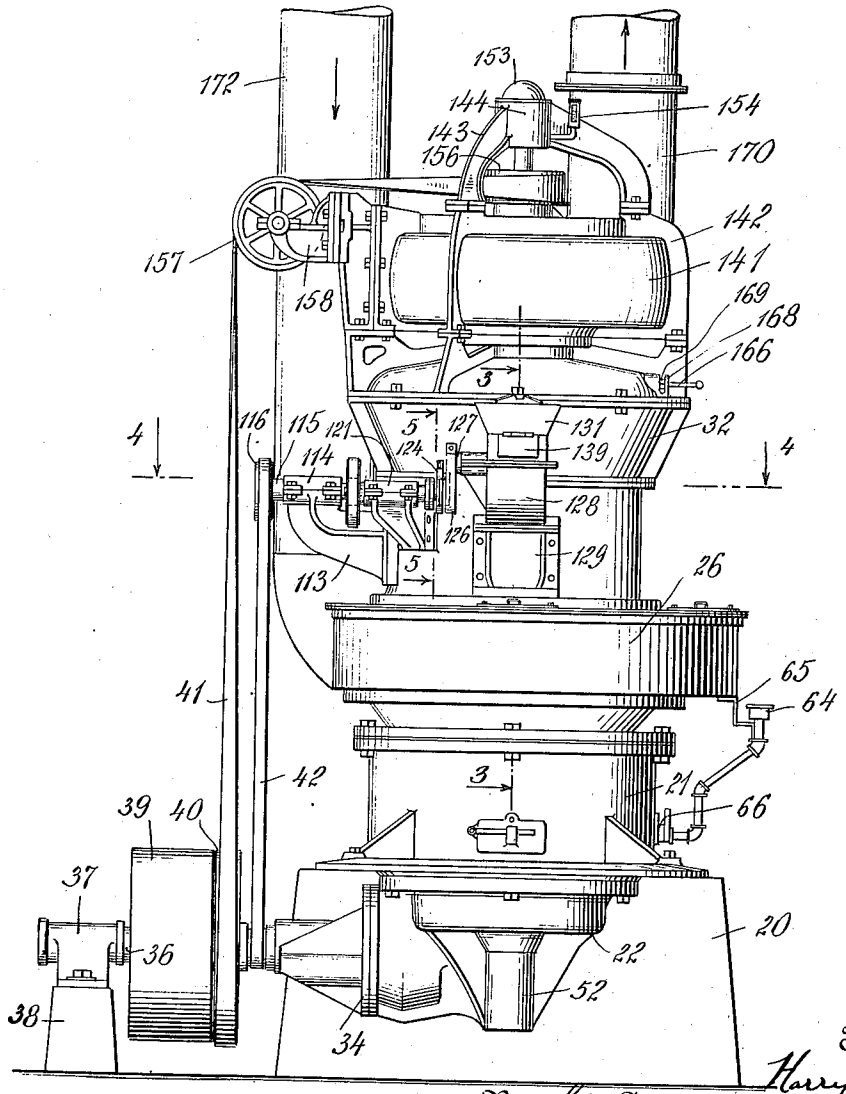
Feb. 19, 1924. 1,484,298

H. R. COLLINS

PULVERIZER MILL

Filed Nov. 8, 1919 6 Sheets-Sheet 1

Fig. 1,



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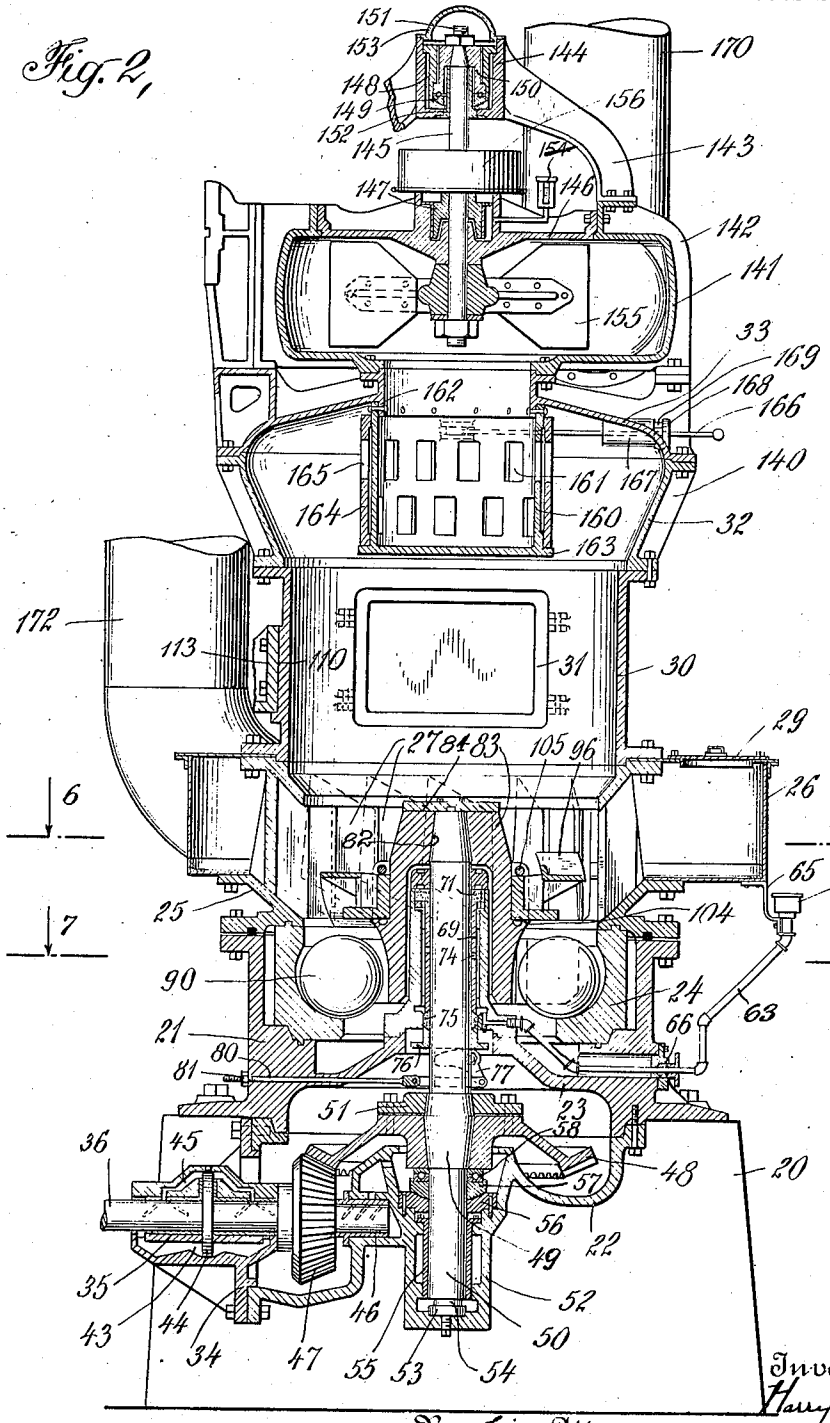
Feb. 19, 1924. 1,484,298

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PULVERIZER MILL

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Fig. 2.



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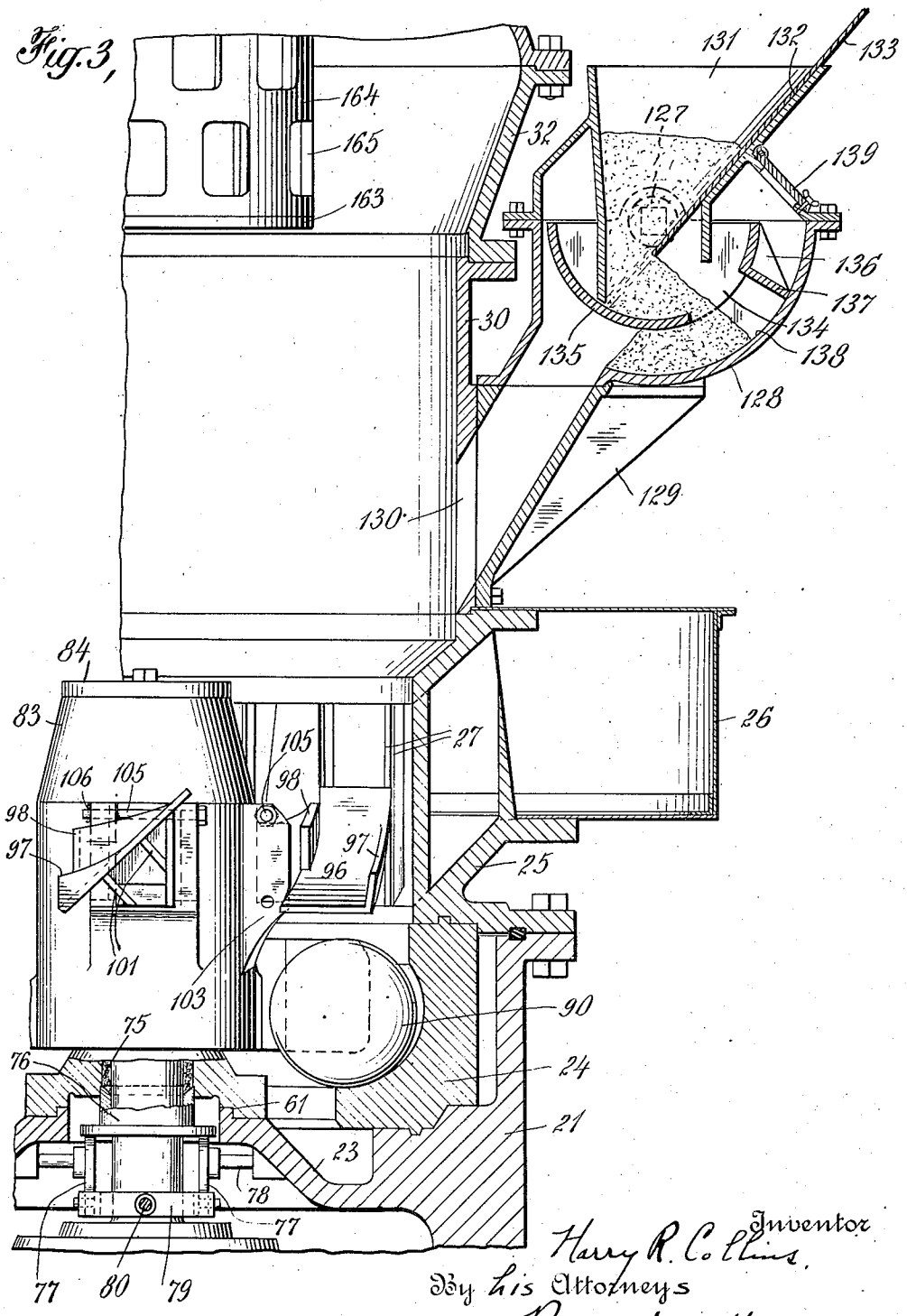
Feb. 19, 1924. 1,484,298

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PULVERIZER MILL

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Fig. 3,



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Feb. 19, 1924. 1,484,298

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PULVERIZER MILL

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Fig. 4,

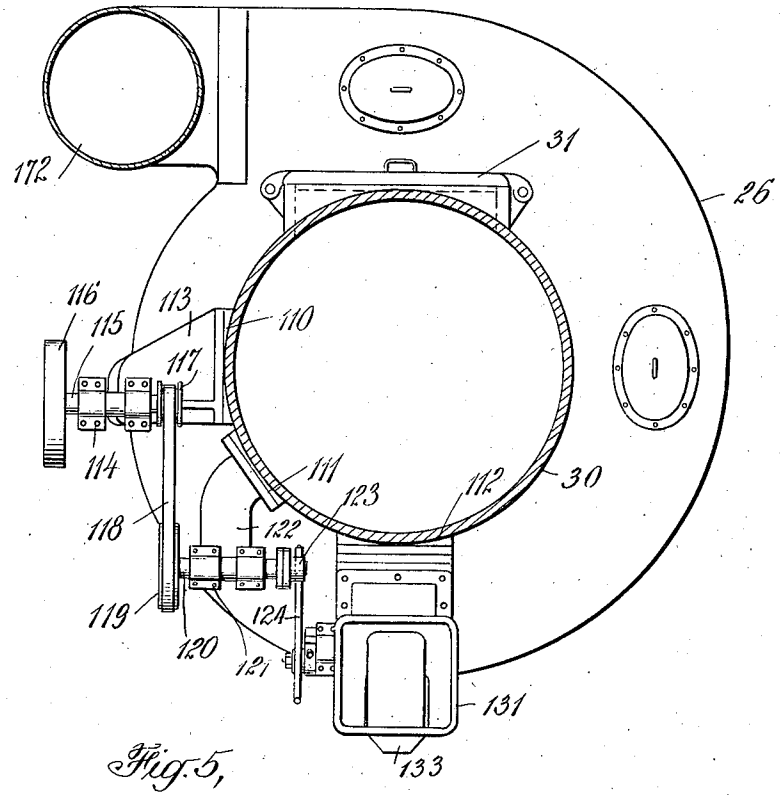
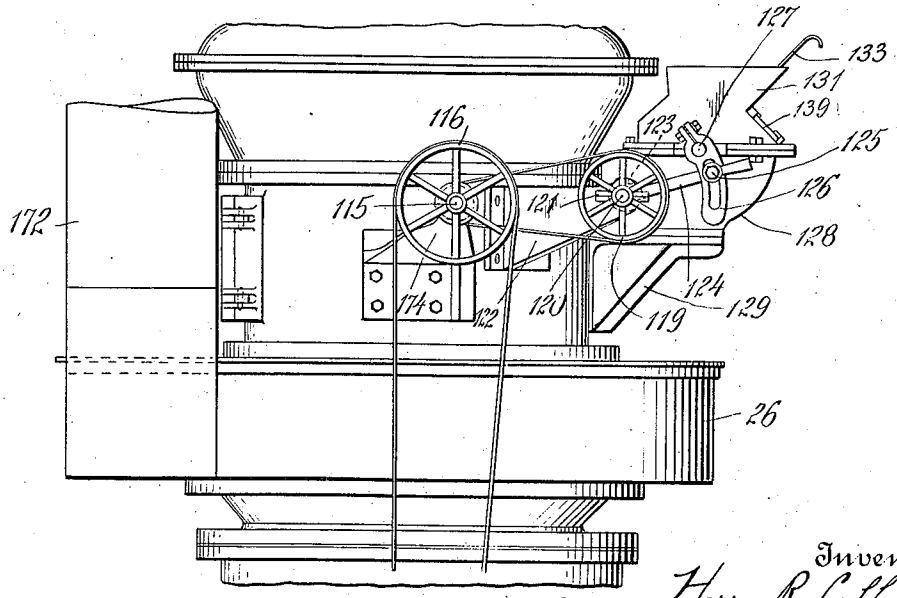


Fig. 5,



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PULVERIZER MILL

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Fig. 6,

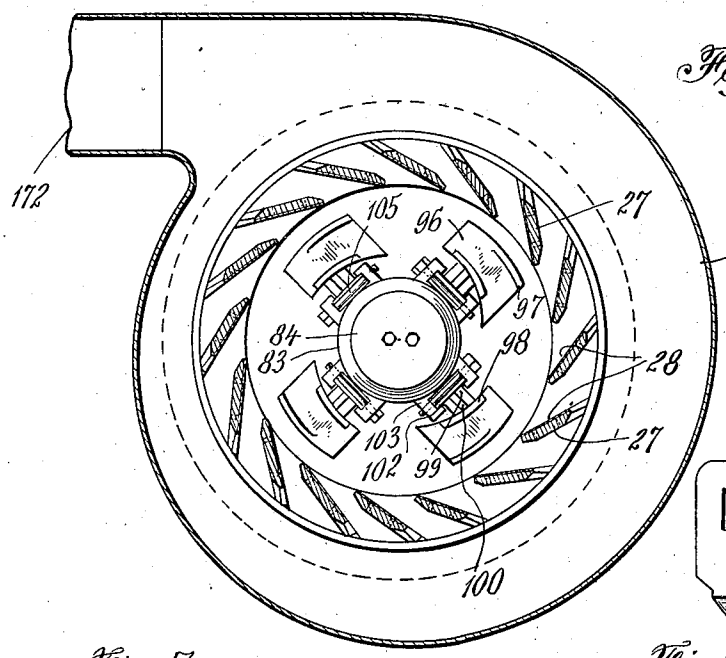


Fig. 9,

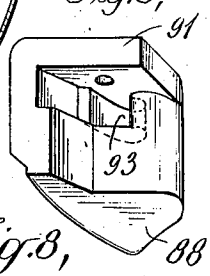


Fig. 7,

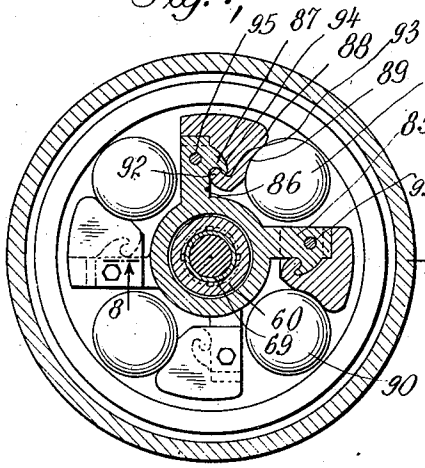


Fig. 8,

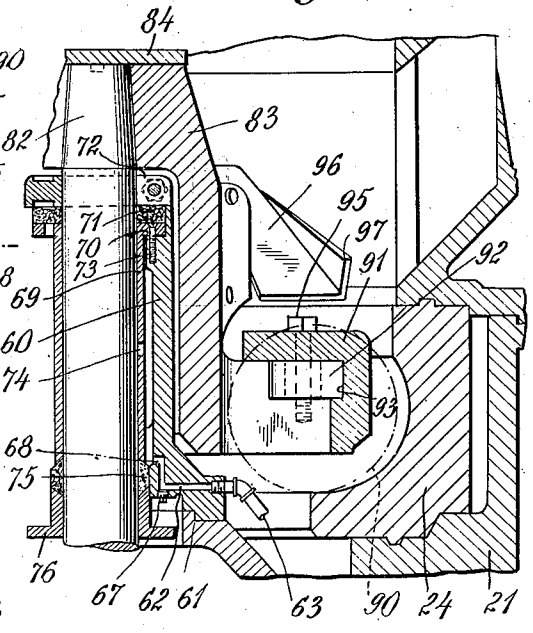
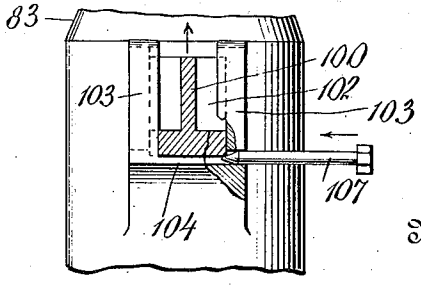


Fig. 10,



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Feb. 19, 1924. 1,484,298

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PULVERIZER MILL

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Fig. 11,

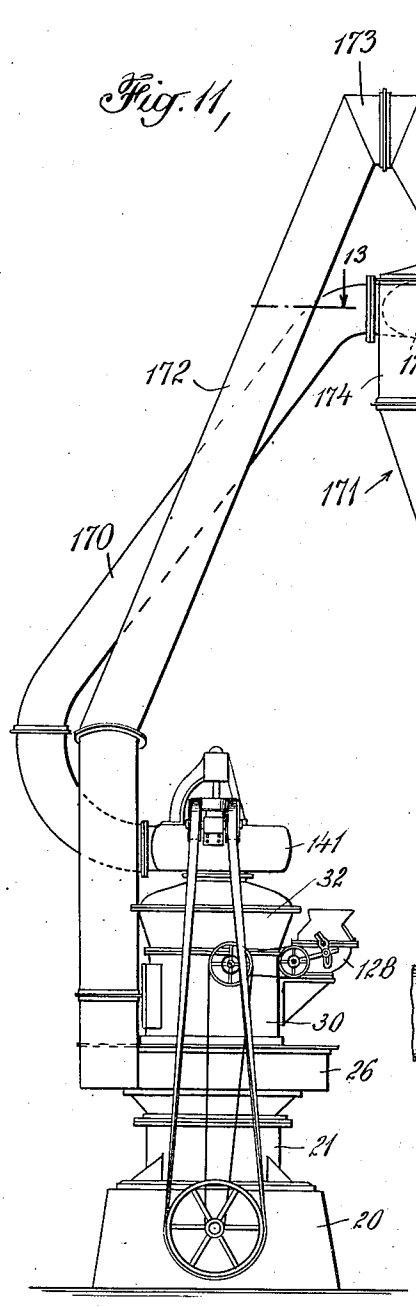


Fig. 12,

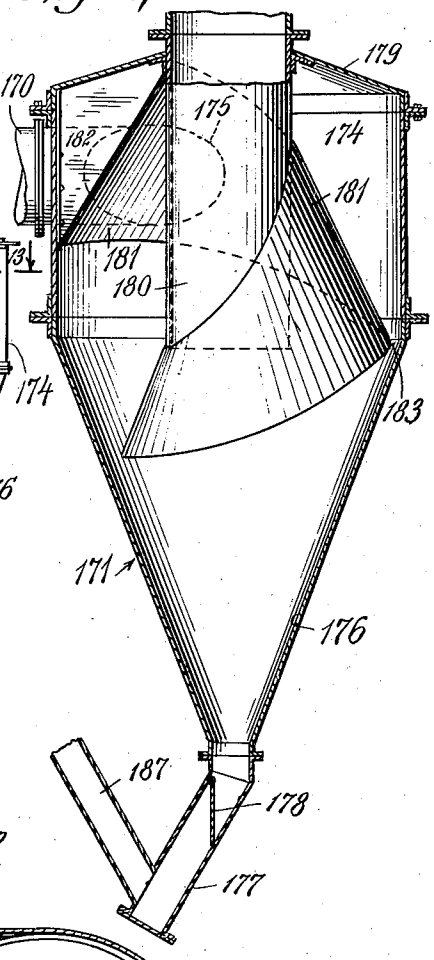
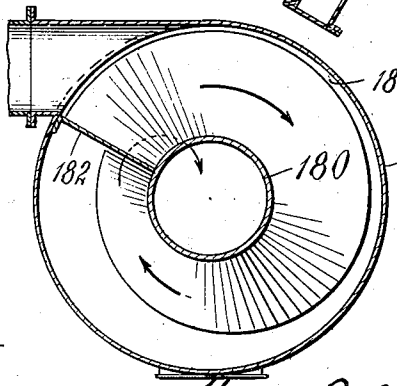


Fig. 13,



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Patented Feb. 19, 1924. 1,484,298

UNITED STATES PATENT OFFICE.

HARRY RAYMOND COLLINS, OF ALLENTOWN, PENNSYLVANIA, ASSIGNOR TO FULLER-LEHIGH COMPANY, A CORPORATION OF PENNSYLVANIA.

PULVERIZER MILL.

Application filed November 8, 1919. Serial No. 336,571.

To all whom it may concern:

Be it known that I, HARRY R. COLLINS, a citizen of the United States, residing at Allentown, in the county of Lehigh, State of Pennsylvania, have invented certain new and useful Improvements in Pulverizer Mills; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a pulverizing unit, comprising a mill within which material is reduced to a finely divided condition and an air separator associated with the mill and in which the pulverized material is separated and delivered for subsequent use.

It has previously been proposed to apply air separators to pulverizer mills of the general type shown for example in United States patents to James W. Fuller, Nos. 849,779, 922,468 and 1,039,721. In such mills there is a race-way having a number of pulverizing balls therein propelled by a series of rotating pushers, and the pulverized material is removed upwardly from the pulverizing zone largely by the suction of rotating blades which lift the finely pulverized material into the field of a superjacent series of fan blades. If the mill is not employed in connection with an air separator, these blades float the pulverized material against and through a cylindrical screen surrounding the upper part of the pulverizing chamber.

When mills of the above type are used in connection with air separators, it is customary to provide an additional fan for causing a circulation of air laden with pulverized material through the separator, where the material is deposited, and back to the mill to take up a new supply of material and convey it to the separator. The motive power for the fan is independent of the motive power for driving the rotatable parts of the mill, and the mechanism for supplying to the mill the material to be pulverized therein is driven by other independent motive power.

As distinguished from prior constructions of pulverizing mills provided with air separators, the present invention provides a pulverizing mill and air separator unit of improved construction, in which all of the moving parts including the fan for producing circulation through the separator and also the feeder are driven from a common shaft connected to a suitable source of power, so that their speeds are dependent upon the speed of the mill and variations in the latter are accompanied by corresponding variations in the speeds of the other parts of the apparatus. Thus a more uniform operation of the apparatus may be obtained, and the necessity for independent regulation of the speed of the fan and the feeder in accordance with variations in speed of the mill is eliminated. All of the parts of the mill are carried by a casting resting directly upon the foundations for the mill, and the grinding zone is located immediately above the casting so that vibration caused by the moving parts is reduced to a minimum. The construction of the mill is also simplified by omitting the fan blades, which in the usual types of Fuller mills are located above the lifting blades. The air current which is produced by a fan mounted at the top of the mill passes through a separator of novel construction where the material is freed from the air and the air then returns to the mill and passes with a substantially constant pressure through ports into the interior of the mill in the zone of action of the lifting blades to take up a new supply of material and convey it to the separator. At the top of the separating chamber of the mill is a lantern-like damper by which the rate of flow of the pulverized material laden air into the zone of operation of the fan and from thence into the conduit leading to the air separator may be controlled. This damper may be adjusted from the outside of the mill by means of two rods connected to opposite sides of the damper, but extending through the same side of the mill in position for convenient manipulation.

The material to be pulverized is fed to the mill from an overhead bin by means of a reciprocating feeder mounted on the side of the mill. This feeder is driven directly from the main countershaft of the mill by means of a belt which drives a reducing countershaft, which in turn drives by means of a belt a crank shaft connected to an arm operating the reciprocating feeder. The connection between the crank shaft and the arm is made adjustable to permit the operator to vary the amount of material entering the mill. The feeder is arranged to oppose the tendency of the exhaust fan to draw air into

the mill with the material, and in addition the hopper of the feeder is provided with a slide gate which allows the operator to increase or decrease the amount of material entering the feeder.

In the usual form of Fuller mill the main shaft passes entirely through the mill and is supported in bearings at the top and bottom of the casing of the mill, but in the mill of the present invention the main shaft is relatively short and is supported entirely in the lower casings of the mill. The shaft is driven from the main countershaft of the mill by gears which run in an oil well in the bottom or cellar section of the casing. The weight of the shaft and the parts mounted thereon is taken up by a step bearing, which consists of a steel spud mounted in the end of the shaft and resting upon a bronze disk seated in the bottom of the casing. The disk is so constructed that there is always a film of oil between it and the spud and as the pressures are well within the limits of good practice, satisfactory service is assured.

The upper bearing for the shaft is detachably supported upon the base plate by means of male and female machined joints which keep this bearing in alinement with the bottom bearing. The bushing of the upper bearing is provided with top and bottom glands, and a collar surrounds the shaft and may be pressed against the bottom gland by mechanism arranged to be manipulated from the exterior of the mill. In this manner, the entrance of dust and dirt into the bearing and leakage of oil therefrom is prevented. The height of the coil in the bearing is governed by the height of an oil cup mounted on piping which leads into the bottom of the bearing.

The yoke upon which the lifting blades are mounted and which is provided with arms which carry the pushers for propelling the balls is set on the end of the shaft in such a manner that it may be conveniently lifted therefrom and removed through a door in the central section of the mill casing. The body of the yoke encircles the upper bearing and extends practically to the bottom of the bearing thereby preventing material from rising to the height of the top of the bearing due to the yoke arms revolving and keeping the level of material at one point.

The yoke itself involves several improvements in its details of construction. In the usual form of yoke the arms which carry the pushers extend radially from the body of the yoke and fit within sockets in the pushers which are held upon the yoke by pins or bolts. This construction possesses the disadvantage that the pins or bolts are liable to become worn in service and break off so that the pushers under the influence of centrifugal force, will fly off of the ends of the arms with possible injury to the interior of the mill, particularly the concave grinding ring. In accordance with the present invention, the arms are set back relatively to their usual position so that the front face of each arm is radial to the body of the yoke, and this face is provided with a hook adapted to engage a corresponding depression within the pusher so that when the latter is applied to the arm it is held firmly thereon against the effect of centrifugal force without the use of any other fastening devices, although in practice a bolt or pin will be passed through the pusher and the arm as an additional safeguard. This arrangement permits the use of larger arms since they are located back of instead of within the pushers, so that the strength and durability of the yoke is correspondingly increased.

The invention also provides an improved arrangement for detachably securing to the body of the yoke the lifting blades which elevate the pulverized material from the zone of action of the balls. The yoke is provided with a number of pairs of vertical guides arranged between and above the pusher arms and into which the brackets of the lifting blades may be fitted. The blades may be held in place by a pin passed through the top of the guides, and provision is made for dislodging the blades in case they become wedged in position by the entrance of dust or dirt by means of a pin which may be driven through the bottom of the guides to lift the blades and permit them to be more easily removed.

The invention also provides an improved air separator. The usual form of separator comprises an upper cylindrical chamber into which the dust laden air enters and a lower conical chamber from the bottom of which the material is discharged. The top of the separator is provided with a pipe extending into the chambers and through which the air escapes. In separators of this general type the air entering the upper chamber passes partly around this chamber and then takes the shortest path to the discharge pipe carrying with it more or less material which can only be removed by a subsequent passage through the same or another separator.

In accordance with this invention, the central discharge pipe is surrounded by an inclined, spiral ribbon, the outer edge of which is spaced a short distance from the inner surface of the casing. Air admitted to the top of the casing follows the spiral path of the ribbon with gradual increase in its volume and consequent reduction in velocity until it reaches the lower end of the ribbon from whence it may then escape into the discharge pipe. The air thus passes in

a relatively long circular path through the casing so that centrifugal force exerts its greatest action in separating the material therefrom. By spacing the outer edge of the ribbon from the inner surface of the casing the material that collects on this surface may fall to the bottom of the casing and be discharged through a trap.

By virtue of this construction the air returning from the separator to the pulverizing mill contains considerably less material than does the return air from a separator of ordinary construction, and consequently the fan which produces the circulation of air may be run at slower speed and with less expenditure of power, so that the cost of operating the unit pulverizer and air separator is correspondingly reduced.

Other features and advantages of the invention will appear more clearly from a description of a preferred embodiment thereof as illustrated in the accompanying drawings, in which:—

Fig. 1 is an external view of the pulverizer mill with the pipes leading to the air separator broken away.

Fig. 2 is a central vertical section of the mill.

Fig. 3 is a view of the central portions of the mill, showing the feeder in section and the yoke and parts associated therewith on a larger scale.

Fig. 4 is a plan view in section along the line 4—4 of Fig. 1.

Fig. 5 is an external view of the central portion of the mill showing the feeder.

Fig. 6 is a view in section, along the line 6—6 of Fig. 2, of the casing through which air returns to the mill.

Fig. 7 is a view principally in section through the grinding mechanism of the mill along the line 7—7 of Fig. 2.

Fig. 8 is a vertical section of one half of the yoke and the upper bearing for the main shaft.

Fig. 9 is a rear view of one of the pushers for the grinding balls.

Fig. 10 is a detail view showing the arrangement for dislodging the lifting blades from their supports on the yoke.

Fig. 11 is a view of the entire unit comprising the mill and the air separator associated therewith.

Fig. 12 is a vertical sectional view of the separator; and

Fig. 13 is a horizontal sectional view of the separator taken along the line 13—13 of Fig. 11.

Referring to the drawings, in which similar reference characters denote similar parts throughout the several views, 20 represents the base or foundation of the mill which is preferably constructed of concrete brought down to a solid footing below the frost line. Upon the foundation is mounted the base section 21 of the mill, to the bottom of which is connected a cellar section 22 surrounding the driving gears and carrying the lower bearing of the main shaft as will appear more in detail hereinafter. The bottom section 21 is provided with an inwardly directed portion 23 upon which the upper bearing of the main shaft is mounted. The grinding ring 24 is also supported upon shoulders within the section 21. Attached to the top of section 21 and also fitting the top of the grinding ring is a section 25 surrounded by a casing 26 into which the air returns from the separator and from which it is directed into the mill by substantially tangential blades or partitions 27 extending between the top and bottom of the section 25. Each blade should preferably be protected on its inner face with a steel or chilled iron wear plate 28 to receive the impact of any material which may be thrown outwardly by the rotating lifting blades of the mill. The top and bottom of the section 25 are inclined downwardly and inwardly to direct the air downwardly as it enters the mill. The casing 26 may be provided with apertures closed by covers 29 to permit access to the interior of the casing for cleaning or repairs. On top of section 25 is a central section 30 which is provided with a door 31 through which access may be had to the interior of the mill for the purpose of cleaning the same or removing or repairing the yoke or the grinding balls. The feeder mechanism, which will be hereinafter described, is mounted upon the exterior of this section of the casing. On top of the section 30 is a flaring section 32 to the top of which is attached a cover section 33 upon which are mounted various parts of the apparatus as will be hereinafter described.

The cellar section 22 of the mill is provided at one side with an opening into which is fitted a plate 34 which carries a bearing 35 for a main countershaft 36, the other end of which is mounted in a bearing 37 on a pedestal 38. The shaft carries a pulley 39 adapted to be connected by a belt to a suitable source of power such as an electric motor, a gas or a steam engine or the like. The shaft also carries a second pulley 40 over which passes a belt 41 for driving the fan which produces the circulation of air through the mill and the separator. The mechanism for feeding material into the mill is also driven from the shaft 36 by means of a belt 42 which may pass directly around the shaft or around a third pulley mounted upon the shaft.

The plate 34 is provided with chamber 43 forming an oil well beneath bearing 35, and the shaft carries a collar 44 adapted to lift the oil from the well and allow it to flow through ducts 45 to the interior of the bush-

ing of the bearing. The inner end of shaft 36 is fitted within a bearing bushing 46 set in a socket formed in the cellar section of the mill. Between the bearings 35 and 46 there is a beveled pinion 47 attached to the shaft 36 and engaging a beveled gear 48 attached to an enlarged portion 49 of the main shaft 50. The enlargement 49 is formed with oppositely tapering portions, over the lower one of which the hub of gear 48 fits, while a safety collar 51 fits over the upper portion, and is clamped to the gear by bolts to hold the gear firmly upon the shaft.

The weight of the main shaft 50 and the parts mounted thereon is borne by a step bearing at the lower end of the shaft and a ball bearing beneath the hub of beveled gear 48. The step bearing is located in an extension 52 of the cellar section 22 and comprises an adjustable bronze disk 53 and a steel spud 54 at the lower end of the shaft. A bushing 55 detachably mounted within the extension 52 prevents lateral displacement of the lower end of the shaft. Above the bushing 55 is a bridgepiece 56 upon which is mounted a member 57 which carries one of the rings of a ball bearing 58, the other ring of which is attached to the bottom of the hub of beveled gear 48. This ball bearing is so constructed and proportioned with respect to the step bearing at the bottom of the mill, as to aid in carrying the weight of the shaft and the parts mounted thereon.

The details of the upper bearing for shaft 50 appear most clearly in Figs. 3 and 8, taken in connection with Fig. 2. Mounted upon the inner edge of the portion 23 of the bottom section 21 is a vertical bearing 60 which is held in correct alinement with the bottom bearing of the mill by a male and female machined joint 61. At the bottom of bearing 60 is a duct 62, leading to a pipe 63 which passes through a passageway in the casing 21 and carries at its upper end an oil cup 64 which may be additionally supported by means of a bracket 65 attached to the bottom of casing 26. The pipe 63 may be surrounded at the point where it passes out of the casing 21 by a suitable stopper or bushing 66 to prevent the escape of material through the passageway in which the pipe is placed. The duct 62 may be provided with a suitable drain cock 67 and at its inner end it communicates with a circular port 68 through which oil may enter the chamber within the bearing 60.

The shaft 50 rotates within a bronze bushing 69 which at its upper end is provided with an outwardly extending shoulder 70 having apertures through which oil may flow to a packing ring 71. A collar 72 is clamped upon shaft 50 immediately above the packing ring for preventing the entrance of dust into the top of the bearing. The shoulder 70 is provided with additional apertures for receiving screws 73 which enter the end of bearing 60 and hold the bushing in place. The bushing may be provided with any number of apertures 74 to permit oil to flow between it and the shaft. At the bottom of the bushing is a packing ring 75, preferably formed with inclined faces. Below the ring is a gland 76 surrounding the main shaft and adapted to be held against the lower edge of the ring by a pair of cams 77 (see Figs. 2 and 3) mounted on pivots 78 projecting from the portion 23 of the casing section. The lower ends of the cam 77 are connected by a yoke 79 to which is attached a rod 80 passing through the wall of the casing and provided at its end with an adjusting nut 81 by which the position of the rod and consequently the pressure of the gland 76, against the packing ring 75, may be regulated. By means of this mechanism, the ring 75 may be held against the bottom of the bearing bushing 69 with any desired degree of pressure, thus producing a tight joint at the bottom of the upper bearing so as to prevent the entrance of any material into the bearing or leakage of oil therefrom. The ring 71 and collar 72 at the top of the bearing will prevent any material entering at this end, so that there is provided a bearing, which, while located in a region of the mill where pulverized material is being produced, will effectively prevent material from entering the bearing and injuring the shaft and the bushing.

The upper end of the main shaft is tapered as at 82, and upon this tapered end is fitted a yoke body 83 which is provided with a depending portion closely surrounding the upper bearing of the shaft to lessen the tendency for pulverized material to penetrate into the bearing. At the top of the yoke is a plate 84 which is bolted to the end of the shaft to prevent the yoke from being displaced upwardly during operation of the mill. Projecting outwardly from the bottom of the yoke are pusher arms 85 of which four are shown in the embodiment illustrated herein, although it will be understood that any other desired number may be provided. These pusher arms are so disposed with respect to the yoke that their front faces 86 are radial to the axis of the yoke. The faces are provided at their tops with curved projections or hooks 87 formed integrally with the arms. The arms are adapted to carry pushers 88 having their front faces curved as at 89 to fit the grinding balls 90 which are propelled by the pushers.

As shown most clearly in Figs. 7 and 8, the pushers are adapted to fit over the outer ends of the arms with a portion 91 resting upon the tops of the arms. The top of the end of each arm is extended as at 92 to form a lug adapted to fit into a correspond-

ingly shaped recess 93 in the inner face of the pusher that engages the end of the arm. The inner face of the pusher that engages the front face of the arm is provided with a curved socket 94 of substantially the same shape as the hook 87 and adapted to receive the latter when the pusher is fitted upon the arm. In order to place the pusher upon the arm, the hook 87 is inserted into the socket 94 and then the pusher is swung outwardly and to the rear to bring the lug 92 into the socket 93. The force exerted against the pusher by the balls when the mill is in operation, will be such as to prevent any tendency of the pusher from becoming detached from the arm, but as an additional safeguard and to lessen the possibility of a slight amount of movement between the pusher and the arm which might tend to wear away these parts, there is provided a bolt or pin 95 which passes through the top portion 91 of the pusher and enters the arm.

Mounted upon the yoke above the zone of action of the grinding balls are inclined curved lifting blades 96 each having its outer edge turned upwardly at the lower end of the blade as indicated at 97. The inner edge of each blade is formed integrally with or attached to a curved member 98 which is attached to the outer end of a bracket 99 which is provided with a vertical rib 100 also joined to the member 98. Suitable bracing ribs 101 are provided between the under face of the blade 96 and the curved member 98 and bracket 99 to aid in supporting the blade. The bracket 99 and rib 100 are attached to or formed integrally with a member 102 which is adapted to fit within a pair of parallel guideways 103 projecting from the sides of the yoke substantially midway between two of the pusher arms 85 so that the lifting blades 96 will be disposed above the grinding balls 90 as will appear most clearly from a consideration of Figs. 6 and 7. The two guideways 103 of each set are connected together at their bottom by a shelf 104 upon which the member 102 is seated when the lifting blade is in place. To prevent the lifting blade from being raised during the operation of the mill, a holding pin 105 is inserted through apertures in the top of the channel members as shown most clearly in Fig. 3. This pin may be held in place by a cotter pin 106, by means of a nut or in any other convenient manner. It may happen during the use of the mill that a deposit of pulverized material will accumulate around and within the guideways and prevent the lifting blades being readily removed from the yoke. In order to aid in dislodging the blades, the guideways 103 may be provided at their lower ends with apertures into which may be inserted a pointed pin 107 as shown most clearly in Fig. 10. These apertures will be located partly above the shelf 104, and the latter will be provided with a groove corresponding to the lower part of the apertures so as to permit the pin 107 to be driven through these parts to dislodge the lifting blade to permit it to be more easily removed.

The arrangement of the yoke and the parts associated therewith upon the upper end of the main shaft 50 permits the body of the yoke or any of the elements mounted thereon or the grinding balls 90 to be lifted out of the mill through the door 31 in the casing section 30, it being understood that the door will be of sufficient size to permit any of the parts to pass through it. After the yoke has been removed, access may be obtained to the upper bearing for adjustment or repair.

The mechanism for feeding material to the mill is mounted upon the casing section 30, and for this purpose the exterior of this section is provided with flat-faced pads 110, 111 and 112. Attached to pad 110 is a bracket 113 provided with a bearing 114 within which is mounted a countershaft 115 having at its outer end a pulley 116 over which passes the belt 42 leading from the main countershaft of the mill. The inner end of countershaft 115 carries a pulley 117 of relatively small diameter, which, by means of a belt 118, is connected to a pulley 119 of larger diameter on the end of a third countershaft 120 mounted in bearings 121 at the outer end of a bracket 122 attached to pad 111. Connected to the other end of countershaft 120 as by means of an eccentric 123 is an arm 124 which is attached by means of a pin 125 to a curved, slotted, rocker arm 126 which, in turn, is attached to the outer end of a shaft 127 upon which is mounted the movable parts of the feeder.

The feeder comprises a case 128 supported on a bracket 129 which is attached to the pad 112 and is hollow as shown most clearly in Fig. 3 to form a chute through which material may be fed to the mill, it being understood that the pad 112 and the adjacent wall of the casing are provided with an aperture as at 130 to permit the material to enter the mill. Attached to the top of the feeder casing 128 is a hopper or bin 131 having an inclined face 132 upon which is slidably mounted, as by being held in guideways in the sides of the hopper, a gate 133 by means of which the quantity of material discharged from the bin may be controlled. Suspended from the shaft 127 within the feeder casing is a sling member 134 consisting of a portion 135 concentric with the shaft 127 and extending from side to side of the feeder casing. The sling is also provided with a short, curved portion 136 spaced from the portion 135 to form an aperture through which material may pass, and the portion 136 has a

radial extension 137, the outer edge of which lies close to the bottom of casing 128, which is curved as at 138 concentrically with respect to shaft 127. A door 139 which is normally closed permits access to the interior of the feeder casing for cleaning and repairs.

The feeder described above operates as follows:

The counter shaft 115 is continuously driven from the main countershaft of the mill by belt 42. Owing to the difference in diameter of the pulleys 117 and 119, the shaft 120 will be driven by the belt 118 at slower speed. As the shaft 120 rotates, the rocker arm 126 will be oscillated on account of the eccentric connection between the end of arm 124 and shaft 120. The amount of throw of the rocker arm may be adjusted by altering the point at which the arm 124 is connected thereto, and for convenience in making this adjustment the outer end of the arm 124 is formed as a handle. The oscillatory movement imparted to the feeder shaft 127 will cause a corresponding movement of the sling 134 and when the curved portion 135 moves into the upper part of the feeder casing, the material will fall over the lower edge of this portion and be deposited on the curved bottom 138 of the feeder casing in position to be forced into the chute leading to the interior of the mill by the radial portion 137 of the sling. It is intended that the portion 137 shall not move far enough to sweep all of the material into the chute, so that some of it will remain at the bottom of the feeder casing and thus fill up the passageway leading from the hopper of the feeder to prevent the entrance of air into the casing of the mill. The amount of material discharged from the hopper of the feeder may be controlled by means of the gate 133. When the sling moves in the opposite direction on the next oscillation, it cuts off the flow of material into the chute leading to the interior of the mill and the curved portion of the sling becomes filled with material which will be discharged therefrom on the next oscillation of the sling. At all times, the parts of the sling and the material passing into the feeder occupy such positions as to effectively prevent the admission of air into the mill through the feeder, so that there is no extraneous air supplied to the normal current of air which flows through the mill and the air separator, and which might tend to interfere with the proper operation of the apparatus.

The top section 32 and the cover section 33 of the mill, are each provided with cooperating bracing ribs 140. Upon the top of the cover section 33 is mounted a fan casing 141 which is also provided with bracing ribs 142 adapted to register with the bracing ribs of the cover section to produce a strong, rigid, mounting for the fan and its casing. Mounted upon the ribs 142 above the fan casing, is a tripod 143 provided at its apex with a cylindrical socket 144 which contains a bearing from which is suspended a shaft 145 entering the fan casing 141 through cover plate 146 which, on its upper face, is provided with a bearing 147 of any suitable construction to prevent lateral displacement of the shaft. The bearing should preferably be provided with a well adapted to be filled from an oil cup outside the bearing.

The upper bearing may be of any suitable construction, but is here shown as comprising a sleeve 148 at the bottom of which is one of the members 149 of a ball bearing. The other member of the ball bearing is in the form of a cap 150 to which the shaft 145 is attached by means of a bolt 151. The upper end of the shaft is surrounded by a bushing 152 attached to the bottom of the cylindrical socket 144. A cover 153 is placed over the bearing to exclude dust and dirt. The bearing may be lubricated by an oil cup 154 of any suitable construction. Mounted upon the lower end of the shaft 145 within the casing 141, is a fan 155 of any suitable construction. The shaft is provided with a pulley 156 around which passes the belt 41 driven from the main countershaft of the machine. In order to change the direction of the belt it is passed over idlers 157 mounted in brackets 158 attached to the fan casing.

For controlling the amount of air laden with pulverized material which is drawn from the casing of the mill by the fan 155 there is provided a lantern-like damper which, as shown most clearly in Fig. 2, comprises a cylindrical inner member 160 provided with ports 161 and attached to a flange 162 surrounding the aperture in the cover section 33. Encircling the section 160 and mounted upon a ledge 163 at the bottom of this section, is a movable cylindrical section 164 provided with ports 165 which may be brought into registry with the ports 161 of the first section in accordance with the amount of air which it is desired shall pass through the damper. The movable section of the damper is provided with diametrically opposite lugs to which are connected rods 166 which pass through bushings 167 formed in the cover section 33. Spaced from the outer end of each bushing is a narrow bushing 168. There is thus formed between the two bushings, a space within which may be placed a nut 169 threaded upon the corresponding rod 166, so that by manipulation of the nuts the two rods 166 may be moved in opposite directions to adjust the position of the movable member 164, with respect to the fixed member 160. The two rods 166 should preferably be brought out to the same side of the mill so that they may be simultaneously manipulated in the most convenient manner to adjust the damper.

Connected to the fan casing 141, is a conduit 170 which leads to the air separator 171 of the pulverizing unit. The conduit 172 through which air returns from the separator to the mill, is connected to the casing 26 which, as shown most clearly in Figs. 4 and 6, is of spiral shape to provide for the connection of the conduit. The separator should be mounted at some distance above the mill so that both of the conduits may be inclined and thus eliminate any flats in the conduits which would permit material to accumulate therein and gradually fill them up. The conduit 172 is provided with an abrupt bend 173 above the separator, so that any material tending to collect therein will fall into the downwardly extending branches and thus be prevented from accumulating in the bend of the conduit as would be the case if the usual curved bend were used.

The separator 171 comprises an upper cylindrical casing 174 provided near its top with a port 175 through which the air laden with pulverized material enters the separator from pipe 170. Attached to the bottom of casing 174 is a conical casing 176 to the bottom of which is connected a chute 177 through which the material is discharged after being separated from the air. The chute should preferably be provided with a check valve 178 of any suitable construction. The cover 179 is provided with a relief pipe 180 extending into the separator and to the top of which the return conduit 172 is connected. Surrounding the relief pipe is an inclined spiral ribbon 181 at the upper end of which is a vertical partition 182 which, as shown most clearly in Fig. 13, occupies such a position with respect to the port 175 as to prevent any air from passing over the upper edge of the ribbon and entering the relief pipe over a short path. The air entering the separator is thus directed by the ribbon in a spiral path around the relief pipe and cannot escape through the latter until it has passed over the lower edge of the ribbon which, as shown most clearly in Fig. 12, extends downwardly from the lower end of the pipe. Also as shown most clearly in the same figure, the free edge of the ribbon is spaced a slight distance from the inner wall of the separator casing, as at 183, in order to permit the material that is deposited upon the wall of the separator to fall to the bottom of the separator and be discharged through the chute 177.

Due to the arrangement and form of the ribbon, the free space above the ribbon which may be occupied by the incoming air, increases, so that the air, as it passes through the separator, may expand with consequent reduction of its velocity, and since the air passes in a circular path at all times and in fact, makes a complete revolution before it can pass out of the relief pipe, centrifugal force will exert its greatest effect in separating the material from the air so that the air returning to the mill will contain considerably less material than would be the case if a separator of the usual construction were employed. On account of the increased efficiency of the separator, the fan 155 which forces the dust laden air to the separator, may be run at lower speed and with less expenditure of power since there is not so much residue from the separating operation which must be carried through the fan and conduits a second time. The cost of operating the unit pulverizer and air separator is correspondingly reduced, and the time required for the pulverizing of a given quantity of material is less than if a separator of the usual construction is employed.

An auxiliary separator 184 is preferably associated with the main separator, although such auxiliary separator may be omitted if desired. This auxiliary separator, which may be of the improved construction of the main separator or of any other suitable construction, is connected to the return conduit 172 by a pipe 185, and the relief pipe 186 of this auxiliary separator opens into the atmosphere. Material deposited in the auxiliary separator is discharged through a conduit 187 connected to the chute 177 of the main separator.

In the operation of the unit pulverizer and air separator described above, the main counter shaft 36 is driven from any suitable source of power, and through the gears 47 and 48 the counter shaft drives the main shaft 50 whereby the balls 90 are propelled in the grinding ring 24. A sufficient amount of lubricant will be placed in the cellar section of the mill to lubricate the bearings of the shafts and the gear connections between them. The oil cup 64 will maintain oil in the upper bearing of the main shaft at a sufficient level to lubricate the entire bearing. The gland 76 will be suitably adjusted by manipulation of the rod 80 to press the packing ring 75 against the bottom of the bushing 69 to prevent leakage of oil from, or entrance of dust into, the bearing. The depending portion of the yoke 83 which closely surrounds the upper bearing will also tend to prevent the entrance of any dust into the latter.

The countershaft 115 of the feeding mechanism is driven in unison with the main shaft, and the feeder mechanism will supply the material to the mill in sufficient quantities and at predetermined intervals to permit the material to be ground most effectively. Since the material is not fed in a continnous stream, only a limited amount of material is being ground at any one time. Therefore the crushing force is being applied to only a limited amount of material, and since it is applied directly to the ma-

terial being pulverized, the power required to operate the mill is reduced to a minimum. If any tramp iron which may not have been previously removed enters the mill, it will fall through the annular space at the bottom of the grinding ring and lodge upon the portion 23 of the base section of the mill and may be removed through ports corresponding to the port shown in Fig. 2 through which the pipe 63 passes, these ports being provided with quick opening cover plates of any suitable construction.

The pulverized material is lifted out of the zone of action of the grinding balls principally by the suction effect of the lifting blades 96 which project the material upwardly into the current of return air which enters the casing through the ports between the blades 27. Under the influence of the fan 155 driven from countershaft 36 the air laden with pulverized material is drawn through the ports of the cylindrical damper, the opening of which will depend upon the volume of air laden with material which it is desired shall pass to the separator. As the air enters the separator, it will follow the course determined by the ribbon 181, and since the space which may be occupied by the air as it follows the course of the ribbon increases, the air will expand with consequent reduction of its velocity and will finally pass over the lower edge of the ribbon and escape through the relief pipe 180 into the conduit 172 which carries it back to the mill to become laden again with pulverized material. The material deposited upon the interior of the separator will fall to the bottom of the same and be discharged through the chute 177.

Whenever it is desired to clean or repair any of the pulverizing elements of the mill, access to the latter may be conveniently obtained through the door 31 which will be of sufficient size to permit any of the elements including the yoke 83 to be removed therethrough. After the yoke has been removed access may be obtained to the upper bearing of the main shaft, and the parts of the bearing may be removed through the door 31 without dismantling the casing of the mill. In case it is desired to clean or repair any of the elements at the bottom of the mill, the cellar section 22 may be removed without disturbing the other parts of the mill which are carried upon the base section 21. In general, the mill is so designed that the parts most liable to require cleaning or repair may be reached without dismantling the entire mill, and the elements that require adjustment from time to time such as the gland 76 and the cylindrical damper may be manipulated from the exterior of the mill. The pulverizing mechanism, the feeder and the fan 155 are all driven in unison from the main countershaft 36, so that any variations in the speed of the latter affect all of the moving parts alike, thereby eliminating the necessity for adjusting the feeder and the fan to compensate for variations in the speed of the pulverizing mechanism. The apparatus thus requires less attention than apparatus in which the various moving parts must be watched from time to time for variations in speed. While a preferred embodiment of the invention has been shown and described, it will be understood that changes in the details of construction may be made without departing from the principle of the invention as defined in the appended claims.

I claim:

1. A pulverizing unit, comprising a vertical casing, a grinding ring, a plurality of grinding balls, a vertical shaft within the casing, means associated with the shaft for propelling the balls along in the grinding ring, means actuated by said shaft for lifting pulverized material from the zone of action of the balls, a conduit leading from the top of the casing, means at the top of the casing for forcing a current of air laden with pulverized material through the conduit, means connected to the conduit for separating the material from the air, a return conduit leading from the separating means and entering the casing at the zone of action of the lifting means, a power driven countershaft, gear connections between the countershaft and the shaft which actuates the balls and the lifting means, and means connected to the countershaft for driving the means for forcing air through the conduits and the separating means in unison with the shaft.

2. A pulverizing unit comprising a casing, means within the casing for pulverizing material, a conduit leading from the top of the casing, means at the top of the casing for forcing a current of air laden within pulverized material through the conduit, means connected to the conduit for separating the material from the air, a return conduit from the separating means to the casing, a member mounted within the casing at the top thereof and provided with ports, means movably mounted upon the first-named member and provided with ports adapted to register with the ports of the first-named member, and means connected to the movable member and extending to the outside of the casing whereby the position of the movable member may be adjusted to regulate the amount of air which may pass through the ports to the means for forcing the air through the conduit.

3. A pulverizing unit, comprising a casing, means within the casing for pulverizing material, a conduit leading from the top of the casing, means at the top of the

casing for forcing a current of air laden with pulverized material through the conduit, means connected to the conduit for separating the material from the air, a return conduit from the separating means to the casing, a cylindrical member mounted within the casing at the top thereof and provided with ports, a movable cylindrical member associated with the first named cylindrical member and provided with ports adapted to register with the ports of the first named member, and means connected to the movable cylindrical member and extending to the outside of the casing whereby the position of the movable member may be adjusted to regulate the amount of air which may pass through the ports in the cylindrical members to the means for forcing the air through the conduit.

4. A pulverizing unit, comprising a casing, means within the casing for pulverizing material, a conduit leading from the top of the casing, means at the top of the casing for forcing a current of air laden with pulverized material through the conduit, means connected to the conduit for separating the material from the air, a return conduit from the separating means to the casing, a cylindrical member mounted within the casing at the top thereof and provided with ports, a second cylindrical member surrounding the first named cylindrical member and movably supported with relation thereto, said second cylindrical member being provided with diametrically opposite lugs, a rod connected to each of the lugs and passing through the casing, and means associated with the rod and adapted to be manipulated from the exterior of the casing for moving the rod to change the position of the movable cylindrical member to determine the amount of air which shall pass through the ports to the means for forcing a current of air through the conduit.

5. A pulverizing unit, comprising a casing having a top section provided with a central aperture and two sets of spaced bushings in the wall thereof, means within the casing for pulverizing material, a fan casing mounted on top of the first named casing and communicating with the latter through the aperture therein, a conduit leading from the fan casing, a fan in the fan casing for forcing a current of air laden with pulverized material through the conduit, means connected to the conduit for separating the material from the air, a return conduit from the separating means to the casing, a cylindrical member attached to the top of the casing concentrically with respect to the aperture therein and provided with ports, a second cylindrical member surrounding and movably mounted upon the first named cylindrical member and provided with ports adapted to register with the ports in the first named cylindrical member, a pair of diametrically opposite lugs projecting from the outer cylindrical member, rods connected to the lugs and passing through the bushings in the wall of the top section of the casing, and a nut threaded upon each of the rods and lying between the sections of the bushing whereby the rod may be manipulated to move the outer cylindrical member to control the draft through the fan casing and the conduit connected therewith.

6. A pulverizing unit, comprising a main casing, means within the main casing for pulverizing material, a fan casing mounted on top of the main casing and communicating with the latter through an aperture in the top thereof, a support mounted on the top of the fan casing, a bearing in the support, a vertically disposed shaft rotatably mounted in the bearing and entering the fan casing, a fan mounted on the lower end of the shaft within the fan casing, a conduit leading from the fan casing, means for rotating the shaft and fan to force a current of air laden with pulverized material through the conduit, means connected to the conduit for separating the pulverized material from the air, and a return conduit leading from the separating means to the casing through which air returns after pulverized material has been separated therefrom.

7. A pulverizing unit, comprising a main casing, having an intermediate section provided with a plurality of tangentially arranged apertures communicating with the interior of the casing, an outer casing surrounding the intermediate section, means within the main casing below the intermediate section for pulverizing material, a conduit leading from the top of the main casing, means at the top of the main casing for forcing a current of air laden with pulverized material through the conduit, means connected to the conduit for separating the material from the air, and a conduit between the separating means and the outer casing for conducting return air into the main casing.

8. A pulverizing unit, comprising a main casing having an intermediate section provided with a plurality of vertical, tangentially arranged blades adapted to direct air into the casing, an outer casing surrounding the intermediate section, means within the main casing and below the intermediate section for pulverizing material, a conduit leading from the top of the main casing, means at the top of the main casing for forcing a current of air laden with pulverized material through the conduit, means connected to the conduit for separating the material from the air, a conduit between the

separating means and the outer casing for conducting return air into the main casing, and wear plates attached to the faces of the blades.

9. A pulverizing unit comprising a casing, a grinding ring, grinding balls in the ring, a shaft of abbreviated length situated at the bottom of the casing and terminating a short distance above the grinding ring, a member mounted on the upper end of the shaft and provided with a plurality of arms, pushers mounted on the ends of the arms adapted to engage the balls to propel them through the ring when the shaft is rotated, and means detachably secured to the member above the arms for elevating pulverized material out of the zone of action of the balls.

10. A pulverizing unit, comprising a casing, a grinding ring, grinding balls in the ring, a shaft at the bottom of the casing, a member mounted on the upper end of the shaft and provided with a plurality of arms and a plurality of pairs of guideways between and above the arms, pushers mounted on the ends of the arms adapted to engage the balls to propel them through the grinding ring when the shaft is rotated, brackets detachably mounted in the guideways, and inclined blades at the outer ends of the brackets for lifting pulverized material out of the zone of action of the balls.

11. A pulverizing unit, comprising a casing, a grinding ring, grinding balls in the ring, a shaft at the bottom of the casing, a member mounted on the upper end of the shaft and provided with a plurality of arms and a plurality of pairs of vertical guideways between the arms and above the same, the guideways of each pair being connected at their lower ends by a shelf, pushers mounted on the ends of the arms adapted to engage the balls to propel them through the grinding ring when the shaft is rotated, a bracket detachably mounted in each pair of guideways and adapted to rest upon the shelf, means for preventing upward displacement of the brackets, and inclined blades at the outer ends of the brackets for lifting pulverized material out of the zone of action of the balls.

12. In a pulverizing mill, the combination of a shaft, a member mounted on the shaft having a plurality of pairs of vertical guideways provided at their lower ends with apertures, the guideways of each pair being connected at their bottom by a shelf provided with a channel registering with the lower part of the apertures in the guideways, brackets detachably mounted in each pair of guideways and supported upon the shelf at the bottom thereof, fan blades at the outer ends of the brackets, and means adapted to be inserted through the apertures at the lower ends of the guideways and the channel in the corresponding shelf for dislodging the brackets when they are to be removed from the guideways.

13. A pulverizing unit, comprising a casing, a grinding ring, grinding balls in the ring, a shaft within the casing, a member mounted on the shaft and provided with a plurality of arms, each having a projection at the upper part of its outer end and a hook member projecting from its front face, and pushers mounted upon the arms each having an internal socket adapted to receive the projection on the end of the arm and a curved socket adapted to receive the hook member whereby the pushers are held upon the arms in position to engage the balls to propel the same when the shaft is rotated.

14. A pulverizing unit comprising a casing, means within the casing for pulverizing material, a conduit leading from the top of the casing, means within the casing for forcing a current of air laden with pulverized material through the conduit for separating the material from the air, a return conduit from the separating means to the casing, and a feeder mounted on the casing for feeding material to the pulverizing means and which is constructed and arranged to exclude air from entering the casing with the material.

15. In a pulverizing unit, the combination of a shaft, a member mounted on the shaft and provided with a plurality of pairs of guideways, brackets detachably mounted in the guideways, and blades associated with the brackets.

16. In a pulverizing mill, the combination of a shaft, a member mounted on the shaft provided with a plurality of pairs of vertical guide ways, the guide-ways of each pair being connected at their lower ends by a shelf, a bracket detachably mounted in each pair of guideways and adapted to rest upon the corresponding shelf, means for preventing upward displacement of the brackets, and fan blades associated with the brackets.

17. A pulverizer mill comprising a casing provided with a chamber in its upper part, means within the casing for pulverizing material, a shaft within the casing, means on the shaft for actuating the pulverizing means, means actuated by the shaft for raising material from the pulverizing means, a fan in the chamber at the upper part of the casing and an adjustable damper for controlling the effect of the fan upon the air laden with pulverized material in the casing below the fan, in combination with a separator and conduits through which air may circulate from the fan to the separator and back to the casing.

18. A pulverizing mill comprising the combination of a casing, a grinding ring therein, grinding balls in the ring, a shaft,

pusher arms on the shaft for propelling the balls around in the grinding ring, rotatable lifting means within the casing for raising the material from the grinding ring, a chamber within the upper porton of the casing, a fan located in the chamber and an adjustable damper for controlling the draught of the fan upon the air and pulverized material within the portion of the casing below the fan, in combination with a separator and ducts in which air flows from the fan to the separator and from the separator back to the casing.

In testimony whereof I affix my signature.

HARRY RAYMOND COLLINS.