Nov. 10, 1925. 1,561,235

J. M. HOPWOOD

METHOD OF AND APPARATUS FOR PULVERIZING MATERIAL

Filed Aug. 27, 1923 5 Sheets-Sheet 1

FIG. 1.

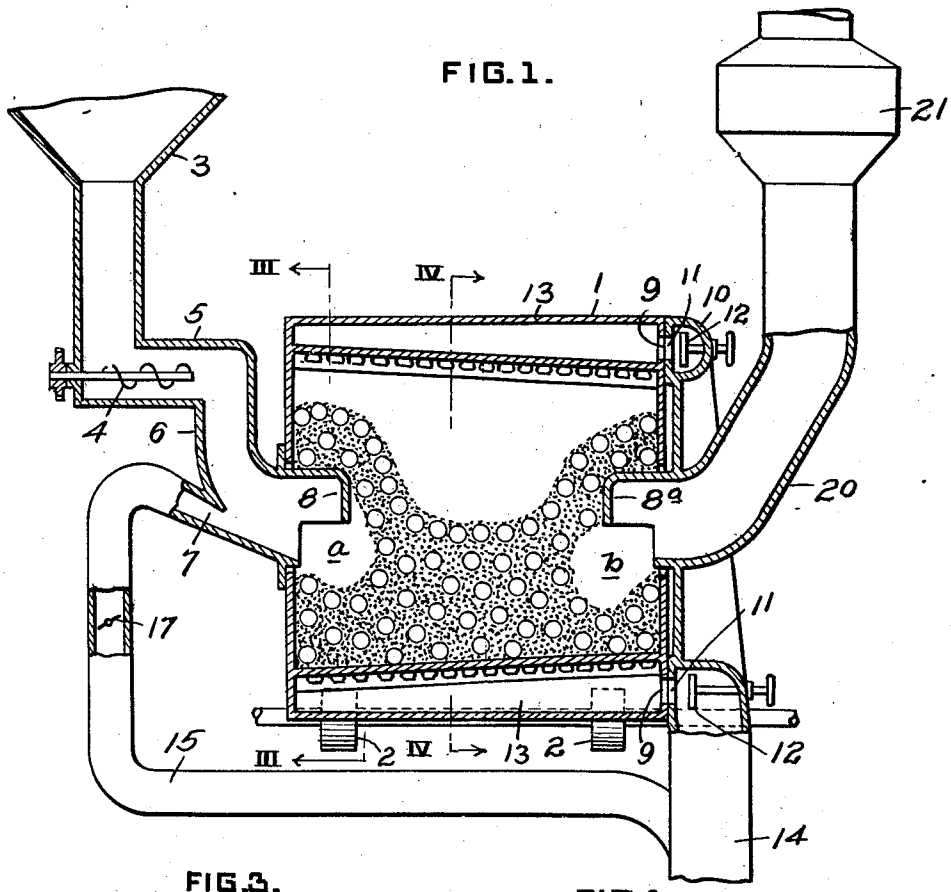


FIG. 3.

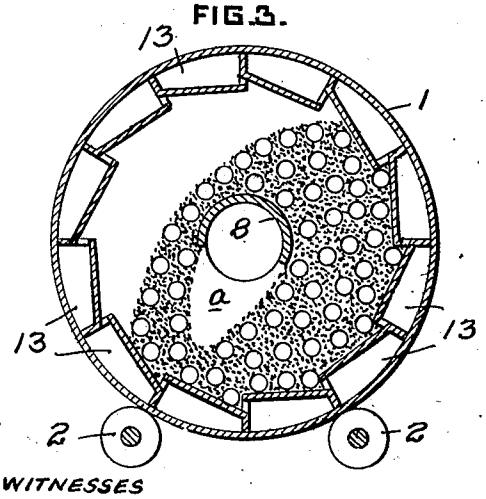
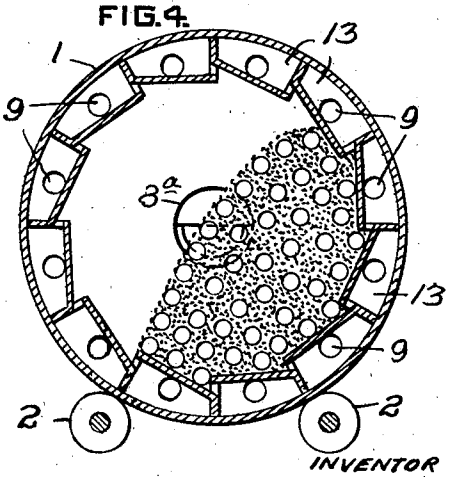


FIG. 4.



WITNESSES

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METHOD OF AND APPARATUS FOR PULVERIZING MATERIAL

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FIG. 2.

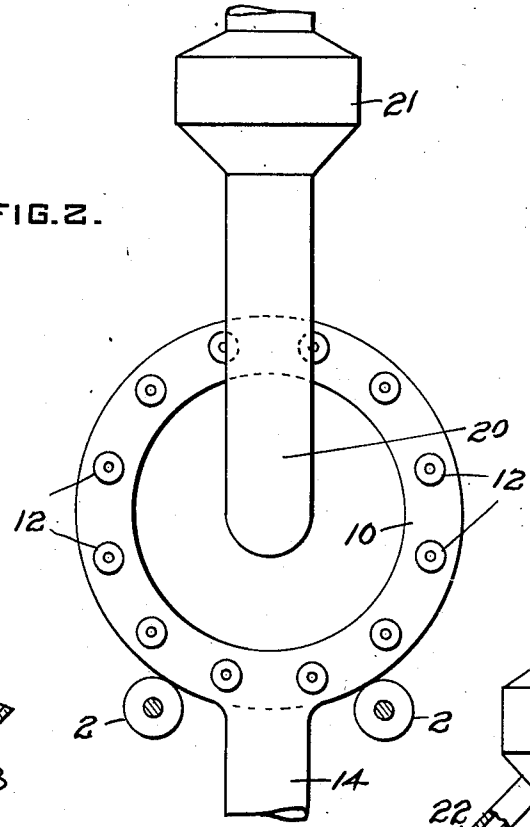
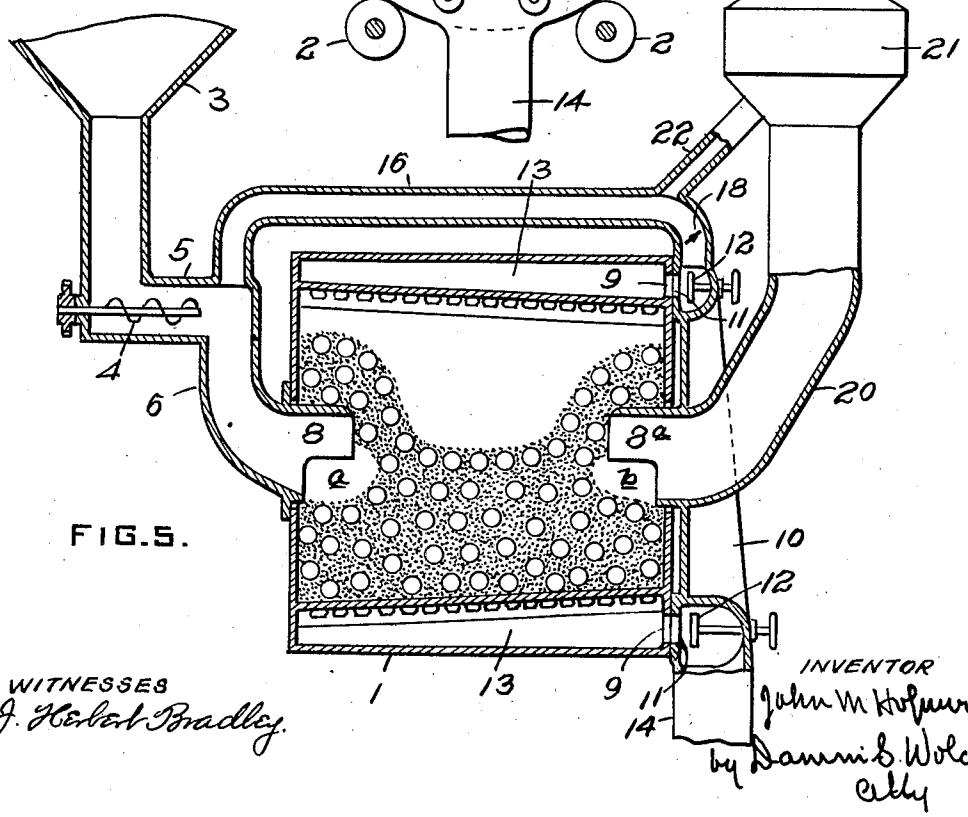


FIG. 5.



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FIG.6.

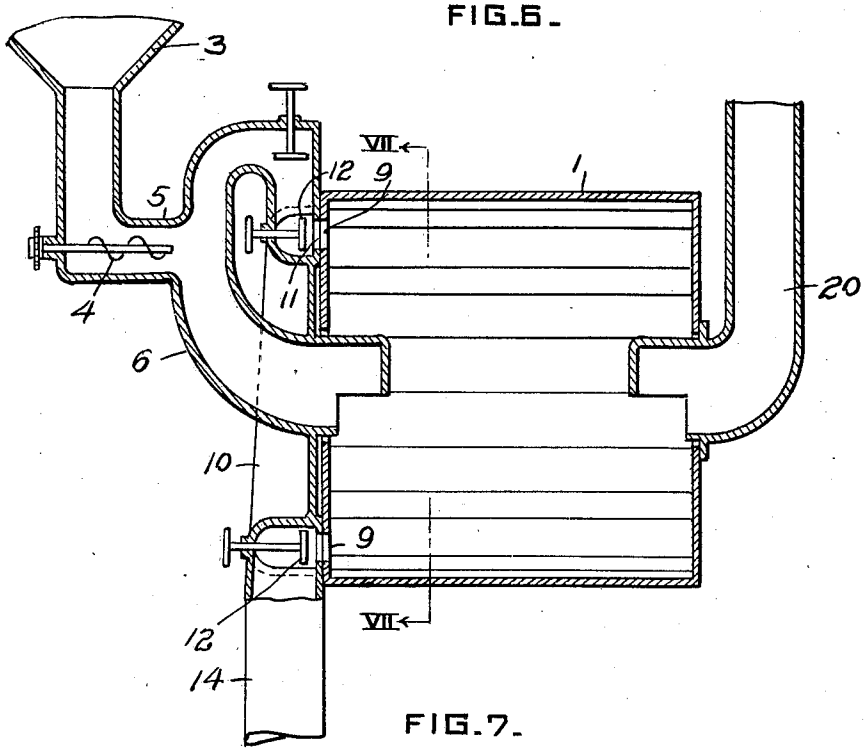
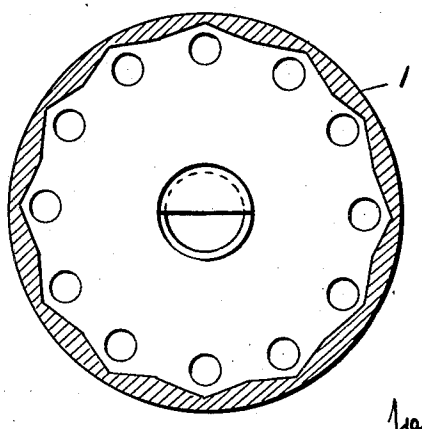


FIG.7.



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METHOD OF AND APPARATUS FOR PULVERIZING MATERIAL

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FIG. 8.

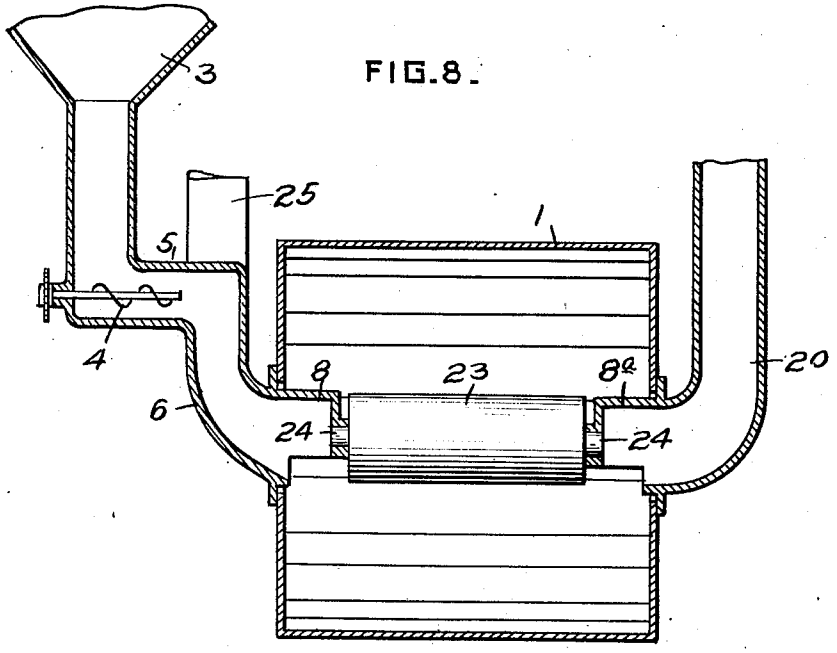
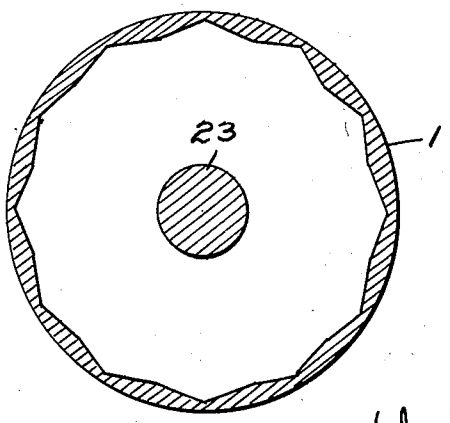


FIG. 9.



WITNESSES

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METHOD OF AND APPARATUS FOR PULVERIZING MATERIAL

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FIG.10.

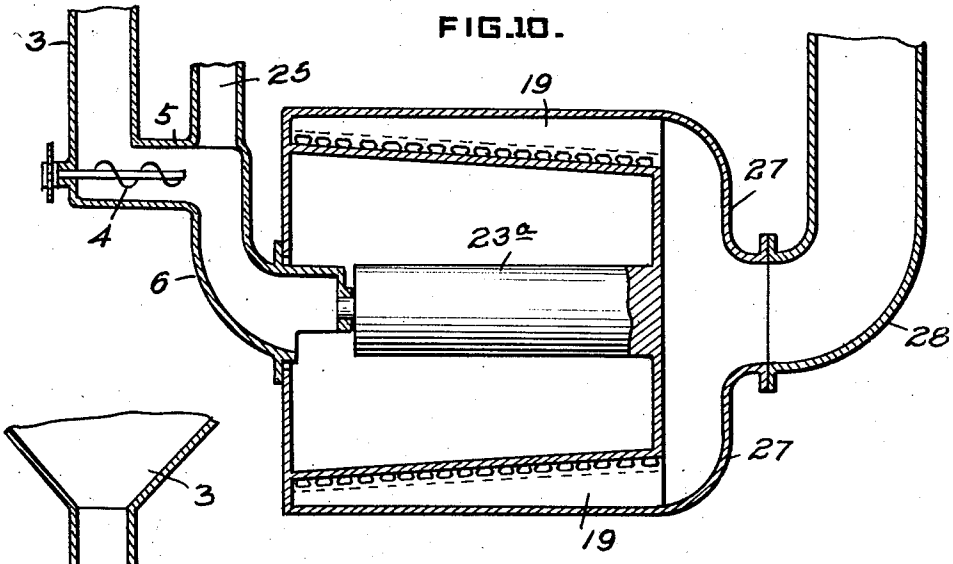


FIG.11.

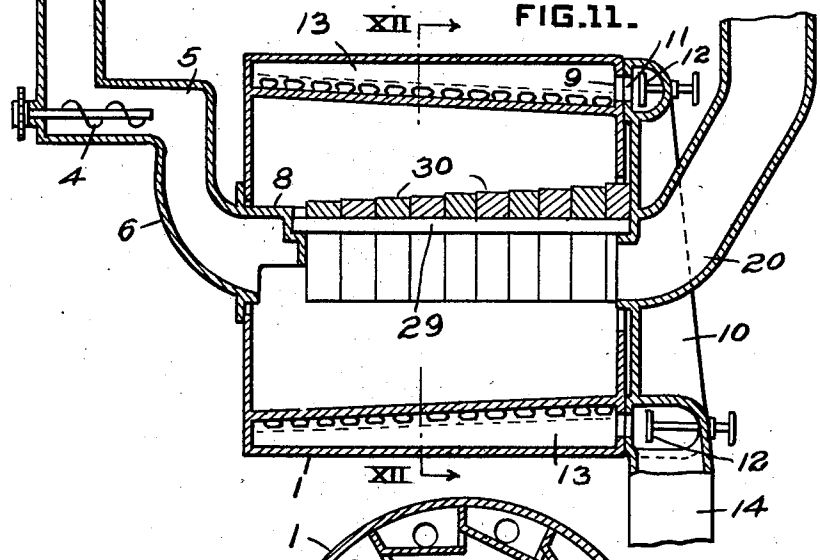
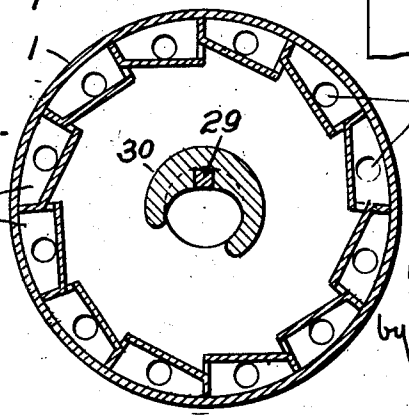


FIG.12.



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Patented Nov. 10, 1925. 1,561,235

UNITED STATES PATENT OFFICE.

JOHN M. HOPWOOD, OF DORMONT, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE BONNOT COMPANY, OF CANTON, OHIO, A CORPORATION OF OHIO.

METHOD OF AND APPARATUS FOR PULVERIZING MATERIAL.

Application filed August 27, 1923. Serial No. 659,537.

To all whom it may concern:

Be it known that I, JOHN M. HOPWOOD, residing at Dormont, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in Methods of and Apparatus for Pulverizing Material, of which improvements the following is specification.

In Letters Patent No. 1,427,234, granted August 29, 1912, to D. V. Sherban, is disclosed a method of pulverizing material and a mechanism especially adapted for the practice of such method, whereby reduction by impact and attrition or abrasion may be efficiently attained at the same time, together with improved distribution of the material and currents of air through the charge.

The invention described herein has for its object the formation at one or both ends of the charge being operated of a pocket or cavity in such relation to the hollow trunnions of the drum that the pocket at one end will serve as a distributing chamber and the packet at the other end as a chamber for collecting the reduced material. It is a further object of the invention to provide for a continuous chamber from end to end of the charge, thereby ensuring a more complete and uniform dissemination of the material throughout the charge. The invention is hereinafter more fully described and claimed.

In the accompanying drawings forming a part of this specification Fig. 1 is a sectional elevation of a pulverizing mill of the ball and drum type, embodying the improvements claimed herein; Fig. 2 is an elevation of the same; Figs. 3 and 4 are sectional views on planes indicated by the line III—III and IV—IV, Fig. 1; Figs. 5, 6, 8, 10, and 11 are views similar to Fig. 1 illustrating respectively certain modifications of the construction shown in Fig. 1; Figs. 7, 9 and 12 are transverse sections on planes indicated respectively by the lines VII—VII, Fig. 6, IX—IX, Fig. 8, and XII—XII, Fig. 11.

In the construction shown herein, the drum 1 is rotatably supported in any suitable manner known in the art as for example by driven rollers 2. The ends of the drum are provided with axial openings for feeding the material into and the removal of reduced material from the drum. The material is delivered by the hopper 3 to the feed screw 4 in a horizontal tubular section 5, connected at its inner end to an elbow 6, the opposite end of the elbow projecting through the end of the drum. The screw 4 regulates the quantity of material delivered to the upper end of the elbow. When dropping through the vertical portion of the elbow, the material enters the line of flow of air, entering the drum through the elbow to ensure a distribution of the material through the charge. This feed air may be introduced through a passage 7 at the lower side of the elbow, as shown in Fig. 1, or may be introduced at the upper end of the elbow, as shown in Fig. 5. A stationary hood 8 preferably semicircular in cross section is so arranged above the opening through which the material is fed, said hood extending into a drum a distance dependent on the horizontal depth desired, in the cavity or pocket formed by the cascading of the charge onto and down on opposite sides of the hood. In operating a mill embodying the improvements claimed herein the drum is rotated at such a speed that gravity will overcome centrifugal force, at such a point above the level of the hood that the forward portion of the upwardly moving part of the charge will drop onto the hood and be divided into two streams. One stream will be diverted to the right of the hood, as in Fig. 3, and into frictional contact with the balls and material in the upwardly moving part of the charge. The other stream will be diverted to the left of the hood as shown in Fig. 3 and the balls and material of this stream will have a free drop onto a portion of charge on the bottom of the drum. While some small percentage of the stream passing to the right of the hood may pass below the hood, the large proportion will be given a cyclonic movement in area X, and in this area or zone the greatest attrition will be effected. The division of the material moving down by gravity into two streams passing respectively on opposite sides of the hood results in the formation of a cavity or pocket *a*, below the hood and communicating freely with the opening through which the material enters the drum. It will be readily understood that by the employment of currents of air entering with the material, the

latter will be distributed along the sides and bottom of the pocket and be carried by the portion of the charge to the right in Fig. 3 into the cyclonic field or zone where attrition is most effective, while some of the material fed into the pocket will be carried down by the stream to the left in Fig. 3 or into the field where impact is most efficient.

While the air entering through the axial opening will in addition to effecting a distribution of material into the charge, also effect a scavenging, i. e., a removal of reduced material from the charge, the air introduced through the axial opening is not sufficient to effect a thorough scavenging, hence provision is made for the introduction of additional air for scavenging.

In the construction shown in Figs. 1, 2 and 5, the air for scavenging or segregating the fine from the coarse material of the charge enters the drum adjacent to the periphery of the drum, then flows inwardly into the charge and passes from the drum laden with dust through an opening in the head opposite that where the material is fed into the drum. In the construction shown in Fig. 1 and Fig. 5, a plurality of ports or openings 9 are formed in the head of the drum through which air is fed into the drum. An annular chamber 10 is arranged to form a tight joint with the outer surface of the head of the drum but permitting the rotation of the drum whereby the ports 9 in the drum are brought into register with ports 11 through the inner wall of the annular chamber. Suitable valves 12 are provided for regulating the flow of air from the annular chamber into the drum to insure any desired distribution of the scavenging air through the charge. In the construction shown in Figs. 1 and 5 the ports 9 are in alinement with passages 13 extending longitudinally of the drum and the inner walls of said passages are perforated for the flow of air into the drum. In the construction shown in Fig. 6, the air from the annular chamber flows directly into the drum preferably in a direction substantially parallel with the axis of the drum. The annular chamber, which may be arranged at either end of the drum as will be seen by reference to Figs. 1 and 6, is connected by a pipe 14 to a suitable source of air under pressure, and the air employed in feeding the material into the drum may be supplied from the same source by means of a pipe 15 connected to the passage 7 of the elbow 6, as shown in Fig. 1 or by a pipe 16 extending from the annular chamber to the vertical portion of the elbow as shown in Fig. 5. The flow of air through the pipes 15 or 16 is controlled by dampers 17 and 18 respectively.

The flow of dust laden air from the drum may be either through an axial opening as shown in Figs. 1, 5, 6, 8 and 11, or through perforations into passages 19 extending longitudinally of the drum as shown in Fig. 10. When the discharge of dust laden air is through an axial opening, it is preferred to so control the movement of the charge at the discharge end of the drum as to form a pocket or cavity *b*. This pocket or cavity is formed in the same manner as the pocket or cavity *a* by arranging a semicircular hood 8^a above the opening through which the dust laden air passes from the drum. In the construction shown herein the dust laden air passes through the elbow 20 to a point of use or a storage of the reduced material. It is preferred that the dust laden air should be passed through a separator 21 wherein the particles which have been sufficiently reduced are separated from the coarser particles, and the latter returned to the feed end of the drum by a pipe 22 as shown in Fig. 5. It will be observed that the pocket or cavity *b* is so located that all the air entering the drum will enter said pocket before escaping through the axial opening and by its movement the air will tend to cause a movement of particles from all portions of the charge to the pocket and as the pocket is comparatively large, the rate of flow of air therethrough will be reduced sufficiently to permit the coarser particles to settle down and be subjected to further reduction.

It is believed that material follows two paths, one from the cyclonic zone where attrition is most effective, the fine material being carried down by the balls adjacent to the right side of the hood or hoods and being released from such balls as they roll or slide down the surface of the ascending portion of the charge. By reason of the forward impetus which the coarser particles will have when gravity causes an inward movement of the charge, a large proportion of the coarse particles will pass over the hoods with the balls and fall on the underlying charge and will be broken down by the impact of the falling balls. The material which has been reduced by impact will be carried into such proximity to the pockets that air flowing through such pockets will pick up such material and carry it onward either into the charge or out of the pocket *b* through the axial discharge opening.

As will be understood by those skilled in the art, more or less fine material will escape from the falling mass of balls and material into the unoccupied portion of the drum, and thus dust will be carried towards the cavity *b* by the air, but before entering this cavity the dust laden air will be screened in passing through the balls and charge falling to the left of the hood 8^a.

It will be readily understood by those skilled in the art that the air flowing from the pockets *a* will be divided up into a multiplicity of small streams penetrating the charge. These streams will leave the pocket in different directions but the general trend will be towards the pocket *b*. By reason of this division there will be a certain acceleration in the rate of flow of the air which rate will however drop as the small streams enter the pocket *b* from which the air will escape at the same rate as its flow into pocket *a*. This drop of rate in the pocket *b* will have a segregating action on the material carried by the air as opportunity is afforded for the coarser particles to settle down in pocket *b*.

In the construction shown in Fig. 1 the hood is provided with a vertical end wall which will deflect the material towards the bottom of the pocket *a*. In some cases, however, this end wall may be omitted as shown in Fig. 5, so that the material, especially the finer particles, will be fed by the current of air against the portion of the charge moving downwardly across the end of the hood.

In some cases it will be desirable to provide a cavity or pocket extending entirely through the charge. In such case a barrier 23 may be arranged intermediate the hoods as shown in Fig. 8. In such construction the barrier is cylindrical in cross section and is provided at its ends with trunnions 24 projecting into the end walls of the hoods. In the construction shown in Fig. 10 a hood is provided only at the feed end, and a barrier 23ª extends from the hood to the opposite head of the drum, to which one end of the barrier is secured in any desirable manner, while the opposite end of the barrier is supported by the hood 8. When employing the construction shown in Fig. 10 all the air, i. e., for material-feeding purposes and for scavenging purposes is introduced into the drum through the elbow 6 by a pipe 25. The air carrying the dust escapes from the drum through perforations into passages 19 which discharge at one end into a chamber formed by a cap 27 on the end of the drum, said chamber communicating with a separator, a furnace or storage chamber through the pipe 28.

In Figs. 11 and 12 is shown a desirable construction when it is desired to form a pocket or cavity extending entirely through the charge and to introduce the material and air for feeding material into one end of such cavity, and to discharge the dust laden air from the other end of such cavity. The material to be reduced and the air for blowing such material into the drum are introduced as shown in Fig. 1 and the scavenging air is also introduced peripherally as in Fig. 1. The portion of the pocket or cavity adjacent to the feed end is formed by a hood 8 as hereinbefore described, and a barrier extends from the hood to the opposite end of the drum. This barrier consists of a bar 29 having one end supported by the hood 8 and its opposite end by the elbow 20, and a plurality of inverted U-shaped sections 30 supported by the bar 29.

It will be observed that in the construction shown in Figs. 8, 10, and 11, that a stationary barrier or deflecting member extends from end to end of the drum and is so located that there may be an uninterrupted flow of material into the feed end of the cavity, formed by the barrier.

I claim herein as my invention:

1. A pulverizing mill of the drum and ball type having an axial opening in one head, a hood arranged above said opening and projecting into the drum, means for delivering material to be reduced and air commingled into the drum through such opening and below and into the hood, whereby the air may be utilized for moving material to be reduced into the drum.

2. A pulverizing mill of the drum and ball type having axial openings in its heads, in combination with hoods arranged above said openings and projecting into the drum and means for delivering material to be reduced and air commingled into the drum through the opening in one end of the drum and below and into the hood at such end.

3. A pulverizing mill of the drum and ball type having axial openings in its heads, in combination with hoods arranged above said openings and projecting into the drum, means for delivering material to be reduced and air commingled into the drum through the opening in one end of the drum and below and into the hood at such end, and means for causing the flow of air into the drum and under the exit hood and out through the axial opening in the other head.

4. A pulverizing mill of the drum and ball type having an opening in one head in combination with a stationary inverted U-shaped barrier extending from one end to the other of the drum and means for delivering material to be reduced and air commingled into the drum below the barrier.

5. A pulverizing mill of the drum and ball type having an opening in one head in combination with a stationary barrier arranged above said axial opening and extending from end to end of the drum and means for delivering material to be reduced and air commingled into the drum through such opening and below the barrier, whereby the air may be utilized for moving material to be reduced into the drum.

6. A pulverizing mill of the drum and ball type having axial openings in its heads for the introduction of material to be reduced and the removal of reduced material, one

of said heads being provided with a plurality of ports or openings adjacent to the periphery of the drum for the admission of air under pressure, and a plurality of valves controlling the flow of air through the respective ports.

7. A pulverizing mill of the drum and ball type having axial openings in its heads for the introduction and removal of material, one of said heads being provided with a plurality of ports or openings adjacent to the periphery of the drum for the admission of air under pressure, a plurality of valves controlling the flow of air through the respective ports in combination with hoods arranged above said axial openings and projecting into the drum and means for delivering material to be reduced into the drum through the opening in one end of the drum and below the hood at such end.

8. A pulverizing mill of the drum and ball type having axial openings in its heads for the introduction and removal of material, said drum being provided adjacent to its periphery with longitudinal passages having their inner walls perforated, in combination with valved means for admitting air under pressure into the respective passages, hoods arranged above the axial openings in the heads and projecting into the drum and means for introducing air and the material to be reduced through the axial opening in one of the heads.

9. The method herein described of reducing material, which consists in causing such movements of different parts of a mass consisting of material to be reduced and crushing bodies as to form separated pockets or cavities in such mass, directing material to be reduced and air under pressure into one of said pockets and causing currents of air to flow inward through said mass of bodies and material towards and into the other pocket.

In testimony whereof, I have hereunto set my hand.

JOHN M. HOPWOOD.