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D. C. PEACOCK
GRINDING MILL AND METHOD

3,204,878

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2 Sheets-Sheet 1

Fig. 2

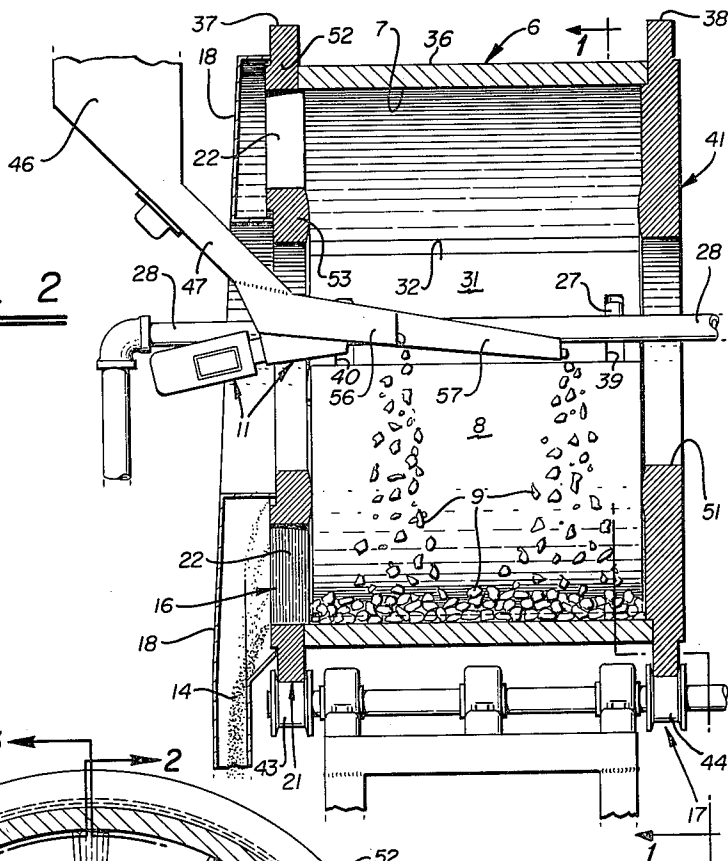
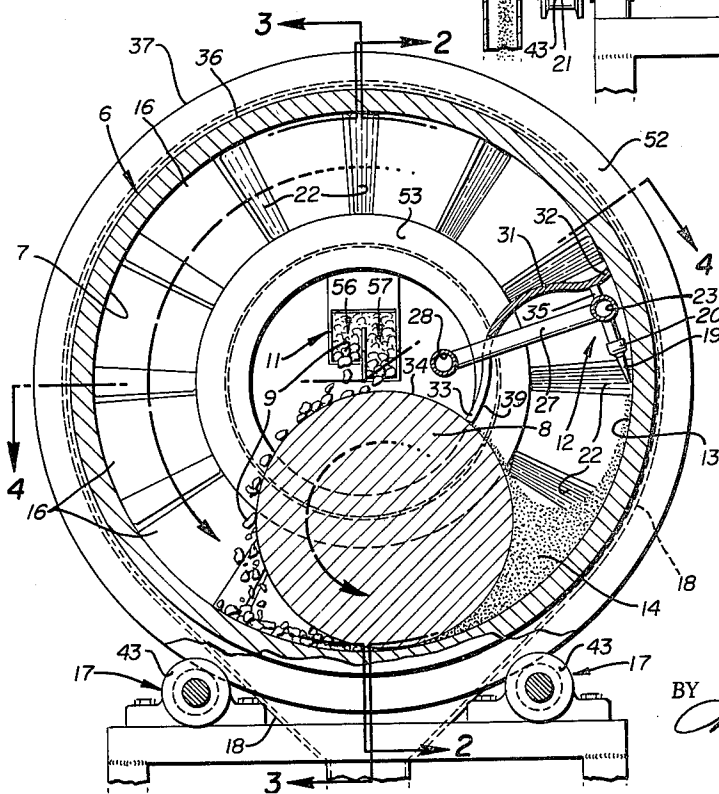


Fig. 1



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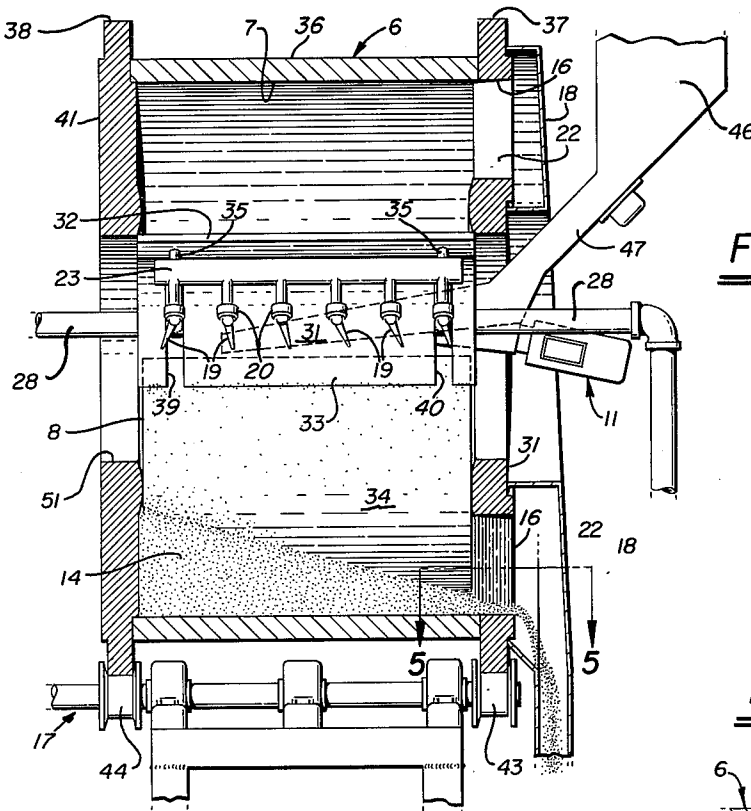


Fig. 3

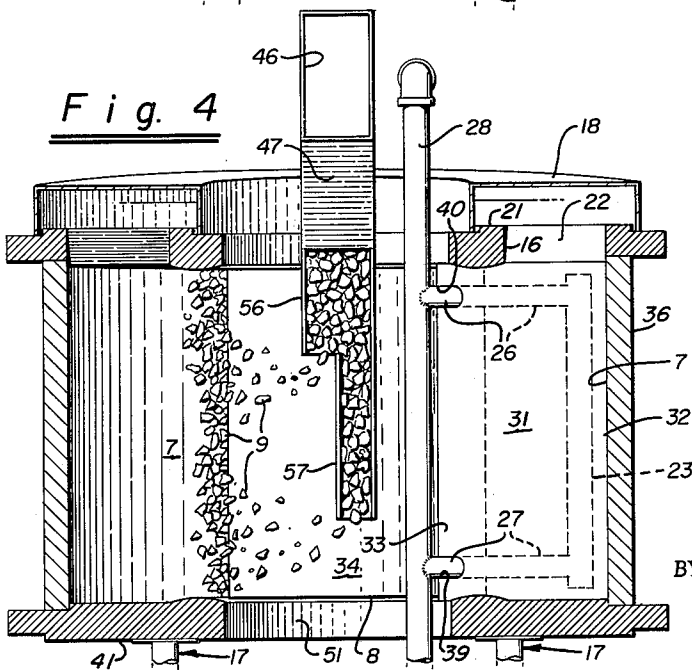


Fig. 4

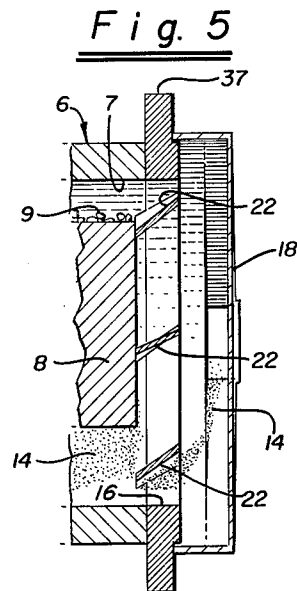


Fig. 5

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GRINDING MILL AND METHOD

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9 Claims. (Cl. 241-15)

The present invention relates to drum and roller type grinding mills.

An object of the present invention is to provide a grinding mill which is particularly designed for the production of a very high output of coarsely ground material with a minimum of fines and slimes; the mill functioning at high efficiency and with relatively low power requirements.

Another object of the present invention is to provide a grinding mill of the character described which is composed of a minimum number of sturdily built parts capable of continuous operation over a long period of use with minimum repair or replacement of parts and with a minimum required shutdown time for such repair or replacement.

The invention possesses other objects and features of advantage, some of which of the foregoing will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of this specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

Referring to said drawings: (3 sheets):

FIGURE 1 is a cross-sectional view of a grinding mill constructed in accordance with the present invention and is taken substantially on the plane of line 1-1 of FIGURE 2.

FIGURE 2 is a cross-section of the mill shown in FIGURE 1 taken substantially on the plane of line 2-2 of FIGURE 1.

FIGURE 3 is a cross-section of the mill as taken substantially on the plane of line 3-3 shown in FIGURE 1.

FIGURE 4 is a cross-section of the mill as taken substantially on the plane of line 4-4 in FIGURE 1.

FIGURE 5 is an enlarged partial cross-section of the mill as taken substantially on the plane of line 5-5 shown in FIGURE 3.

The mill of the present invention is designed to operate at speeds more than double those of standard rod and ball mills and at least twenty-five percent more than that of similar roller mills. The greater peripheral speed of the drum increases the amount of ore crushed in a direct proportion, but only if the crushed material is promptly removed from the mill. Permitting the roller to pass over the material only once prevents over crushing and the formation of undesirable fines and slimes.

To accomplish the foregoing, Applicant has devised a grinding mill which consists briefly of a drum 6 mounted for rotation and providing an internal grinding surface 7; a crushing roller 8 mounted in drum 6 for crushing material 9 received between roller 8 and surface 7; feed means 11 for delivering into drum 6 material 9 to be crushed; means 12 providing and directing a pressurized fluid stream against a portion 13 of surface 7 at the down-stream side of roller 8 for stripping crushed material 14 from surface portion 13; drum 6 having an opening 16 for the discharge of crushed material 14; and means

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17 rotating drum 6 at a speed co-related with the rate of flow of the material feed and fluid stream for substantially completely stripping material 14 from surface portion 13 to prevent recycling of crushed material 14.

5 Roller 8 is preferably a single heavy roller, slightly shorter than the mill drum 6, with an outside diameter of about half the diameter of the drum 6. Roller 8 preferably is free rolling; being driven by the rotation of the mill drum 6.

10 Material 9 entering the mill falls to the bottom in front of roller 8 where it is crushed between the inner surface 7 of drum 6 and the crushing roller 8. The crushed material 14 emerges from the down-stream side of the roller 8 and is met by streams of water or compressed air from means 12 and is washed or blown towards the discharge opening 16 and into a stationary hood 18 where it drops to a screen (not shown) which removes the oversized particles and returns them to the mill. Crushed material 14 is thereby limited to a single pass under roller 8.

20 In accordance with the present construction and to insure a complete longitudinal stripping of the ground material from the drum surface 7 over its full longitudinal length corresponding with the grinding area under roller 8, means 12 here consists of a plurality of longitudinally spaced nozzles 19 which are disposed for directing a plurality of pressurized fluid streams against the interior of the drum for stripping the material and also preferably longitudinally of the drum for driving the stripped ground material out opening 16. It will also be noted from FIGURE 1 that nozzles 19 are directed downwardly onto surface 7 at a height corresponding with the mid point or center plane of the drum. At this point gravitational forces cooperate better with the jet streams to strip the material than, as for example, a lower disposition of the nozzles.

35 As here shown nozzles 19 are connected by swivel connections 20 to a manifold 23 mounted interiorly of the drum, and extending longitudinally thereof and which is in turn connected to and supported by supply conduits 26, 27, and 28 adapted for connection to an appropriate source of pressurized fluid; water or air. Adjustment of nozzle direction is desirable for accommodating different drum speeds and materials.

40 Cooperating significantly with the other parts of the mill in confining the material movement through the mill to a single pass under the roller and out of the discharge opening, and made possible in part by reason of the relatively high rotational speeds contemplated, drum head 21 is here provided with a plurality of circumferentially spaced, radial impeller blades which define therebetween a plurality of discharge openings, heretofore identified as 16, and which aid in driving the crushed material out of the drum. As will be noted from FIGURES 1, 2 and 4 and 5, blades 22 extend radially in the back head 21 and are provided with a pitch as best seen in FIGURE 5 for driving crushed material longitudinally out of the drum.

Crushed material 14 is discharged from between roller 8 and crushing surface 7 at high speed and in a virtual maelstrom at the down-stream side. In order to prevent crushed material 14 from ricocheting off portion 13 of surface 7 and passing overhead to the feed side of the roller, a baffle member 31 is preferably mounted internally of drum 6 with one edge 32 positioned in close proximity to grinding surface 7 and with an opposite edge 33

positioned in close proximity to the periphery 34 of roller 8 when the latter assumes, as it will, a circumferentially displaced position from the bottom of the drum during operation of the mill, see FIGURE 1.

Baffle member 31 is here mounted on the top side of manifold 23 and nozzles 19 so as to provide a compartment, see FIGURE 1, for confining the circumferential movement of crushed material 14. Baffle 31 may be constructed of any suitable material such as steel to withstand the impact of crushed material 14 and is preferably formed with soft rubber ends 32 and 33 to provide a wiping or squeeze action against the roller 8 and the drum surface 7. As here shown baffle 31 may be formed with openings positioned for engagement with pins 35 on the top side of manifold 23 and may be formed with edge slots 39 and 40 disposed for straddling supply pipes 26 and 27 thereby permitting limited vertical displacement of the baffle to accommodate circumferential displacement of roller 8.

The mill is simply constructed of steel plate 36 forming the cylindrical drum 6 carried on trunnion rails 37 and 38 which are attached to front and back heads 41 and 21 respectively, and operate on trunnion wheels 43 and 44. The trunnion wheels are driven by a motor with a speed reduction to give the drum 6 the desired rotation.

Feed means 11 may be any commercial type which will deliver the feed material 9 uniformly along the crushing roller 8 such as the vibratory feeders manufactured by Syntron Company and as here shown the feeder may have chutes 56 and 57. The feeder may be of cantilever type of construction, supported outside of the mill with no supports in the mill. Where the mill is long and supports for the feeder inside the mill are necessary they can be made by extending arms from the pipe 28. The material for feed means 11 may be stored in a hopper 46 and fed by gravity through chute 47.

The front head 41 may be formed with an opening 51 for the purpose of observing the action in the mill and adjusting the nozzles 19. It may also serve as a manhole for entering the mill when necessary.

The back or discharge head 21 may be composed of an outside steel ring 52 which is bolted to the drum 6, and an inner steel ring 53 that serves as a bumper to stop the end play of the crushing roller 8. The crushed material 14 is discharged through the openings 16 between rings 52 and 53 into hood 18.

In operation, the present mill is most suitable for rock or ore that has been prepared by crushing to a suitable size for milling, which for a moderate-sized mill is feed that will pass through a three-quarter inch or one inch screen. The present mill will produce an optimum output in the 4-20 mesh size with a minimum of fines and slimes. The feed 9 ricochets between the surface of the roller 8 and the crushing surface 7 until it passes under the roller 8. The crushed material 14 emerges from the downstream side of roller 8 with great speed into a pool of material which will gravitate through the back head into the discharge hood 18. Feed which adheres to the drum side due to the centrifugal force is met by high pressure water or compressed air from nozzles 19 and is washed or blown through the back head 21 into the discharge hood 18. The crushed material 14 may be dropped down to a screen which separates the oversize from the finished product and the oversize product returned to the feed hopper 46.

The co-functioning of the parts of the mill as above-described enables a running of the mill at relatively high speeds and a single pass high output of a high percentage of ground material in the desired grind range. By way of example it is believed feasible to operate mills of say about 5 foot diameter at peripheral speeds ranging up to about 1,000 feet per minute corresponding with rotational speeds of about 60 r.p.m. This is several times faster than conventional rod and ball mills and considerably faster than any known type of roller mill. The above speed would be above critical speed for this size mill.

Critical speed by way of definition means a speed at or above which material will be held against the peripheral surface of the drum by centrifugal force.

As will also be understood, the free rolling action of roller 8 and the generally balanced concentric movement of the drum and material being ground permits the aforementioned high speed operation with only a small part of the power required to operate conventional rod and ball mills. Finally, since there is nearly always a layer of feed and crushed material between the roller and internal wall of the drum there is little metal to metal contact between these parts and a minimum of wear.

The use of air or water in the jet material stripping streams is optional depending upon the type of material being ground and the purpose for which it is milled. For example, air would be used in the grinding of the material for making cement where the material must be processed dry. On the other hand, water may be used for the grinding of ores which are generally processed wet.

As will also be observed from FIGURES 2 and 3, the discharge openings 16 extend at their radially outer ends to the internal grinding surface 7 of the drum, so that the ground material may flow, as seen in FIGURE 3, horizontally from the grinding surface 7 out through the openings 16. At the same time, it will be seen that the opposite front head member 41 is formed solid and imperforate around the central opening 51 so as to provide a head of ground material urging a hydrostatic flow thereof to the opposite side of the drum and out of the discharge openings 16.

In operation, the free rolling support of the roller 8 on the rotating interior wall of the drum makes it self-adjusting to the load; it adjusts itself forward or back depending on the crushing load; it raises or lowers itself narrowing or widening the distance between the roller and the drum as the crushing requirements change, that is, with more feed it crushes coarser and with less feed finer.

I claim:

1. A grinding mill comprising, a cylindrical drum mounted for rotation about its longitudinal axis substantially horizontally disposed and providing a substantially concentric internal imperforate grinding surface, a crushing roller mounted in said drum for free rolling support on said surface for crushing material received therebetween, feed means for delivering material into said drum for carrying thereby under said roller for crushing, one end of said drum having an opening for discharging crushed material therefrom, means providing and directing a pressurized fluid stream against said surface at the downstream side of said roller for stripping crushed material from said surface and being directed to displace said material toward said discharge opening, and means rotating said drum above critical speed and at a speed co-related with the rate of flow of the material feed and said fluid stream for substantially completely stripping said material from said surface portion to prevent carry-over and recycling of crushed material in said drum and thereby confining the material movement through said mill to a single pass under said roller and out of said discharge opening.

2. A grinding mill comprising, a cylindrical drum mounted for rotation about its longitudinal axis substantially horizontally disposed and providing a substantially concentric internal imperforate grinding surface, a crushing roller mounted in said drum for free rolling support on said surface for crushing material received therebetween, feed means for delivering material into said drum for carrying thereby under said roller for crushing, one end of said drum having an opening for discharging crushed material therefrom, a plurality of longitudinally spaced nozzles in said drum adapted for connection to a source of fluid under pressure and being disposed for directing pressurized fluid streams against said surface at the downstream side of said roller for stripping crushed material from said surface and being directed to displace said material longitudinally of said drum toward said discharge

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opening, and means rotating said drum above critical speed and at a speed co-related with the rate of flow of the material feed and said fluid stream for substantially completely stripping said material from said surface portion to prevent carry-over and re-cycling of crushed material in said drum and thereby confining the material movement through said mill to a single pass under said roller and out of said discharge opening.

3. A grinding mill comprising, a cylindrical drum mounted for rotation about its longitudinal axis substantially horizontally disposed and providing a substantially concentric internal imperforate grinding surface, a crushing roller mounted in said drum for free rolling support on said surface for crushing material received therebetween, feed means for delivering material into said drum for carrying thereby under said roller for crushing, a head member mounted at one end of said drum for rotation therewith and being formed with a central opening, a plurality of radial impeller blades carried by said head member around said opening and defining material discharge openings therebetween, said blades being formed and functioning on rotation to drive crushed material out of said drum through said openings, means providing and directing a pressurized fluid stream against said surface at the down-stream side of said roller for stripping crushed material from said surface and being directed to displace said material longitudinally of said drum toward said blades, and means rotating said drum above critical speed and at a speed co-related with the rate of flow of the material feed and said fluid stream for substantially completely stripping said material from said surface portion to prevent carry-over and re-cycling of crushed material in said drum and thereby confining the material movement through said mill to a single pass under said roller and out of said discharge opening.

4. A grinding mill comprising, a cylindrical drum mounted for rotation about its longitudinal axis substantially horizontally disposed and providing a substantially concentric internal imperforate grinding surface, a crushing roller mounted in said drum for free rolling support on said surface for crushing material received therebetween, feed means for delivering material into said drum for carrying thereby under said roller for crushing, head members mounted at the opposite ends of said drum for rotation therewith and being formed with aligned center openings, a plurality of radial blades carried by one of said head members around the central opening therein and defining material discharge openings therebetween, said blades being formed and functioning on rotation to drive crushed material out of said drum through said openings, a fluid conduit mounted through said center openings and internally of said drum and extending longitudinally thereof and being adapted for connection to a source of fluid under pressure, and a plurality of nozzles connected to said conduit at longitudinally spaced positions in said drum for directing pressurized fluid streams against said surface at the down-stream side of said roller for stripping crushed material from said surface and being directed to displace said material longitudinally of said drum toward said blades, and means rotating said drum above critical speed and at a speed co-related with the rate of flow of the material feed and said fluid stream for substantially completely stripping said material from said surface portion to prevent carry-over and re-cycling of crushed material in said drum and thereby confining the material movement through said mill to a single pass under said roller and out of said discharge opening.

5. A grinding mill comprising, a cylindrical drum mounted for rotation about its longitudinal axis substantially horizontally disposed and providing a substantially imperforate concentric grinding surface, a crushing roller mounted in said drum for free rolling support on said surface for crushing material received between said roller and surface, feed means for delivering into said drum material to be crushed, means providing and directing a pres-

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surized fluid stream against said surface at the down-stream side of said roller for stripping crushed material from said surface, said drum having an opening for the discharge of crushed material, and means rotating said drum above critical speed and at a speed co-related with the rate of flow of the material material feed and said fluid stream for substantially completely stripping said material from said surface to prevent re-cycling of crushed material, said roller assuming in the aforesaid operation a position circumferentially displaced from the bottom of said drum, and a baffle member mounted internally of said drum and having one edge positioned in close proximity to said grinding surface and an opposite edge positioned in close proximity to the periphery of said roller in its circumferentially displaced position.

6. A grinding mill comprising, a drum having longitudinally spaced head members and a cylindrical side wall providing an internal grinding surface concentric to the longitudinal axis of said drum, means supporting and rotating said drum with its axis horizontal and at above critical speed, said head members being formed with axially aligned center openings, a crushing roller mounted in said drum for free rolling support on said surface for crushing material received therebetween, feed means extending through one of said openings for delivering material into said drum, fluid means extending into said drum through one of said openings and being formed to direct a pressurized fluid stream against said grinding surface at the down stream side of said roller for stripping crushed material from said surface, and a plurality of blades carried by one of said head members in circumferentially spaced relation around the center opening therein and set radially and concentrically to said axis and defining material discharge openings therebetween extending at their radially outer ends to adjacent said grinding surface, said blades having a pitch driving crushed material from said grinding surfaces longitudinally out of said discharge openings, the portion of the opposite head member surrounding its center opening being substantially imperforate to provide a head of ground material urging flow thereof to said discharge openings.

7. A grinding mill comprising, a drum having longitudinally spaced head members and a cylindrical side wall providing an internal grinding surface concentric to the longitudinal axis of said drum, means supporting and rotating said drum with its axis horizontal and at above critical speed, said head members being formed with axially aligned center openings, a crushing roller mounted in said drum for free rolling support on said surface for crushing material received therebetween, feed means extending through one of said openings for delivering material into said drum, fluid means extending into said drum through one of said openings and being formed to direct a pressurized fluid stream against said grinding surface at approximately 90° above the bottom of said drum and at the down stream side of said roller for stripping crushed material from said surface, a plurality of blades carried by one of said head members in circumferentially spaced relation around the center opening therein and set radially and concentrically to said axis and defining material discharge openings therebetween extending at their radially outer ends to adjacent said grinding surface, said blades having a pitch driving crushed material from said grinding surfaces longitudinally out of said discharge openings, the portion of the opposite head member surrounding its center opening being substantially imperforate to provide a head of ground material urging flow thereof to said discharge openings, and a stationary hood mounted exteriorly of said head member carrying said blades and in position to receive ground material discharged through said discharge openings.

8. The method of grinding material which consists in feeding material to be ground into a horizontal rotating drum having a crushing roller mounted with a free

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rolling support therein, said material being fed in position for passing between said roller and drum for crushing, rotating said drum above critical speed, and directing a pressurized fluid stream onto said drum at the downstream side of said roller to strip crushed material therefrom.

9. The method as characterized in claim 8 wherein the directing of said fluid stream is oriented to impinge said crushed material and said drum at approximately 90° above the bottom of said drum.

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