March 24, 1959 W. F. CLEMENTS ET AL 2,879,006

PULVERIZER GRINDING RINGS

Filed Aug. 9, 1954 2 Sheets-Sheet 1

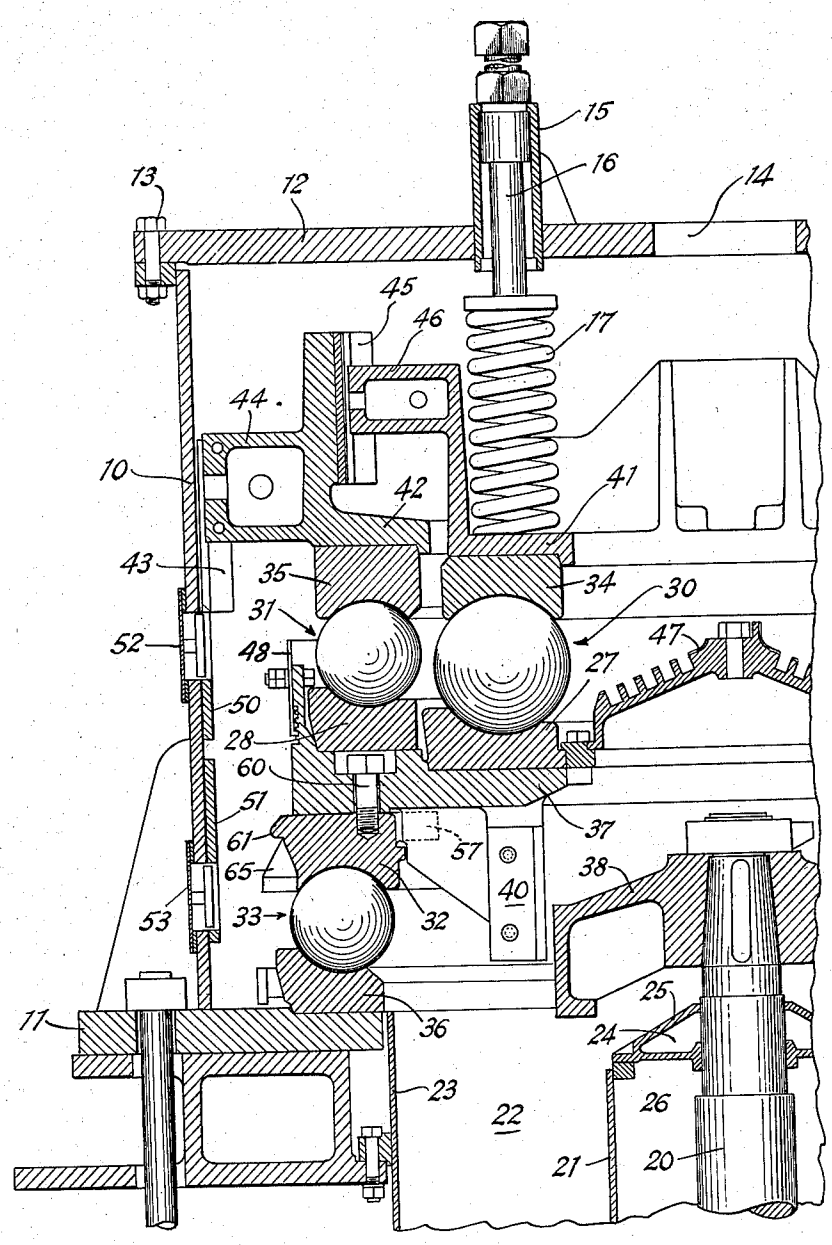


FIG. 1

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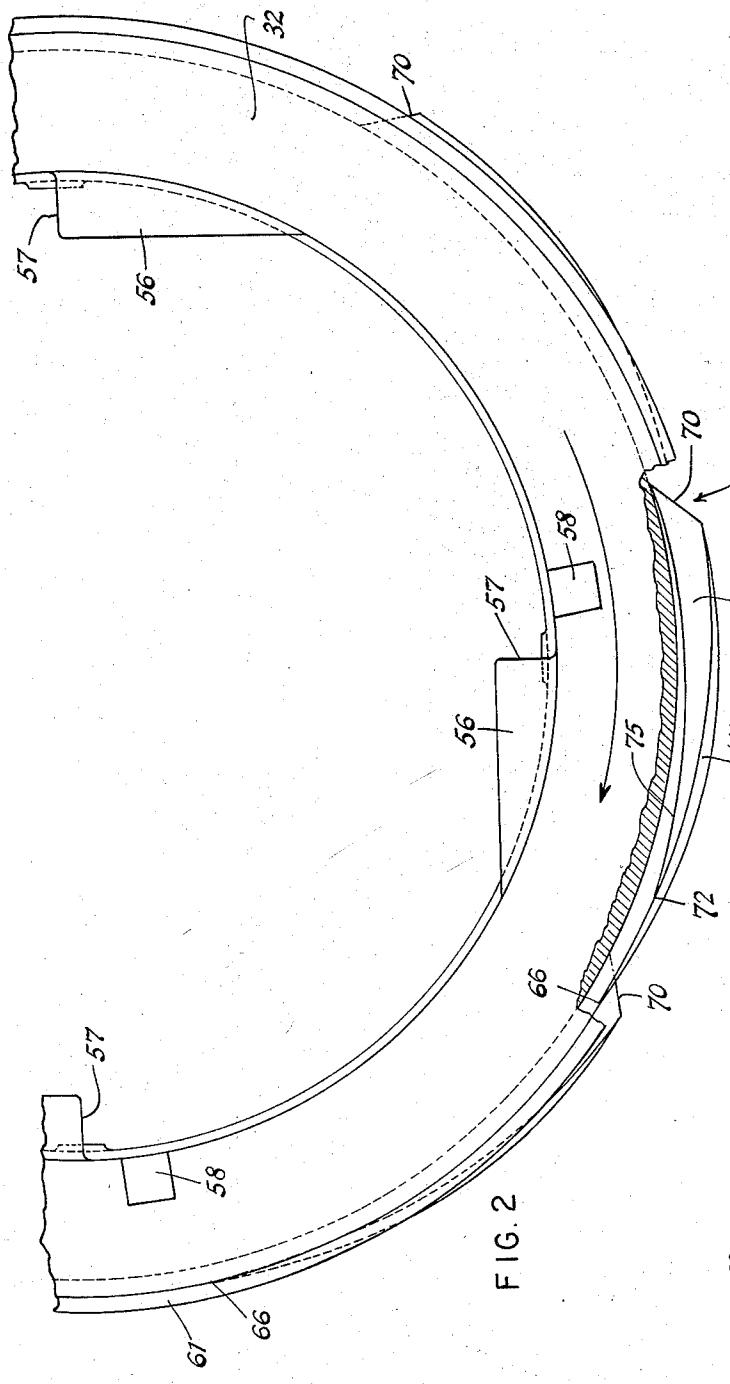


FIG. 2

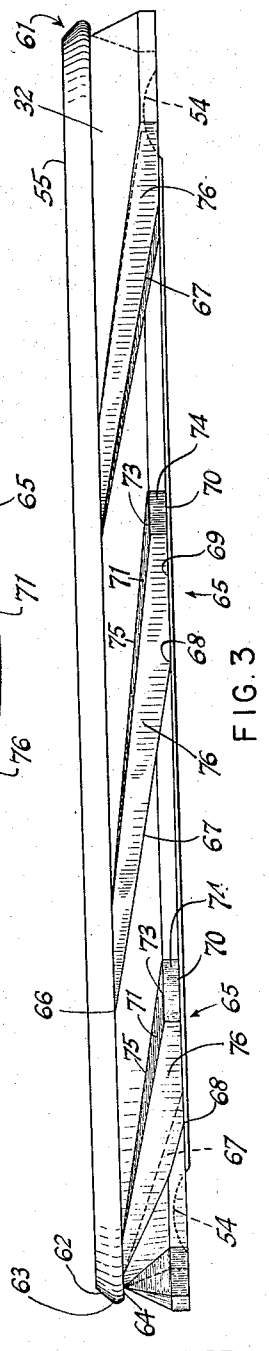


FIG. 3

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PULVERIZER GRINDING RINGS

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Application August 9, 1954, Serial No. 448,628

9 Claims. (Cl. 241—103)

The present invention relates to apparatus for pulverizing materials such as coal, clinkers, rock, ore, and the like, and more particularly to the grinding rings of pulverizers of the gravity discharge type having a plurality of grinding zones therein where the materials are pulverized by relatively moving grinding rings between which rows of rolling grinding elements are positioned.

While not limited thereto, the invention is particularly applicable to a pulverizer of the general type disclosed in the Bailey et al. U.S. Patent 2,076,288 where the material being pulverized is passed under the influence of centrifugal forces in a general horizontal direction through two successive grinding zones and thereafter falls by gravity to the outer circumference of a lower or third grinding zone. In passing the material through the lower grinding zone the material moves in a generally horizontal direction against centrifugal forces by reason of the head or mass of material accumulating adjacent the outer circumference of the grinding zone. Under some circumstances materials will pack in the annular space surrounding the lower grinding zone thereby leading to chocking of the grinding elements, with accelerated wear of the parts. This condition becomes aggravated when grinding some relatively finely divided materials of a low relative grindability, and various expedients have been used to direct and regulate movement of the material into and through the lower grinding zone. Unfortunately, most of the expedients heretofore tried have proven unsatisfactory by reason of accelerated grinding element wear, and increased power consumption in the pulverizer.

In accordance with the present invention we provide vanes or plows and/or a deflecting ring on the outer circumferential surface of a rotating grinding ring so as to regulate the movement of the mass of material adjoining the lower grinding zone, and to direct the movement of the material entering the grinding elements. The plows of the invention are formed integrally with the ring and provide a plurality of circumferentially equally spaced wedge shaped members, the lower surface of which extends outwardly and downwardly of the ring circumference to the level of the grinding surface, with the leading edge thereof disposed adjacent the upper portion of the ring. An outwardly extending ring or shelf projects from the ring circumference above the plows so as to deflect any rising streams of material being ground away from the ring.

The various features of novely which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which we have illustrated and described a preferred embodiment of the invention.

Of the drawings:

Fig. 1 is a section elevation of a portion of a pulverizer incorporating a grinding ring constructed in accordance with the present invention;

Fig. 2 is an enlarged plan of a segment of the grinding ring shown in Fig. 1 with a portion of the ring circumference removed to show the construction of the plows; and

Fig. 3 is a side elevation of the grinding ring drawn to the same scale as Fig. 2.

In the embodiment of the invention shown in the drawings, the grinding ring is shown as installed in a pulverizer of the general type illustrated in said U.S. Patent 2,076,288, where the material being ground is passed through three grinding zones or stages before it is discharged from the pulverizer. In such a pulverizer the unit is usually arranged in closed circuit with an external mechanical separator wherein the fine materials are removed as a finished product and the coarse materials are returned to the pulverizer for further grinding. The grinding systems of this type are characterized by a high rate of production at high fineness with comparatively low power consumption per unit of finished product. Depending upon the material being ground and the fineness desired, pulverizing systems of this type usually are characterized by a high rate of material flow through the pulverizer. This rate may be of the order of several hundreds of tons of material per hour.

As shown in Fig. 1 the grinding elements of the pulverizer are enclosed in a housing including an upright cylindrical casing **10** welded to a heavy annular base plate **11** and having a top plate **12** which is detachably secured to the upper end of the wall **10** by a series of bolts **13**. The top plate is provided with a central opening **14** for the admission of solid materials to be pulverized, and a circular series of cylindrical bushings **15** which accommodate threaded bolts **16** for the transmission of adjustable forces exerted downwardly on the grinding elements of the pulverizer through the compression springs **17**.

The base plate is mounted upon a foundation which is provided with a central cavity directly beneath the pulverizer housing for the installation of the drive mechanism of the pulverizer unit, and a spout for the discharge of the pulverized material leaving the unit.

The drive mechanism includes a motor and gear reducer (not shown) transmitting rotational power through an upright shaft **20** which is coaxial with the pulverizer casing **10**. The drive shaft **20** is enclosed in part by a cylindrical wall **21** which is coaxial with the shaft and forms the inner side of an annular discharge spout **22** which is defined on its outer side by a radially spaced cylindrical wall **23**. The lower end of the discharge spout **22** is defined by an annularly inclined plate (not shown) welded to the walls **21** and **23** and connected at its lower end to a material discharge pipe. An air seal chamber **24** is disposed on the upper end of the inner wall **21** with the upper surface thereof forming a frusto-conical top **25** to the space **26** surrounding the shaft and enclosed by the inner cylindrical wall **21**. Compressed air is supplied to the chamber **24** in sufficient volume and pressure to permit a slight leakage of air upwardly around the pulverizer drive shaft **20** to avoid leakage of pulverized materials downwardly into the gear drive mechanism of the unit.

Each of the grinding zones of the pulverizer shown includes upper and lower grinding rings on opposite sides of a circular series of grinding balls. In the arrangement illustrated the lower grinding rings **27** and **28** of the inner and outer upper grinding zones **30** and **31**, respectively, of the pulverizer, and the upper grinding ring **32** of the lower grinding zone **33** of the pulverizer are arranged for rotation as driven by the pulverizer drive shaft **20**. The upper grinding rings **34** and **35** of the inner and outer upper grinding zones **30** and **31**, respectively, are substantially fixed in a stationary position, but are permitted relative vertical movement with respect to each other through guide arms and guide plates hereinafter

described. The lower grinding ring 36 of the lower grinding zone 33 is rigidly mounted directly on the base plate 11.

In effect, the three grinding stages or zones 30, 31 and 33 are mounted for relative vertical grinding zone movement, with the total weight of the grinding elements plus the downward force exerted by the compressive springs 17 imposed upon the lower grinding ring 36 and the base plate 11.

With the rings 27, 28 and 32 attached to an intermediate ring 37, a rotational movement is transmitted to the assembly through a yoke 38 mounted on the tapered upper end of the shaft 20, with the rotational forces of the drive transmitted through a circumferential series of guide arms on the yoke bearing on wearing plates 40 on the ring 37.

The upper rings 34 and 35 of the upper grinding zones are separately attached to inner and outer spiders 41 and 42, respectively, which are independently fixed against rotation by arms bearing against stop or guide surfaces. A circumferential series of upright stops or guide surfaces 43 are secured to the cylindrical casing 10 of the pulverizer, and are engaged by a corresponding series of arms 44 projecting outwardly from the spider 42. The outer spider 42 is constructed to provide a circular series of equally spaced seats for a row of adjustable compression springs (not shown) which is similar to the springs 17, and is constructed to provide a circumferential series of equally spaced, upright guide surfaces 45. The spider 41 positions the upper ring 34, and is provided with a circumferentially equally spaced series of outwardly projecting arms 46 which are spaced to engage the guide surfaces 45 of the spider 42. With the described arrangement, the upper grinding rings 34 and 35 are fixed in a non-rotative position relative to the pulverizer casing 10 while differential vertical movement of the grinding zones 30 and 31 is permitted as occasioned by wear of the grinding rings. As wear occurs in the lower grinding zone 33, the rotative assembly of the intermediate ring 37, with the rings 27, 28 and 32 shifts its vertical position relative to the vertical position of the driving yoke 38.

The intermediate ring 37 of the grinding ring drive assembly is of annular construction and is provided with a central cover plate 47 which receives and distributes the raw material delivered through the opening 14. The outer circumference of the upper grinding zone 31 is provided with a vertically adjustable dam 43 which is positioned to restrict flow of pulverized materials from the upper grinding zones 30 and 31. As the material overflows the upper edge of the dam 48, it falls by gravity into the annular space between the outer side of the lower grinding zone 33 and the casing 10. With the extremely high rate of material movement through a pulverizer of this type the pulverizer casing 10 is provided with removable and replaceable wearing plates 50 and 51 positioned internally of the casing 10 adjacent the upper and lower grinding zones 31 and 33. Suitable observation doors 52 and 53 are provided in the casing 10 for the inspection of the grinding zones.

When grinding material of a low grindability to a high fineness, the materials have a tendency to pack in the space outwardly adjacent the lower grinding zone 33. This is particularly a characteristic of materials such as cement clinker which is ground to a high fineness in the manufacture of Portland cement. Occasionally, the annular ring of material is packed sufficiently adjacent the zone 33 to cause sliding between the wearing surfaces of the upper grinding ring 32 and the circular series of the balls. Sliding instead of rolling relationship between these grinding elements seriously decreases the life of the grinding parts and leads to higher maintenance costs. Frequently the packed condition of the material adjacent the lower grinding zone also has a tendency to cause either inward or outward wear of the grinding rings 32 and 36, relative to the original or new pitch diameter of the rings and balls. When inward or outward wear can be avoided, an increased life of the parts can be expected.

In accordance with the present invention we have found that a novel arrangement of plows and a deflecting baffle or shelf will drastically improve the wear life of the grinding elements in the lower grinding zone 33 of the pulverizer. When grinding cement clinker the addition of the plow and deflecting shelf of the present invention has resulted in an improvement of 30 to 40% in the wear life of the upper grinding ring. This improvement is apparently caused by an improved distribution of the cement clinker entering the grinding zone so that the wear of rings and balls is substantially vertical and without appreciable inward or outward wear of the rings.

As shown particularly in Figs. 2 and 3, the ring 32 is formed with one surface having a circular track 54 therein while the opposite annular surface 55 of the ring is substantially flat, to match the companion surface of the intermediate ring 37. As shown in Fig. 2, the inner circumference of the ring is provided with circumferentially equally spaced lugs 56 each of which is provided with a flat face 57 to engage a corresponding surface on the intermediate ring 37. In addition, the upper face 55 of the ring is provided with slots 58 having a tapered lower surface to accommodate wedges which are used in the assembly of the ring with the intermediate ring 37. As shown in Fig. 1, the grinding ring 32 is attached to the intermediate ring 37 by stud bolts 60.

The outer circumference of the ring 32 is provided with a circumferential baffle or shelf 61 of substantially uniform width and cross- sectional shape. The sheif extends outwardly from the upper face 55 of the ring 32 and is provided with a downwardly inclined upper surface 62 merging into a curved end portion 63. The lower surface 64 of the shelf is substantially parallel to the upper ring face 55 and merges into the body of the ring.

Beneath the shelf 61, a plurality of plows 65 are integrally formed on the circumferential surface of the ring 32. The plows are eight in number, in the illustrated embodiment of the invention, but the number may vary with ring diameter and with the type of service expected from the unit. The illustrated embodiment, however, is particularly effective in the pulverization of cement clinker.

The plows are essentially formed as a wedge wrapped around the outer circumference of the ring 32 with the wedge tapering downwardly and outwardly with respect to the ring circumference.

Referring to Figs. 2 and 3, the ring is constructed for clockwise rotation with the leading edge or point 66 of the plow 65 positioned on the circumference of the ring 32 immediately below the lower surface 64 of the shelf 61. From this position the lower surface 67 of the plow inclines downwardly and outwardly to a position 68 substantially in horizontal alignment with the lower surface of the grinding ring 32. From this point an extension 69 of the lower surface of the plow extends circumferentially of the ring and parallel to the grinding surface of the ring to a trailing edge 70 which is inclined towards the ring surface at an angle of approximately 50° with respect to a radially intersecting line.

The upper surface 71 of the plow inclines downwardly and outwardly with respect to the ring circumference from a leading edge or point 72 adjacent the lower surface 64 of the shelf 61 circumferentially spaced from the point 66. The surface 71 inclines downwardly to a trailing edge 73 which is in vertical alignment with the training edge 70 and forms therebetween a trailing surface 74. Referring particularly to Fig. 2, it will be noted the inner edge 75 of the upper surface 71 follows a curved line intersecting the inner end of the line 73 at a point having a lesser radius with respect to the ring center than

that of the point 72. With the construction described the outer circumferential surface 76 of the plow inclines outwardly of the ring toward the trailing surface 74. If desired to relieve wear on the lower surface 64 of the shelf 61, the points 66 and 72 may be displaced radially outward of the ring as far as the curved surfaces 63 with appreciable effect upon the functioning of the plows.

In the operation of the pulverizer, the plows of ring 32 direct the movement of material downwardly into the grinding zone 33 and avoid an accumulation of packed material adjacent the edge of the zone. The operation of the relatively moving rings 32 and 36, and balls, have a tendency to force some of the partially pulverized materials outwardly and upwardly along the outer surface of the ring. This material is deflected outwardly towards the pulverizer casing 10 by the edge surface of the shelf 61, thereby avoiding excessive washing of the outer intermediate ring 37 surface.

When grinding cement clinker to a standard Portland cement fineness specification, the plows 65 and shelf 61 are particularly effective in causing desirable vertical wear of the grinding ring of the lower grinding zone 33 and thereby permitting maximum grinding element service. When grinding other materials to different fineness specifications the shelf 61 has been used to advantage without the use of the plows 65, and under other conditions the plows alone without the shelf have been effective for grinding purposes. However, in general, with most materials the combination of shelf and plows has been best for improved grinding element life.

While in accordance with the provisions of the statutes we have illustrated and described herein a preferred embodiment of the invention, those skilled in the art will understand that changes may be made in the method of operation and form of the apparatus disclosed without departing from the spirit of the invention covered by our claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. A pulverizer of the type having a circular row of rolling grinding elements operable between a rotatable upper grinding ring and a stationary lower grinding ring, means for rotating said upper grinding ring about a vertical axis, means for delivering material to be pulverized to the outer circumference of said rotating grinding ring, and means for directing the movement of said material into said rolling grinding elements comprising a plurality of circumferentially equally spaced plows integral with and projecting outwardly of the upper grinding ring, each of said plows having surfaces tapering outwardly and downwardly, a minor horizontal and vertical dimension at a top leading edge position to a major horizontal and vertical dimension at a lower trailing edge position to wedge said material outwardly and downwardly relative to said ring.

2. A pulverizer of the type having a circular row of rolling grinding elements operable between a rotatable upper grinding ring and a stationary lower grinding ring, means for rotating said upper grinding ring about a vertical axis, means for delivering material to be pulverized to the outer circumference of said rotating grinding ring, a shelf projecting outwardly of the upper portion of said upper grinding ring, and means for directing the movement of said material into said rolling grinding elements comprising a plurality of circumferentially equally spaced plows projecting outwardly of the upper grinding ring, each of said plows having a lower surface tapering outwardly and downwardly from a position on said ring periphery adjacent said shelf to the lower level of said ring.

3. A pulverizer of the type having upper and lower grinding zones, each of said zones including a circular row of rolling grinding elements operable between a substantially stationary grinding ring and a rotatable grinding ring, means for rotating the upper grinding ring of said lower grindnig zone, means for delivering partially ground material to the outer circumference of said lower grinding zone, a shelf circumferentially encircling the upper portion of the rotating ring periphery of said lower grinding zone, and means for directing said material into said lower grinding zone comprising a plurality of circumferentially equally spaced plows projecting outwardly of the rotatable grinding ring of said lower grinding zone, each of said plows having upper and lower surfaces tapering outwardly and downwardly from a leading edge positioned adjacent said shelf to the lower level of said rotating ring.

4. A pulverizer of the gravity discharge type comprising upper and lower grinding zones, the upper grinding zone including at least one circular row of rolling grinding elements operable between an upper substantially stationary grinding ring and a lower rotatable grinding ring, the lower grinding zone including at least one circular row of rolling grinding elements operable between an upper rotatable grinding ring and a lower substantially stationary grinding ring, means for rotating the lower grinding ring of said upper grinding zone and the upper grinding ring of said lower grinding zone, means for delivering material to be pulverized to the inner side of said upper grinding zone for movement of said material outwardly through said upper grinding zone and downwardly by gravity to the outer circumference of said lower grinding zone, and means for directing the movement of said material into said lower grinding zone comprising a plurality of circumferentially equally spaced plows integral with and projecting outwardly of the rotatable grinding ring of said lower grinding zone, each of said plows having vertically spaced upper and lower surfaces tapering outwardly and downwardly from a leading edge positioned on the upper portion of said ring periphery with the leading edge of one plow spaced above the lower end portion of the adjacent plow.

5. A pulverizer of the gravity discharge type comprising upper and lower grinding zones, the upper grinding zone including at least one circular row of rolling grinding elements operable between an upper substantially stationary grinding ring and a lower rotatable grinding ring, the lower grinding zone including at least one circular row of rolling grinding elements operable between an upper rotatable grinding ring and a lower substantially stationary grinding ring, means for rotating the lower grinding ring of said upper grinding zone and the upper grinding ring of said lower grinding zone, a shelf outwardly encircling the upper portion of the periphery of said upper grinding ring of said lower zone, means for delivering material to be pulverized to the inner side of said upper grinding zone for movement of said material outwardly through said upper grinding zone and downwardly by gravity to the outer circumference of said lower grinding zone, and means for directing the movement of said material into said lower grinding zone comprising a plurality of circumferentially equally spaced plows projecting outwardly of the rotatable grinding ring of said lower grinding zone, each of said plows having vertically spaced upper and lower surfaces tapering outwardly and downwardly from a leading edge of one plow positioned on said shelf with the leading edge spaced above the lower end portion of the adjacent plow.

6. A pulverizer of the gravity discharge type comprising upper and lower grinding zones, the upper grinding zone including at least one circular row of rolling grinding elements operable between an upper substantially stationary grinding ring and a lower rotatable grinding ring, the lower grinding zone including at least one circular row of rolling grinding elements operable between an upper rotatable grinding ring and a lower substantially stationary grinding ring, means for rotating the lower grinding ring of said upper grinding zone and the upper grinding ring of said lower grinding zone, means for de-

livering material to be pulverized to the inner side of said upper grinding zone for movement of said material outwardly through said upper grinding zone and downwardly by gravity to the outer circumference of said lower grinding zone, and a shelf projecting outwardly from the upper portion of the periphery of said upper grinding ring of said lower zone.

7. An article of manufacture comprising a ring having a circular track in one annular surface and being substantially flat on the opposite surface thereof, lug means on the inner circumference of said ring for attaching to a rotatable member, and a circumferential shelf projecting outwardly of the outer circumference of said ring from the annular substantially flat surface of said ring opposite from said circular track and spaced from the annular surface containing said circular track, the surface of said shelf closest to said circular tract being substantially parallel to said substantially flat surface.

8. An article of manufacture comprising a ring having a circular track in one annular surface and being substantially flat on the opposite surface thereof, means for attaching said annular ring to a supporting member, and a plurality of circumferentially equally spaced plows positioned on the outer circumference of said annular ring, each of said plows having a lower surface tapering outwardly and circumferentially from a position adjacent the substantially flat surface of said annular ring to a position in substantial alignment with the surface of said ring containing said circular track.

9. An article of manufacture comprising a ring having a circular track in one annular surface and being substantially flat on the opposite surface thereof, means for attaching said annular ring to a supporting member, a circumferential shelf projecting outwardly adjacent the substantially flat annular surface of said ring, and a plurality of circumferentially equally spaced plows positioned on the outer circumference of said annular ring, each of said plows having a lower surface tapering outwardly and circumferentially from a position adjacent the said shelf to a position in substantial alignment with the surface of said ring containing said circular track.

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