April 9, 1940. C. S. RAMSEY 2,196,642

APPARATUS FOR PULVERIZING MATERIALS

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Fig. 1

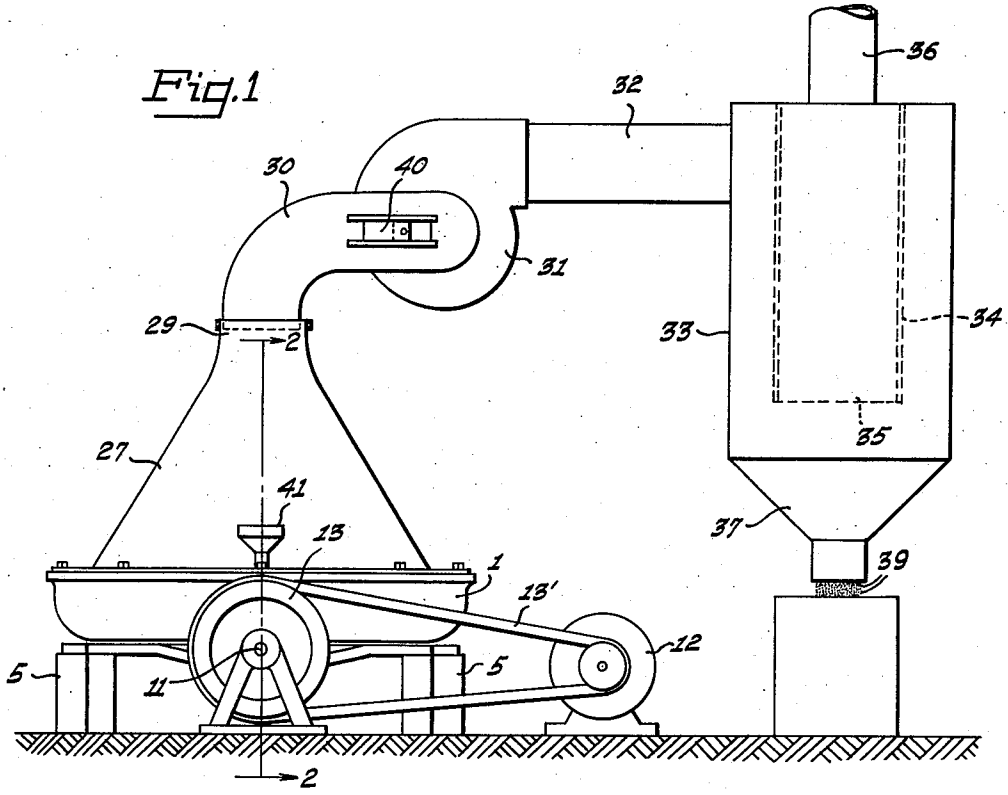


Fig. 6

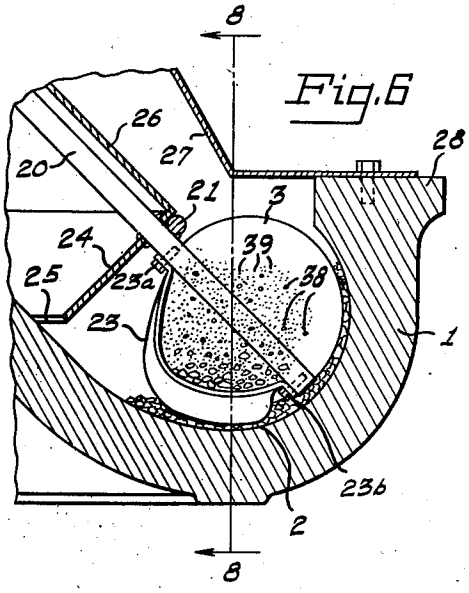
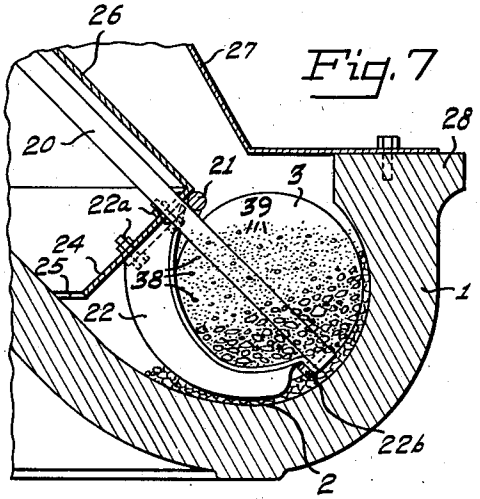


Fig. 7



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APPARATUS FOR PULVERIZING MATERIALS

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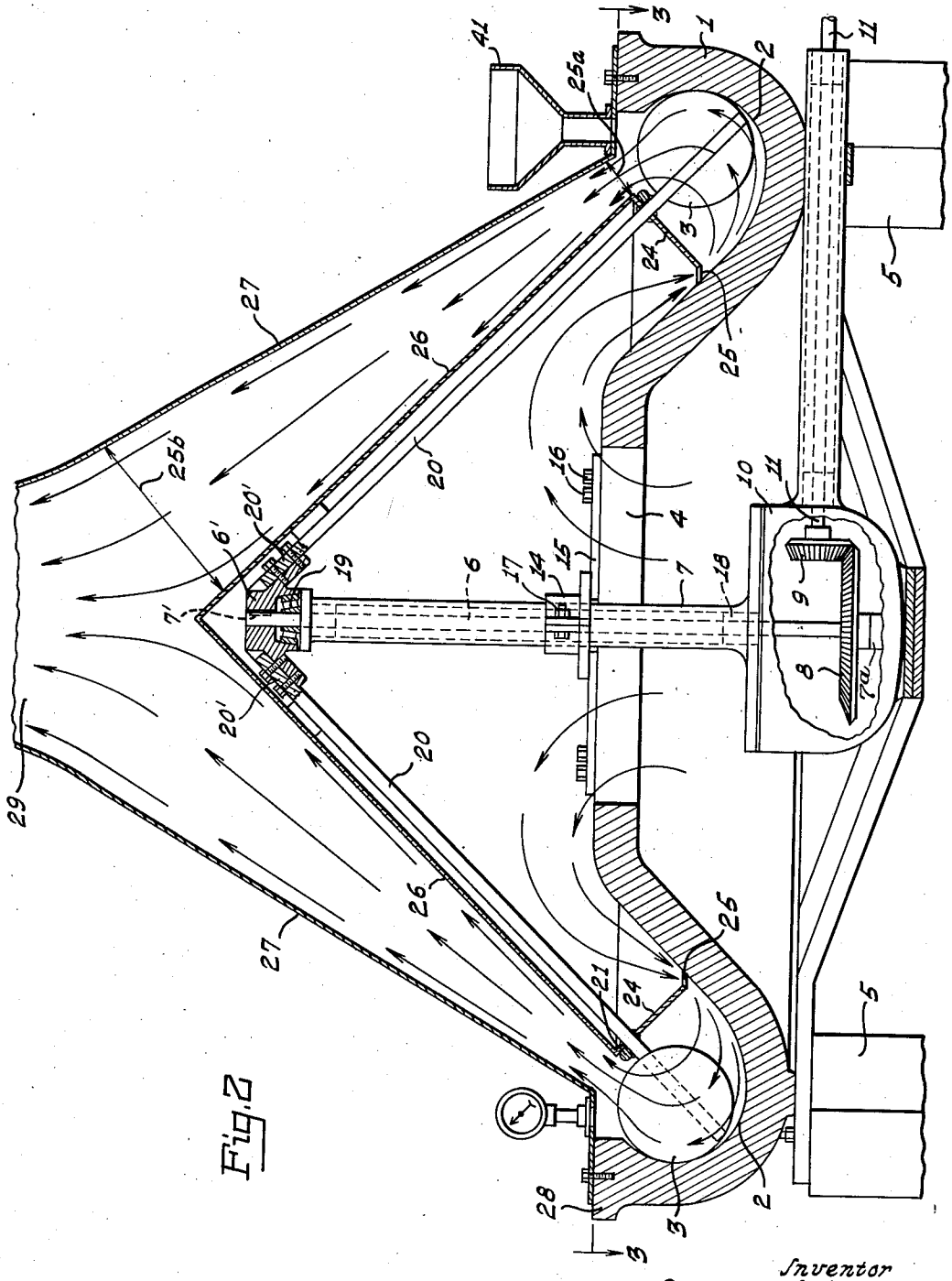


Fig. 2

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APPARATUS FOR PULVERIZING MATERIALS

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Fig. 3

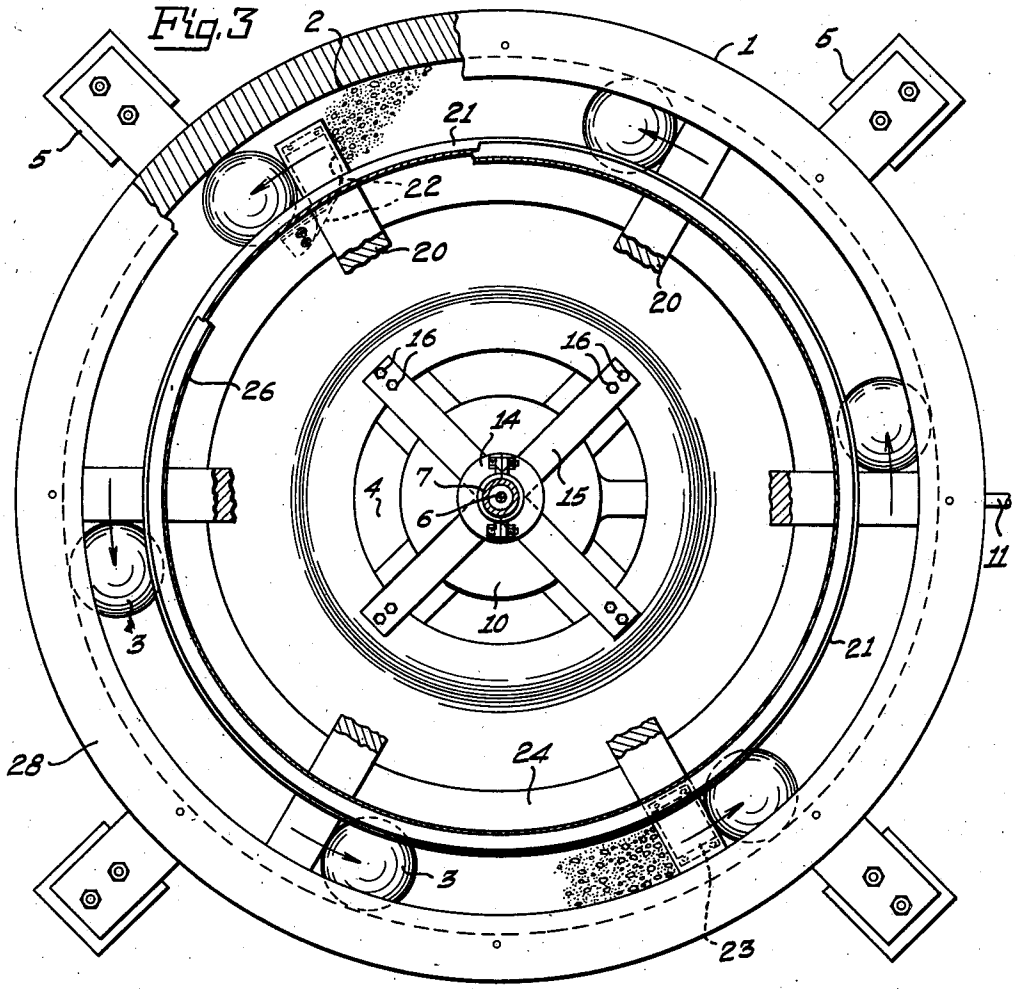
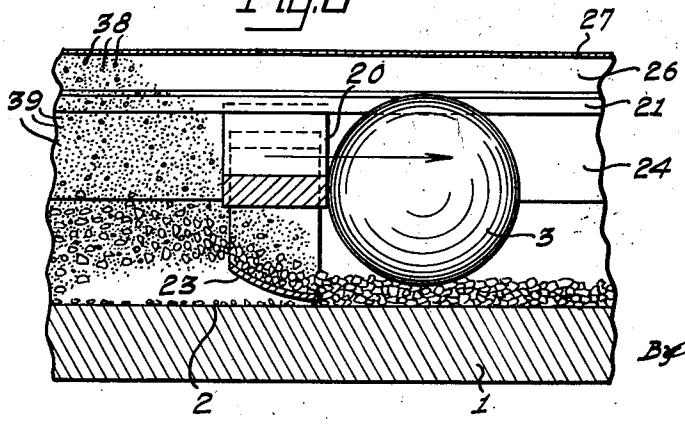


Fig. 8



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APPARATUS FOR PULVERIZING MATERIALS

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Fig. 4

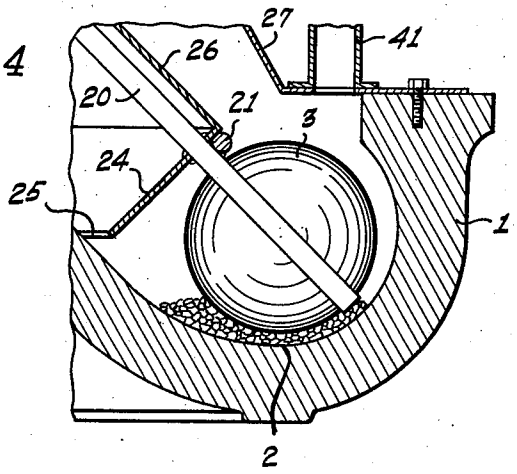


Fig. 5

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UNITED STATES PATENT OFFICE

2,196,642

APPARATUS FOR PULVERIZING MATERIALS

Clarence S. Ramsey, Springfield, Ohio

Application April 12, 1938, Serial No. 201,575

2 Claims. (Cl. 83—45)

This invention relates to the pulverizing and fine grinding of hard materials such as ores, limestone, rock fertilizer, rocks from which cement is made, and similar materials whose particle size has to be reduced. This invention may also be utilized for the pulverizing or grinding of light weight materials such as cereals, farinaceous seeds, paint pigments, cosmetic powders, coal, etc.

It is the particular object of this invention to provide an economical means of grinding or pulverizing materials without the use of water, and classifying the materials pulverized without the aid of screens.

It is a further object of this invention to avoid the use of intricate return circuits and unnecessary regrinding. The material to be pulverized is fed to the mill, crushed to the proper size when necessary, the finely pulverized material formed in the mill being immediately and continuously removed.

It is a further object of this invention to protect all the bearings from the abrasive action of the dust and grit, and to provide a low starting torque and low power requirement for operation. In this manner a highly efficient low cost pulverizing device is provided.

It is a further object of this invention to violently agitate the material in the mill in order that the finely pulverized material may be immediately and instantly removed from the mill, and further to throw the material being pulverized in contact with the grinding balls, to prevent the material from packing in the mill.

It is a further object of this invention to rotate the free grinding balls in the ball race sufficiently rapid to impart centrifugal force to the free balls so that they will rotate on their own axes, thereby increasing their crushing force in addition to their weight, and to further compel the free balls to ride in the outer periphery portion of the ball race. In this manner particles of material being ground are crushed between the ball and the outer wall of the race as the ball rotates.

It is a further object of this invention to rotate the free balls by arms extended from a central shaft in such a manner that the free balls cannot escape from their respective compartments.

It is a further object of this invention to remove the pulverized material, continuously and immediately upon being formed, from the mill by means of air or gases drawn through the device in such a manner that the air or gas sucked in sweeps the ball race and comes into intimate contact with the pulverized material in entraining and removing it.

It is a further object of this invention to make use of a low cost means for operating the pulverizing or grinding device. For instance one-half of the rear axle of an automobile or truck together with the driving shaft may be utilized as a unit to transmit power for rotating the pulverizing device. Thus an oil sealed transmission means is readily made available for running in oil or grease at a greatly reduced cost.

In the accompanying drawings forming a part of this specification:

Figure 1 is a side elevational view of the pulverizing mill showing the arrangement of the attached blower and dust collecting means;

Figure 2 is a cross sectional view taken along the line 2—2 of Figure 1, looking in the direction of the arrows;

Figure 3 is a cross sectional plan view with certain parts broken away, taken along the line 3—3 of Figure 2, and looking in the direction of the arrows;

Figure 4 is a cross sectional detail view of a portion of the ball race showing the position of the grinding ball therein when the mill is stationary;

Figure 5 is a cross sectional view in detail of the ball race and accompanying casing passageway showing the particles being classified therein and the material being pulverized. The pulverizing ball is shown in the position it takes in the race during the pulverizing operation;

Figures 6 and 7 are detail cross sectional views similar to Figure 4, showing the attached agitating and discharger means; and

Figure 8 is a cross sectional detail view of the ball and scraper arrangement shown in Figure 6, taken along the line 8—8, looking in the direction of the arrows.

Referring to the drawings in detail, wherein like character references indicate the same parts in the various views:

The pulverizing or grinding device 1 comprises a bowl or dish shaped casting having a curved ball race runway 2 extending around the rim of the bowl, and provided with grinding balls 3 mounted to rotate in the ball race 2.

The bowl or dish shaped member 1 has a central opening 4 providing an air or gaseous passageway to the inner part of the grinding device. The member 1 is mounted on a suitable support 5. Extending upward through the central opening 4 is a rotatable shaft 6 mounted on the sta-

tionary housing 7 and arranged so as to be rotated by ring and pinion gear means 8 and 9, respectively. The ring and pinion gears are mounted in the housing gear box 10.

Power is supplied to the gears through the shaft 11 attached to the pinion 9, by means of the motor 12, or an equivalent power supplying means. The pinion drive shaft 11 may have a flywheel 13 attached to its outer end which is driven by the motor 12 by means of the belt 13' as illustrated in Figure 1.

The housing 7 of the vertical drive shaft 6 is rigidly bolted to the member 1 by means of the collar 14 and plate 15 and bolts 16 and 17, as illustrated in Figures 2 and 3. The base of the rotatable shaft 6 is provided with appropriate thrust bearings 7a and roller bearings as indicated at points 18 and 19 of Figure 2.

At the top of the shaft 6 and housing 7 is a hub 6' which is keyed to the drive shaft 6 at 7'. At 20' bolted to the hub 6' are a plurality of downwardly extending arms 20, which are arranged to enter the ball race 2 and contact the freely movable ball 3. There may be as many arms as is desirable radiating from the hub 6' to the ball race, depending largely upon the diameter of the ball race. A compartment or space is thus formed in the ball race between the arms in which one or more balls may be placed.

On the under surface of at least two of the arms 20 are rigidly attached agitator or particle discharger means such as 22 and 23, as shown in Figure 3, extending from the arm to near the bottom of the ball race, so shaped to conform to the contour of the ball race, and just escaping contact with the race. The discharger member 22 is formed to provide a plow shaped surface so as to lift the material to be pulverized from the internal and bottom portion of the ball race and throw it to the external portion of the race so that it will come in contact with the rotating balls passing therealong. The agitator means 23 will be attached to another arm and so shaped as to conform to the contour of the ball race, just escaping the ball race surface, and formed so as to lift the material being pulverized from the surface of the ball race and violently agitate it. The discharger means 22 is attached to the plate 24 as indicated at 22a, and the opposite end is attached to the arm 20 as at 22b, as illustrated in Figure 7. The agitator member 23 may be bolted to the portion of the arm member 20 which extends into the race at 23a and 23b, as illustrated in Figure 6. In each case the members 22 and 23 are disposed so that they will not drag the bottom of the ball race.

There may be one, two, or more, particle discharger and agitator means installed, depending upon the requirements of the material to be pulverized. If only two particle discharger and agitator means are installed, the best results may be obtained if they are installed on opposite arms such as indicated in Figure 3, one of the discharger means being of the agitator type such as 23, illustrated in Figure 6, whereas the other particle discharger means 22, illustrated in Figure 7, is of the type heretofore indicated which lifts the material being pulverized from the bottom portion of the ball race and throws it in the path of the rotating balls. In all cases, however, the agitators or particle discharger members are protected from contact with the balls since they are attached to the arm or extending rotating parts connected thereto.

It is, however, an essential feature of this device that the material being pulverized is constantly lifted from the surface of the ball race so that the finely pulverized material may be instantly and continuously removed from the mill, and the material left is thrown to the periphery of the ball race in order that it may come in contact with the balls.

The arms 20 have a ring member 21 attached to each arm over the ball race in a manner so as to prohibit the balls from jumping out of the race. This is accomplished by attaching the ring 21 to the extremities of the arms 20 such that the distance between the ring and the outer wall of the race is slightly less than the diameter of the balls rotating therein. The ring member 21 is positioned so that ordinarily it is not in contact with the grinding balls during the rotation thereof. This ring member strengthens the rotating member of the device and aids in supporting the attachments thereto.

Rigidly attached and hermetically sealed to the under surface of the ring 21 is a plate 24 extending completely around the same, and directed downward and inward to a suitable distance from the surface of the internal portion of the ball race to provide a narrow opening 25 adjacent the inner side wall of the race 2. The opening space 25, as illustrated in Figure 2, provides a passageway to permit air or gases to be drawn therethrough into the mill between the plate and the inner wall of the ball race. The plate 24 or partition is also attached and hermetically sealed to the arms 20 at their junction with the ring so that air can only enter the ball race through the space 25 between the lower edge of the plate and the bottom of the inner portion of the ball race.

The base of a cone shaped hood 26 is attached and hermetically sealed to the outer upper surface of the ring and arms, and the apex extended above the hub 6' on the vertical shaft, so that the hub, shaft and casing, including the arms and the open spaces between the arms, will be enclosed. The base of this cone 26 is continuous with the plate 24 attached to the under surface of the ring 21. This hood member 26 may be split horizontally on a level below the hub in order to provide a ready access to the key 7' on the hub for removal and adjustment.

External to the above cone shaped hood is a second cone shaped hood 27, the base of which corresponds to the outer surface of the ball race 1, and is bolted to the outer circular flange surface portion 28, which corresponds to the thickness of the outer wall of the ball race. This outer hood is so formed that it completely covers the ball race and approaches an apex over the center of the ball race and the inner hood which covers the vertical shaft, casing, hub and arms, as illustrated in Figure 2. An opening is provided in the apex of the external cone shaped hood 27, as at 29. The opening 29 is connected to the intake 30 of the centrifugal blower or suction fan means 31 which is of the conventional type. The intake 30 is hermetically sealed to the apex opening 29, and the fan is arranged to force the gas and entrained particles entering the passageway 29 and 30 therealong through the conduit 32 into the centrifugal collector 33.

The collector 33 is provided with a circular baffle plate means 34 concentrically disposed and provided with an opening at the lower end as at

35. The upper end is connected to the exit pipe 36 for removing the air or gas after the entrained particles have been removed. The entrained pulverized material is drawn off through the hopper 37.

The external hood means 27 is so shaped that its sides are not parallel to the inner hood 26, as illustrated in Figures 2 and 5. There is thus provided a greater distance between the two hoods at the apex than at the base, thereby decreasing the velocity of the gas flowing upward toward the apex as compared with the velocity of the gas at the base over the ball race and through the restricted throat passageway 25*a* at the base of the cone shaped hood members 26 and 27. In this manner the relatively coarse particles 38 of the material, which have not been sufficiently pulverized, entrained by the gas and discharged through the passageway 25*a* into the gradually enlarging exit chamber 29, will gravitate downward along the surface of the inner cone 26 and fall back into the ball race 2. The finely ground and pulverized particles 39 of the desired size are entrained by the gas and carried upward through the exit 29 and thence into the collector 33, as more clearly indicated in Figure 5.

The distance 25*a* is of such dimension that the total cross sectional area of the circular throat exit passageway 25*a* will be substantially less than the circular cross sectional area defined by the cones 26 and 27 in the uppermost part, as at 25*b*. In this manner the velocity of the gas and entrained particles moving from the throat 25*a* upward to the enlarged section 25*b* is effectively reduced so that the larger particles drop out and gravitate back into the pulverizing section of the mill, as indicated in Figure 2.

It will be understood that by varying the cross sectional area ratio, illustrated at 25*a* and 25*b*, the differential velocity of the gas passing therealong may be adjusted in accordance with the nature of the material being pulverized. The velocity of the air moving through the top portion of the cone 27 is ordinarily maintained substantially constant so that the particles of the desired uniform size will be removed and collected.

The volume of the air or gas drawn through the mill may be varied by adjusting the opening in the bleeder valve 40 or by varying the speed of the fan 31. For coarse grinding or pulverizing light material the bleeder valve 40 in the intake pipe of the suction fan may be opened to decrease the air velocity from the mill.

At the base of the outer hood member 27 directly over the ball race are mounted one or more ports 41 that may be opened or closed at will, either by rubber dams secured over the top of the port or by any other convenient sealing means. These ports may be as many as desirable, spaced around the hood. Preferably they should be circular in form for convenience. The ports 41 may be opened for permitting more air to enter the ball race or for inspection, and one or more may be used for feeding material into the mill.

It will be noted that there are open spaces between the inner wall of the ball race and the transmission case, such as indicated at 4, Figure 2. The space 4 may be left open or screened or partially closed by a cone shaped hood approaching the transmission case, or by any other suitable means. Sufficient space must be left, however, for allowing ready access of air or gas which is to be drawn through the mill to the suction fan and collector means.

The suction fan should be operated by a separate motor so that it will operate at normal speed at all times. If the fan is operated from a pulley running off the mill transmission, then in the event the mill is overloaded, slowing down, the fan would also be slowed down and consequently the mill would become clogged. On the other hand, if the fan is operated with its own motor and running at normal speed, the simple procedure of ceasing to feed the mill at the first sign of overloading will avoid the difficulty mentioned.

It will be noted that when the fan is in operation, air or gas can be drawn into the mill through one place only, namely the space between the internal wall of the ball race and the bottom of the plate 24, as indicated by the character reference 25 on Figure 2. The air then is drawn through the bottom of the ball race, and passes between the inner and outer hood to the fan, as illustrated in Figure 2.

The operation of the mill is as follows:

The suction fan 31 is actuated and when it reaches its maximum speed the mill is started, and thereafter the material previously crushed to the proper size is fed into the mill through one or more of the ports 41 situated directly over the ball race. The material introduced falls into the ball race and comes in contact with the balls running freely therein.

The particular discharger members 22 and 23 function to prevent the material from settling in the dependent portion of the ball race and throw the material to the periphery of the race in direct path of the rotating balls. At the same time during this agitation and distribution of the material, the finely pulverized material is entrained by the air currents drawn therethrough by means of the suction fan. The air current must pass under the edge of the plate or partition in the ball race which further agitates the material and sweeps the internal side and bottom of the ball race and continues towards the external and upper portion of the ball race. This functions to aid in lifting the material from the bottom of the race and carrying it into intimate contact with the rotating balls.

When it is desired to shut down the mill it should be stopped and the suction fan allowed to run until all pulverized material is removed from the mill, so that when started again it will be practically empty. There will also be a small amount of coarse material left in the mill because the discharger members 22 and 23 are maintained in close proximity, being out of contact with the lower dependent portion of the ball race so that some coarse material will not be picked up. The discharger means 22 and 23 may be so placed that the bottom of the ball race will be dragged but this will be undesirable because of the excessive wear on both the members and the walls of the ball race. Aside from this the starting torque would be much higher and the loss of power by friction during operation would be greatly increased. This, of course, is not desired.

It is understood that my invention is not to be limited to the exact details of construction, since obvious modifications within the scope of this invention may be made by those skilled in the art.

Having thus fully described my invention

what I claim as new and desire to secure by Letters Patent is:

1. In a pulverizing mill, the combination of a bowl-shaped member having a central opening for passage of air, said bowl having a circular ball race extending around the rim thereof, freely rotatable balls in the race, a cone-shaped hood disposed over and hermetically sealed to the bowl-shaped member enclosing the ball race, a vertically disposed rotatable drive shaft extended through the central opening of the bowl-shaped member, a cone-shaped hood fixed to the drive shaft and rotatable therewith, the wall of said hood extending into the race at an angle less than the wall of the first named hood to define a restricted throat passage-way, a circumscribing plate connected to the lower edge of the wall of the second named cone and extended at right angles thereto, said plate stopping short of the inner wall of the race defining an air passage, means for rotating the drive shaft, said drive shaft having a plurality of circumferentially spaced arms extended into the race for moving the balls around the race, and said first named hood having an opening for connection with a suction means.

2. In a pulverizing mill the combination of a bowl-shaped member having a central opening for passage of air, said bowl-shaped member having a circular runway extending around the rim thereof, freely rotatable balls in the runway, a vertically disposed rotatable shaft extended through the central opening of the bowl-shaped member, a hub fixed to the upper end of the shaft, circumferentially spaced downwardly extended arms fixed to the hub, said arms terminating within the runway to engage and move the balls under rotation of the shaft, a conical casing fixed to the arms, the wall of the casing being extended into the runway and having a right angular circumscribing plate, the free edge of the plate stopping short of the inner wall of the runway defining an air passage way in communication with the central opening of the bowl-shaped member, means for rotating the shaft, agitator and discharge means carried by the arms and positioned within the runway, a second conical casing enclosing the first casing and hermetically sealed around the runway, said second named casing having a wall disposed at an angle greater than the wall of the first named casing defining a restricted throat above the runway, and said second named casing having an opening in its apex for connection with a suction means.

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