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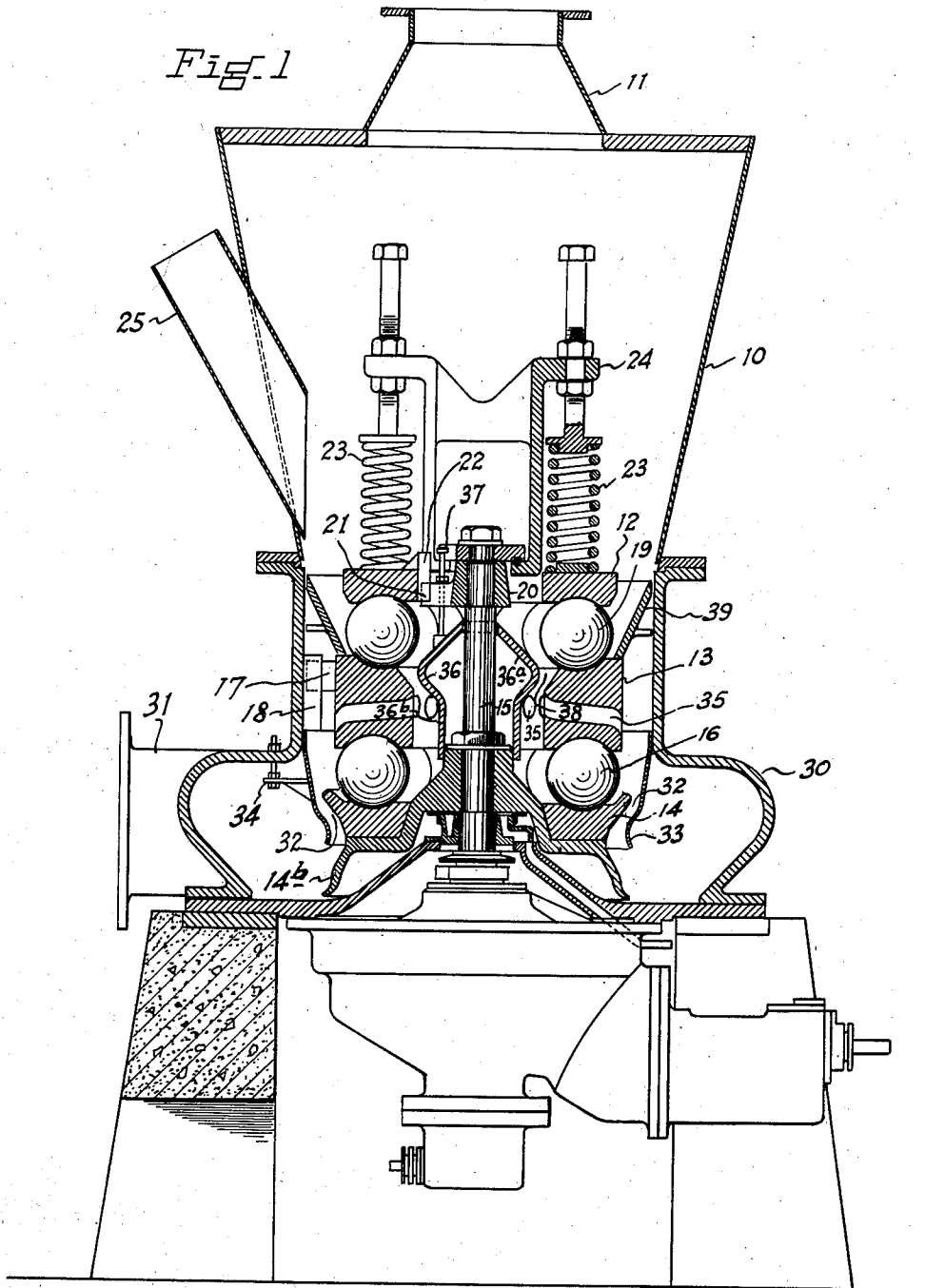
L. W. HELLER

2,220,104

PULVERIZER

Filed Dec. 29, 1934

2 Sheets-Sheet 1



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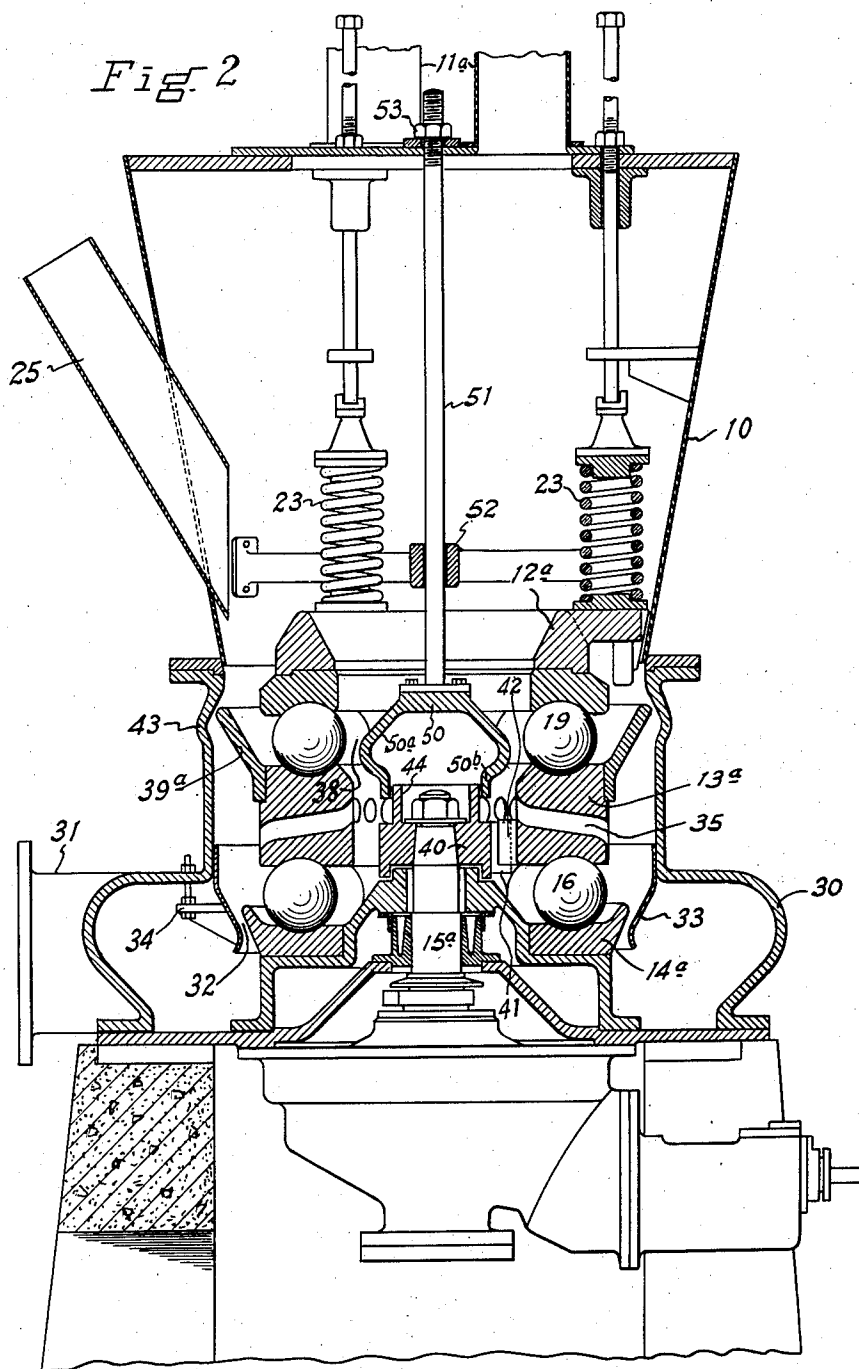
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PULVERIZER

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Application December 29, 1934, Serial No. 759,608

19 Claims. (Cl. 83-45)

The present invention relates to the construction and operation of pulverizers and more particularly, to pulverizers involving cooperating resiliently loaded rolling grinding elements and grinding rings and a selective discharge of the pulverized material by a gaseous carrier medium passed through the pulverizer in a flow path generally counter to the flow of material.

In pulverizers of the character described including two or more superposed circular rows of rolling grinding elements, such as metallic balls, one of the main problems is the proper distribution of the material undergoing pulverization between the rows in order to provide the most effective grinding conditions and distribution of the wear on the grinding parts. As the material usually passes too rapidly through the upper grinding stage, the flow of material has been heretofore controlled by damming or restricting the material flow from the upper grinding stage by means of screens, grids, dams or orifices. Such devices have not proved wholly satisfactory for the purpose as they either cause a quantity of material to be retained in the pulverizer on shutting down or have their regulating effect continuously affected by wear and deterioration in use.

In accordance with my present invention, such objectionable characteristics of prior control devices are avoided by effecting the desired regulation by controlling the velocity of the carrier medium at one or more critical points in the material flow path by means of a device or devices subjected to little or no wear in operation in conjunction with an improved material flow permitting the centrifugal effect of the rotating grinding parts to be most advantageously utilized.

A main object of my invention is the provision of a pulverizer having an improved path of flow of the material undergoing pulverization relative to the gaseous carrier medium.

A further object is the provision of a pulverizer having simple and effective means for regulating the distribution of the material undergoing pulverization therein and better distributing the wear on the grinding parts, and thereby increasing the fineness of the pulverized material discharged and the pulverizer capacity.

The various features of novelty which characterize my 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 I have illustrated and described preferred embodiments of my invention.

Of the drawings:

Fig. 1 is a sectional elevation of one form of pulverizer constructed in accordance with my invention; and

Fig. 2 is a view similar to Fig. 1 of a modified construction.

The pulverizer illustrated in Fig. 1 comprises a sectional casing 10 of circular cross-section having an outlet 11 in the top thereof for the discharge of pulverized material and enclosing upper, intermediate and lower vertically spaced horizontally arranged metallic grinding rings 12, 13 and 14, respectively. The lower ring 14 is secured to a bell-shaped yoke 14^a mounted on a vertical drive shaft 15 arranged axially of the grinding rings and shaped to support a circular row of metallic grinding balls 16. The intermediate ring 13 is supported on the balls 16 and held in a non-rotary floating position relative to the casing by one or more lugs 17 positioned between pairs of plates 18. An upper circular row of grinding balls 19 rests on the ring 13 and in turn supports the upper ring 12, which has a floating drive connection with the drive shaft 15 through a drive yoke 20 having one or more lugs 21 positioned between corresponding pairs of plates 22 on the upper ring. A grinding pressure is adjustably applied to the upper row of balls by means of a circular series of coiled springs 23 positioned between the top of the upper ring 12 and corresponding arcuately spaced interconnected posts 24 held on the end of the drive shaft, as shown. The upper row of balls cooperates with the upper and intermediate grinding rings to form an upper grinding stage receiving material to be pulverized at the outer side of the row of balls 19 from a feed pipe 25 and discharging pulverized material at the inner side of the row of balls. The pulverized material from the upper stage drops past the inner side of the intermediate ring to the inner side of the lower row of balls 16, which cooperate with the intermediate and lower rings to form a lower grinding stage having an outward flow of material therethrough.

The lower section of the casing 10 is enlarged at its lower end to form an annular box 30 having an inlet 31 for a suitable gaseous carrier medium, such as preheated air. The pulverizer is constructed to provide a flow of air in a substantially annular stream upwardly through the casing to the outlet 11 with successive contacts with

the stream of material undergoing pulverization. In the construction shown, the air enters below and at the outer side of the lower grinding stage through a variable annular throat 32 formed between the outer side of the grinding ring 14 and a downwardly tapering substantially conical baffle 33 adjustably supported on the casing 10 by brackets 34. The annular stream of air passes upwardly through the throat 32 at a sufficiently high velocity to sweep up the pulverized material passing over the edge of the lower grinding ring. After leaving the throat 32, the material-laden air expands in the space thereabove, causing any oversize particles to drop out and either return to the grinding surface of the lower ring 14 or restrict the air flow through the throat sufficiently to cause an increase in air velocity sufficient to carry them away.

The material-laden air flows inwardly through a series of inwardly inclined ports 35 formed in the intermediate ring 13 and extending from the outer side of that ring to a second expansion space at the inner side of the ring 13 wherein the air stream changes direction, causing any oversize material in suspension to drop out of the air stream and return to the inner side of the row of balls 16. The material-laden air then passes upwardly in an annular stream through the stream of material descending from the upper to the lower grinding stage, scavenging the descending material to separate particles of the desired fineness.

The velocity of the air stream passing upwardly at the inner side of the ring 13 is advantageously regulated to control the interstage flow of material. The means employed for this purpose consists of a cone member 36 surrounding the drive shaft 15 and having a downwardly flaring upper portion 36^a, the lower end of which is arranged adjacent to the inner side of the ring 13 to provide a narrow annular throat 38 therebetween, and a reduced cylindrical lower portion 36^b fitting over and sealing the joint between the drive yoke 14^b and the drive shaft. The cone 36 is adjustable axially of the drive shaft to vary the location of the lower end of the portion 36^a relative to the ring 13 and thereby the effective flow area of the throat 38, by means of threaded rods 37 mounted in the drive yoke 20. The air stream after passing through the throat 38 passes upwardly mainly past the inner side of the balls 19 and outwardly through the openings between the spaced posts 24 to the outlet 11. Any oversize material separating by gravity from the air stream in the upper casing section will be returned to the upper grinding zone for further grinding. An annular conical baffle 39 is mounted on the ring 13 with its upper end substantially in contact with the casing to direct the material into the ball row 19 and prevent the air stream short-circuiting the upper grinding stage.

In operation, material delivered by the inlet pipe 25 and material separated in the upper part of the casing passes from the outer side of the row of balls 19 substantially radially inwardly and is discharged at the inner side of the ball row. The passage of the material through the upper grinding stage is partly opposed by the centrifugal effect of the rotating balls and ring 12 and the velocity of the air stream passing the inner side of the balls 19, the air velocity being controlled at the throat 38 to retain the material in the upper grinding stage a predetermined time and thereby effect the desired grinding action in the upper stage. The location of the throat 38 at

the inner side of the ring 12 is also advantageous as it permits a greater width of throat than if it were located at the outer side of the ring with the same total area. Since the intermediate ring 13 is non-rotary and the cone 36 rotates with the upper ring 12, a relative movement is provided between the walls of the throat 38 which prevents material permanently lodging therein. The material pulverized in the upper stage drops through the uprising air stream which picks up a large proportion of the descending fine material, the remaining material being delivered to the inner side of the lower row of balls 16. The material passes substantially radially outwardly through the lower row of balls, its passage being accelerated by the centrifugal effect of the rotating balls and lower ring and restricted by the uprising outer edge of the lower ring. The material leaving the lower grinding stage at the outer side of the row of balls 16 is swept up by the ascending high velocity air stream. The material-laden air then passes upwardly at the outer side of the balls 16 and through the ports 35 as previously described. The baffle 33 may be thus adjusted to insure an air velocity sufficient to sweep up all of the material discharged from the lower grinding zone, while the cone 36 is adjusted to control the discharge of material from the upper grinding stage and thereby the flow of material interstage.

With the flow control provisions constructed and arranged as described it is practical to vary the air flow through the pulverizer for different rates of pulverization or moisture content of the material without choking the pulverizer, since the air velocity at the critical locations can be effectively adjusted. If the quantity of air to be passed becomes so great due to the requirements for drying or transportation that the velocities and pressure drops through the ports 35 and throat 38 tend to become excessive, valve controlled openings may be provided in the baffle 33 to permit a portion of the air to by-pass the ports 35. Under certain conditions when changes in the total air quantity passed are desirable, automatic means can be provided for actuating one or both of the throat area adjusting means in accordance with changes in the quantity of air supplied. The foregoing construction provides a particularly effective control of the amount of pulverization in the several stages, and the delivery of material of the desired degree of fineness to the mill outlet.

Where the flow restricting provisions used heretofore have been adjustable, the making of such adjustments usually required the shutting down of the pulverizer. In Fig. 2 I have illustrated a modified construction wherein the regulating devices for both the throats 32 and 38 are externally adjustable without requiring any change in the pulverizer operation. In this modification, the upper and lower grinding rings 12^a and 14^a respectively are non-rotary, while the intermediate ring 13^a has a floating drive connection with the drive shaft 15^a through a drive yoke 40 and cooperating lugs and plates 41 and 42 respectively. The air and material flow paths are similar to those previously described. Regulation of the throat 38 is effected by a cone member 50 having an upper downwardly flaring section 50^a and a lower reduced sleeve section 50^b surrounding and slidable on an upstanding sealing flange 44 carried by the yoke 40. The cone 50 is carried by a rod 51 positioned in a fixed guide 52 and extending upwardly through the top of the casing between the outlets 11^a. The projecting end

of the rod is held by a nut 53, which controls the position of the cone and thereby the effective area of the throat 38. In view of the tilting of the rotary intermediate ring 13^a in operation, the portion of the casing adjacent the upper end of the conical baffle 39^a on the ring is curved outwardly at 43 parallel to the arc in which the adjacent edge of the ring will move on tilting of the ring. The same clearance is thus maintained between the ring and casing at all times permitting a small quantity of air to flow there-through in normal operation.

While I have illustrated and described my invention, as applied to a multi-stage pulverizer, those skilled in the art will understand that certain features of the invention are similarly adapted for use in single stage pulverizers and that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims. In my claims, the term "air" is used generically to cover any gaseous carrier medium suitable for removing pulverized material in the manner described.

I claim:

1. A pulverizer comprising a casing having an outlet for pulverized material in the upper part thereof and enclosing vertically spaced upper, intermediate and lower grinding rings, upper and lower circular rows of rolling grinding elements positioned between said upper and intermediate and said intermediate and lower grinding rings respectively and cooperating therewith to form an upper grinding stage having a flow of material therethrough in one direction and a free discharge of material therefrom and a lower grinding stage receiving material from said upper stage and having a flow of material therethrough in the opposite direction, means for delivering material to be pulverized to the inlet side of said upper row of elements, and means for directing an annular stream of air upwardly through said casing past the discharge side of said lower row of elements and then past the discharge side of said upper row of elements, said air flow directing means including baffle means spaced from the discharge side of said intermediate grinding ring and arranged relative to said intermediate grinding ring to define opposite sides of an annular air passage of substantially reduced flow area along the discharge side of said intermediate grinding ring and thereby provide an increased air velocity at the discharge side of said upper row of elements.

2. A pulverizer comprising a casing having an outlet for pulverized material in the upper part thereof and enclosing vertically spaced upper, intermediate and lower grinding rings, upper and lower circular rows of rolling grinding elements positioned between said upper and intermediate and said intermediate and lower grinding rings respectively and cooperating therewith to form an upper grinding stage having a flow of material therethrough in one direction and a free discharge of material therefrom and a lower grinding stage receiving material from said upper stage and having a flow of material therethrough in the opposite direction, drive means arranged to rotate said intermediate grinding ring relative to said upper and lower grinding rings, means for delivering material to be pulverized to the inlet side of said upper row of elements, and means for directing an annular stream of air upwardly through said casing past the discharge side of said lower row of elements and then past the discharge side of said upper row of elements, said air flow directing

means at the discharge side of said intermediate grinding ring consisting of annular baffle means extending along the discharge side of said intermediate grinding ring and spaced radially therefrom to form an annular air passage of substantially reduced flow area along the discharge side of said intermediate grinding ring to thereby provide an increased velocity of air flow upwardly past the discharge side of said intermediate grinding ring and upper row of elements.

3. A pulverizer comprising a casing having an outlet for pulverized material in the upper part thereof and enclosing vertically spaced upper, intermediate and lower grinding rings, upper and lower circular rows of rolling grinding elements positioned between said upper and intermediate and said intermediate and lower grinding rings respectively and cooperating therewith to form an upper grinding stage having a flow of material therethrough in one direction and a lower grinding stage receiving material from said upper stage and having a flow of material therethrough in the opposite direction, means for delivering material to be pulverized to the inlet side of said upper row of elements, means for directing an annular stream of air upwardly through said casing past the discharge side of said lower row of elements and then past the discharge side of said upper row of elements, regulable means at the discharge side of said lower row of elements for controlling the air velocity past said lower row of elements, and regulable means at the discharge side of said upper row of elements for controlling the air velocity past said upper row of elements.

4. A pulverizer comprising a casing enclosing a plurality of vertically spaced horizontally arranged grinding rings, an upper circular row of rolling grinding elements positioned between a pair of said grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between a pair of said grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, drive means arranged to effect relative rotation between vertically adjacent grinding rings, means for directing a stream of air past the outer side of said lower row of elements and then past the inner side of said upper row of elements, and regulable baffle means at the inner side of said upper row of elements for controlling the air velocity past said upper row of elements.

5. A pulverizer comprising a casing enclosing a plurality of vertically spaced horizontally arranged grinding rings, an upper circular row of rolling grinding elements positioned between a pair of said grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between a pair of said grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, drive means arranged to effect relative rotation between vertically adjacent grinding rings, means for directing a stream of air past the outer side of said lower row of elements and then past the inner side of said upper row of elements, regulable means at the outer side of said lower row of elements for controlling the air velocity past said lower row of elements, and regu-

lable means at the inner side of said upper row of elements for controlling the air velocity past said upper row of elements.

6. A pulverizer comprising a casing enclosing vertically spaced horizontally arranged rotary upper and lower grinding rings, a horizontally arranged non-rotary grinding ring intermediate said upper and lower grinding rings, an upper circular row of rolling grinding elements positioned between said upper and intermediate grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between said intermediate and lower grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, a drive mechanism arranged to effect rotation of said upper and lower grinding rings, said intermediate grinding ring having ports for material-laden air extending transversely thereof, means for directing a stream of air past the outer side of said lower row of elements, through said ports and past the inner side of said upper row of elements, and regulable means at the inner side of said upper row of elements for controlling the air velocity past said upper row of elements.

7. A pulverizer comprising a casing enclosing vertically spaced horizontally arranged rotary upper and lower grinding rings, a horizontally arranged non-rotary grinding ring intermediate said upper and lower grinding rings, an upper circular row of rolling grinding elements positioned between said upper and intermediate grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between said intermediate and lower grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, a drive mechanism arranged to effect rotation of said upper and lower grinding rings, said intermediate grinding ring having ports for material-laden air extending transversely thereof, means for directing a stream of air past the outer side of said lower row of elements, through said ports and past the inner side of said upper row of elements, regulable means at the outer side of said lower row of elements for controlling the air velocity past said lower row of elements, and regulable means at the inner side of said upper row of elements for controlling the air velocity past said upper row of elements.

8. A pulverizer comprising a casing enclosing vertically spaced horizontally arranged rotary upper and lower grinding rings, a horizontally arranged non-rotary grinding ring intermediate said upper and lower grinding rings, an upper circular row of rolling grinding elements positioned between said upper and intermediate grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between said intermediate and lower grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, a drive mechanism arranged to effect rotation of said upper and lower grinding rings, said intermediate grinding ring having ports for material-laden air extending transversely thereof, means

for directing a stream of air past the outer side of said lower row of elements, through said ports and past the inner side of said upper row of elements, and a cone member adjustably mounted on said drive mechanism at the inner side of said upper row of elements for controlling the air velocity past said upper row of elements.

9. A pulverizer comprising a casing enclosing vertically spaced horizontally arranged rotary upper and lower grinding rings, a horizontally arranged non-rotary grinding ring intermediate said upper and lower grinding rings, an upper circular row of rolling grinding elements positioned between said upper and intermediate grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between said intermediate and lower grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, a drive mechanism arranged to effect rotation of said upper and lower grinding rings, said intermediate grinding ring having ports for material-laden air extending transversely thereof, means for directing a stream of air past the outer side of said lower row of elements, through said ports and past the inner side of said upper row of elements, an adjustable conical baffle at the outer side of said lower row of elements for controlling the air velocity past said lower row of elements, and a cone member adjustably mounted on said drive mechanism at the inner side of said upper row of elements for controlling the air velocity past said upper row of elements.

10. A pulverizer comprising a casing enclosing upper and lower grinding rings, a circular row of rolling grinding elements positioned between said grinding rings, means for supplying material to be pulverized to the inner side of said row of elements, drive means arranged to effect relative rotation between said grinding rings, and means for directing a stream of air upwardly past the outer side of said lower grinding ring and row of elements, said air directing means including an annular baffle mounted on said casing at the outer side of said elements and cooperating with the outer side of said lower grinding ring to define therebetween an annular air passage of substantially reduced flow area along the outer side of said lower grinding ring and thereby provide an increased air velocity at the outer side of said row of elements.

11. A pulverizer comprising a casing enclosing upper and lower grinding rings, a circular row of rolling grinding elements positioned between said grinding rings, means for supplying material to be pulverized to the inner side of said row of elements, drive means arranged to effect relative rotation between said grinding rings, said upper grinding ring having ports for material-laden air extending transversely thereof, means for directing a stream of air upwardly past the outer side of said row of elements and then through said ports, and regulable baffle means at the outer side of and below said row of elements for controlling the air velocity past said row of elements.

12. A pulverizer comprising a casing enclosing upper and lower grinding rings, a circular row of rolling grinding elements positioned between said grinding rings, means for supplying material to be pulverized to the inner side of said row of elements, drive means arranged to effect relative rotation between said grinding rings, said upper

grinding ring having ports for material-laden air extending transversely thereof, means for directing a stream of air past the outer side of said row of elements and then through said ports, and a conical baffle adjustably mounted on said casing at the outer side of said row of elements for controlling the air velocity past said row of elements.

13. A pulverizer comprising a casing enclosing vertically spaced horizontally arranged non-rotary upper and lower grinding rings, a horizontally arranged rotary grinding ring intermediate said upper and lower grinding rings, an upper circular row of rolling grinding elements positioned between said upper and intermediate grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between said intermediate and lower grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, a drive mechanism arranged to effect rotation of said intermediate grinding ring, means for directing a stream of air past the outer side of said lower row of elements and subsequently adjacent to the inner side of said upper row of elements, and regulable baffle means adjacent to the inner side of said upper row of elements for varying the velocity of said air stream.

14. A pulverizer comprising a casing enclosing vertically spaced horizontally arranged non-rotary upper and lower grinding rings, a horizontally arranged rotary grinding ring intermediate said upper and lower grinding rings, an upper circular row of rolling grinding elements positioned between said upper and intermediate grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between said intermediate and lower grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, a drive mechanism arranged to effect rotation of said intermediate grinding ring, said intermediate grinding ring having ports for material-laden air extending transversely thereof, means for directing a stream of air past the outer side of said lower row of elements through said ports and subsequently past the inner side of said upper row of elements, means at the inner side of said upper row of elements for controlling the air velocity past said upper row of elements, and means for externally operating said last mentioned means.

15. A pulverizer comprising a casing enclosing a plurality of vertically spaced horizontally arranged grinding rings comprising upper, intermediate and lower grinding rings, an upper circular row of rolling grinding elements positioned between said upper and intermediate grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between said intermediate and lower grinding rings and arranged to receive material at the inner side thereof from said upper row of elements through a substantially annular passage at the inner side of said intermediate grinding ring and to discharge material pulverized thereby at the outer side of said lower row of elements, drive means arranged to

effect relative rotation between said upper and lower grinding rings and said intermediate grinding ring, and regulable means at the inner side of said intermediate grinding ring for controlling the radial width of said passage.

16. A pulverizer comprising a casing enclosing a plurality of vertically spaced horizontally arranged grinding rings, an upper circular row of rolling grinding elements positioned between a pair of said grinding rings, means for supplying material to be pulverized to the outer side of said upper row of elements, a lower circular row of rolling grinding elements positioned between a pair of said grinding rings and arranged to receive material from said upper row of elements at the inner side of said lower row of elements and to discharge material pulverized thereby at the outer side thereof, drive means arranged to effect relative rotation between vertically adjacent grinding rings, regulable means at the outer side of said lower row of elements for controlling the discharge of material from said lower row of elements, and regulable means at the inner side of said upper row of elements for controlling the passage of material from said upper row to said lower row of elements.

17. A pulverizer comprising a casing enclosing a lower rotary grinding ring, a circular row of rolling grinding elements supported on said lower grinding ring, a non-rotary upper grinding ring supported on said grinding elements, said lower grinding ring having a material discharge edge at the outer side of said grinding elements, means for rotating said lower grinding ring, means for delivering material to be pulverized to the inner side of said row of grinding elements, and means for directing a stream of air upwardly past the outer side of said lower grinding ring to sweep up pulverized material discharging therefrom including means cooperating with the outer periphery of said lower grinding ring to define therebetween a restricted throat passage below the level of the discharge edge of said lower grinding ring.

18. A pulverizer comprising a casing enclosing a lower grinding ring, a circular row of rolling grinding elements supported on said lower grinding ring, an upper grinding ring supported on said grinding elements, said lower grinding ring having a material discharge edge at a level below the centers of said grinding elements, drive means arranged to effect relative rotation between said grinding rings, means for delivering material to be pulverized to the inner side of said row of grinding elements, and means for directing an annular stream of air upwardly past the outer side of said lower grinding ring to sweep up pulverized material discharging therefrom including means cooperating with the outer periphery of said lower grinding ring to define therebetween an annular passage having a restricted throat below the level of the discharge edge of said lower grinding ring.

19. A pulverizer comprising a casing enclosing a lower rotary grinding ring, a vertical drive shaft arranged axially of and operatively connected to said lower grinding ring, a circular row of rolling grinding elements supported on said lower grinding ring, a non-rotary upper grinding ring supported on said grinding elements, said lower grinding ring having a material discharge edge at a level below the centers of said grinding elements, means for delivering material to be pulverized to the inner side of

said row of grinding elements, and means for directing an annular stream of air upwardly past the outer side of said lower grinding ring to sweep up pulverized material discharging therefrom including an annular plate shaped relative to and cooperating with the outer pe-

riphery of said lower grinding ring to define therebetween an annular passage having a restricted throat below the level of the discharge edge of said lower grinding ring.

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