized material is drawn by a suitable suction system through pipe 56 and thence separated by conventional mechanism. The heavy particles of material, which need further pulverization, drop to chute 58 which leads to a conventional recirculating mechanism for feeding it back to funnel 48. A flap valve 60 in chute 58 prevents short circuiting the suction source connected to pipe 56, thereby assuring a strong air draft downwardly through the open-topped space 37 between hollow shaft 36 and feed pipe 46 and thence through the spaces between discs 30 and 34 and the baffles thereon. This air sweeps clean the exposed microscopic edges exposed on surfaces of material held in place behind the baffles 32*a*, 32*b*, 32*c*, 44*a*, 44*b* making the minute sharp exposed edges susceptible to the abrasive action of the larger heavier particles that are violently impinged against them, plus the additional abrasive action due to the extra might or force of the larger particles produced by the effect of centrifugal force as these heavier particles slide over the exposed surfaces. In the case of the wet process, the density of the feed material solution may be regulated by the additional flow of liquid down space 37.

The lower end of hollow shaft 36 is provided with a replaceable wear ring 62 to protect the shaft from the damage caused by relatively large flying particles discharged from the lower end of the feed pipe 46 and deflected by the whirling mechanism. A deflector 64 on the lower end of the feed pipe directs the inflowing material against the inner surface of baffle 32*a*. While the centrifugal forces rapidly increase radially outwardly from the center of disc 30, they are relatively small near the rotational axis, and deflector 64 prevents pile-up of inflowing material on the axis of the disc by feeding the material off-center. The baffles on discs 30, 34 are provided at their free edges with inturned lips 66. As the material moves radially outward against the baffles, it will build up until there is formed of the material an inner face substantially as indicated by dash lines. As a result of the outwardly increasing centrifugal forces, the inner surface of the material built up against baffles becomes steeper progressively outward. The material emitted from the lower end of feed pipe 36 falls first against the material built up against baffle 32*a* and thence slides diagonally upwardly and outwardly until it reaches the top of the piled-up material. From that point, while there remains still an upward opponent against the material, the latter is no longer constrained against outward movement and therefore assumes a trajectory which brings it against the inclined surface of the material built up against baffle 44*a*, the latter of which is spinning in the opposite direction. The particles of material then flow downwardly and thence outwardly after violent contact with the material lying against baffle 44*a*. As considered in plan, the material moving beyond baffle 32*a* moves with a helical motion in one direction, whereas the material moving beyond baffle 44*a* has a helical motion in the opposite direction. Between the free edges of baffles 32*a* and 44*a*, the particles have intersecting paths which bring them into a violent collision. This action and interaction occurs in the spaces between each of the interdigitating baffles and thus, taking also into account the grinding action caused by engagement of the particles against the surfaces of the built-up material, most of the particles are reduced to extremely fine powder as, for instance, in the case of small pebbles or crushed stone used as starting material. While the material built up against the inner surfaces of the baffle protects the latter from substantial wear, it has been found that the greatest erosion occurs at the free edges of the baffles over which the material slides as it works its way radially outward. So as to avoid replacement or repair of the entire disc and baffle assembly, there have been provided split rings 68 of L-shape in cross section, and which snap into engagement on the inner sides of lips 66. It will be understood that various other fastening means, such as bolts, may be supplied for holding the rings in place. Split rings 68 having splits 69 are preferably formed of wear and corrosion resistant material, such as stainless steel, and may be formed of or coated with abrasion resistant material, such as Teflon. The discs and baffles may also be coated with abrasion resistant material.

The pulverized material flying outwardly beyond the last baffle engages against the inner surface 73 of the collector manifold, the latter of which includes an outer shell 70 of suitable material, such as metal sheet or plate, and filler material 72, preferably quick replaceable concrete segments or other suitable material. While the inner surface 73 of the concrete may be smooth, it is preferred that it be formed with an annular series of projections, such as triangular ridges 74 which present to the outflying and helically spinning particles surfaces which are substantially 90° to the normal direction of movement of the particles. It will be understood that these projections may be shaped variously, or that inwardly projecting lugs may be embedded in the manifold in order to present transverse surfaces to the outflying material surfaces against which the material particles strike, thereby producing a further disintegration of the particles.

The assembly carried by upper frame 6 is vertically adjustable by means of one or more shims 76 engaged between top plate 10 of lower frame 4 and the lower end of upper frame 6. Thus the vertical spacing between discs 30 and 34 and the depth of interdigitation of the baffles may be regulated, depending on the material to be pulverized and desired speed of rotation. For pulverizing crushed stone, with comparatively little overlap between the baffles, and rotations of shafts 22 and 36 each at high speeds, in their respective directions, have been found to produce very fine powder with one pass.

The embodiment illustrated in Fig. 4 is formed with frame parts and shafts similar to that of Figs. 1 to 3 inclusive, but with essential differences in the baffle and manifold arrangement. Reverting briefly to Figs. 1 and 3, it is noted that the inner surfaces of the material deposited against the baffles are inclined. According to Fig. 4 embodiment, baffles 32*b*′ and 32*c*′ on lower disc 30′ are themselves inclined substantially at the surface angle of repose of the material. Thus, instead of building up with the cross section of a comparatively thick-based wedge, a thin layer of material builds up and is retained against the inner surface of the baffles. The inner-most baffle 32*a'* on lower disc 30' is not inclined, since the effective gravity at this, the central portion of the pulverizing zone is comparatively light and the volume of material which can build up within baffle 32*a'* is small because of the small diameter of the baffle. By inclining the baffles, the weight of the material built up against the baffles is greatly reduced and the free space between the baffles is increased. It will be apparent also that the counter-rotating parallel surface area of the baffles is reduced with accompanying reduction in air drag between the counter-rotating baffles.

In the Fig. 4 embodiment, manifold 50' is formed by a shell 70'. Plate 10' has on its inner free edge an upstanding lip 77, and the last pass of the pulverized material leaving the zone between the baffles and discs is a downward one. Thus, material builds up in manifold 50' as indicated by dash lines so as to protect the material from wear and, at the same time, presents an abrasive surface. At the outset, a deposit of crushed stone may be placed in the manifold to provide an abrasive and durable surface against which the outflying material impinges. In order to accommodate disc 34' and the outermost baffle 32*c'* when the upper frame is adjusted vertically by inserting or removing shims 76, an annular series of concentric split rings 79 are utilized at the top of metal casing 70'. It will be understood that rings 79 are comparable to those utilized for varying the size of the hole for a stove plate. When upper frame 6 is adjusted upwardly, the inner-most of the split rings 79 would be removed. Additional dust sealing expedients may be utilized at this and various other points of the assembly to prevent escape from the machine and to protect the bearings and other machine parts.

The invention is not limited to the apparatus detailed here and before, but is intended to cover all substitutions, modifications and equivalents within the scope of the following claims.

I claim:

1. A centrifugal pulverizer comprising a pair of discs, means mounting said discs for rotation about a common vertical axis, said discs having opposed working faces axially spaced from one another, drive means for independently rotating said discs, a plurality of concentric and substantially annular baffles on the working faces of said discs, the baffles on each disc having free edge portions substantially L-shaped in cross section providing in-turned lips, split wear rings removably mounted on said baffles and nesting within the angles of said L-shaped lips, said split rings being substantially L-shaped in cross-section and having inner edges disposed inwardly on the lips, the baffles on one of said discs being staggered with respect to those on the other, means for feeding material to be puverized centrally between said discs, a manifold surrounding the peripheries of said discs, and a collector disposed below said manifold and in communication therewith.

2. The combination claimed in claim 1, said split wear rings being of springy abrasion-resistant material and in spring engagement beneath the respective lips.

3. A centrifugal pulverizer comprising a pair of discs, means mounting said discs for rotation about a common vertical axis, said discs having opposed working faces axially spaced from one another, drive means for independently rotating said discs, a plurality of concentric and substantially annular baffles on the working faces of said discs, the baffles on each disc having surfaces facing inwardly towards the axis of the disc and in-turned lips on those ends of the surfaces which are disposed towards the opposite disc, split wear rings removably mounted on said baffles adjacent said lips, said split rings having inner edges disposed inwardly on the lips, the baffles on one of said discs being staggered with respect to those on the other, means for feeding material to be pulverized centrally between said discs, a manifold surrounding the peripheries of said discs, and a collector disposed below said manifold and in communication therewith, said split wear rings being of springy abrasion-resistant material and in spring engagement beneath the respective lips.

4. A centrifugal pulverizer comprising a pair of discs, means mounting said discs for rotation about a common vertical axis, said discs having opposed working faces axially spaced from one another, drive means for independently rotating said discs, means for feeding material to be pulverized centrally between the discs, a plurality of concentric and substantially annular baffles on the working faces of said discs, the baffles on one of said discs being staggered with respect to those on the other, said baffles having surfaces facing inwardly towards the axis of the disc and free edge portions past which the material undergoing pulverization flows outwardly, split wear rings removably mounted on the inner sides of said baffles adjacent said free edge portions, said rings being formed of springy abrasion-resistant material and having inner edges disposed radially inward of the free edge portions, the inwardly facing surfaces of said baffles and the wear rings thereon respectively forming substantially L-shaped traps for damming up portions of the outflowing material, inwardly projecting means on said baffles removably supporting said wear rings on said baffles, the centrifugal forces exerted on said wear rings acting to hold the same in place against said inwardly projecting means, and means for collecting the pulverized material thrown outwardly from between the discs.

5. A centrifugal pulverizer comprising a pair of discs, means mounting said discs for rotation about a common vertical axis, said discs having opposed working faces axially spaced from one another, drive means for independently rotating said discs, a plurality of concentric and substantially annular baffles on the working faces of said discs, said baffles comprising flat strips of material of substantially closed configuration each affixed along one edge to the respective disc and with the opposite edge free and disposed towards the opposite disc, the free edges of said baffles having inturned lips thereon, said baffles, save for the innermost one, inclining outwardly from the fixed edge thereof, the baffles on one of said discs being staggered with respect to those on the other, means for feeding material to be pulverized centrally between said discs, a manifold surrounding the peripheries of said discs, a collector disposed below said manifold and in communication therewith, and split wear rings removably affixed on said baffles and nesting within the angles of the L-shaped lips on the free edges thereof, said wear rings having inner edges disposed inwardly towards the axis of the discs beyond the inner edges of the L-shaped lips on the free edges of the baffles.

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