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ROLLER MILL.

APPLICATION FILED JAN. 18, 1917. RENEWED OCT. 19, 1918.

1,309,211.

Patented July 8, 1919.

3 SHEETS—SHEET 1.

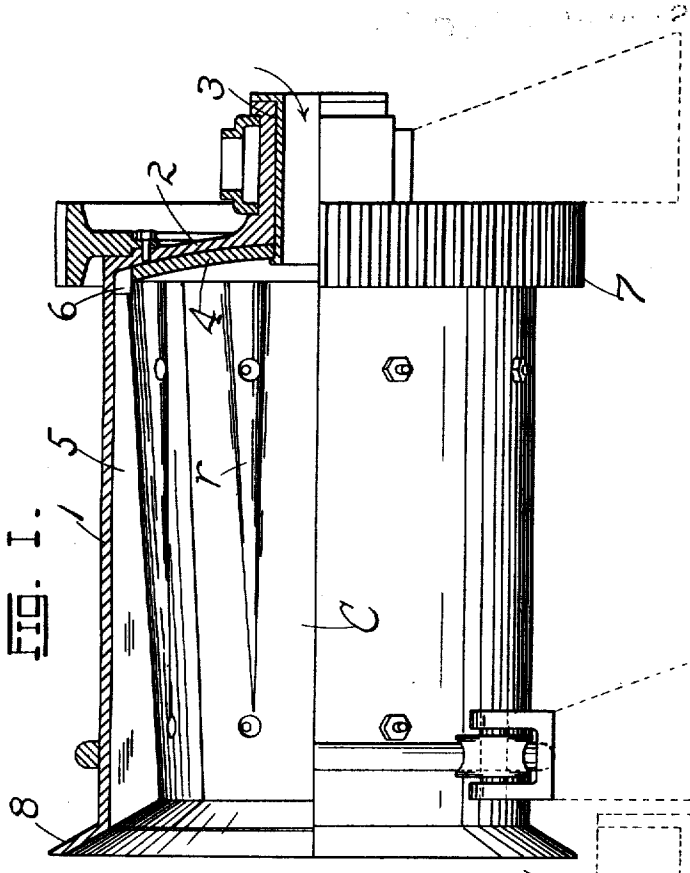



Fig. 1.




Fig. 4.

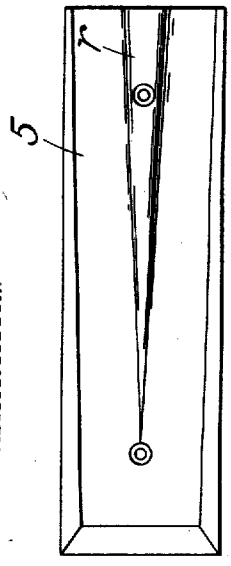



Fig. 3.

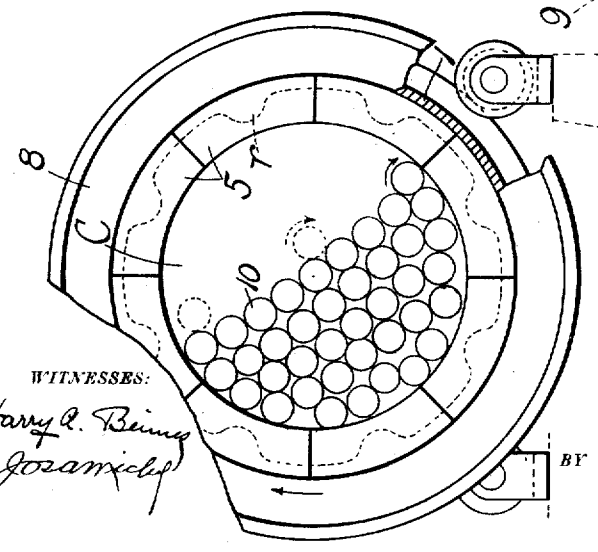



Fig. 2.

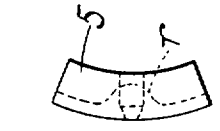



Fig. 5.

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3 SHEETS—SHEET 2.

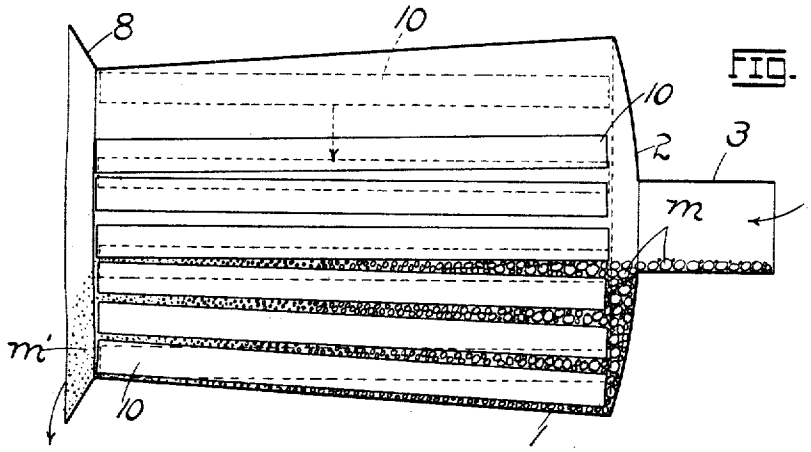



FIG. 6.

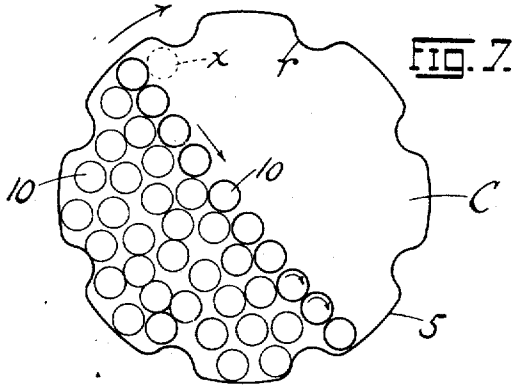



FIG. 7.

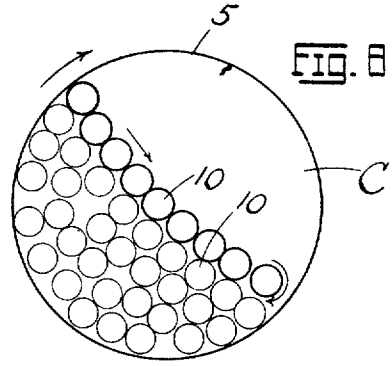



FIG. 8.




FIG. 11.

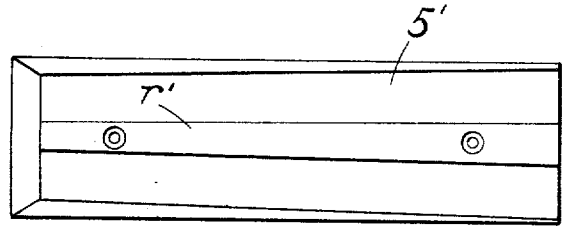



FIG. 9.

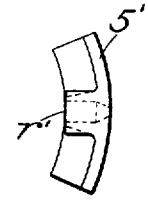



FIG. 10.

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3 SHEETS—SHEET 3.

Fig. 12.

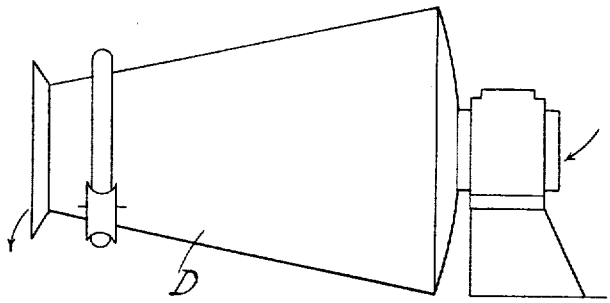



Fig. 13.

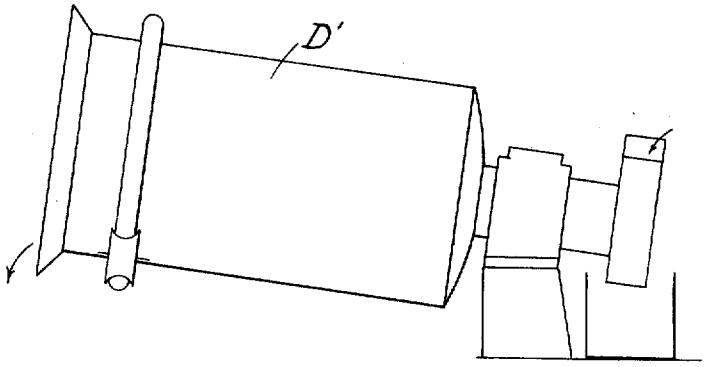
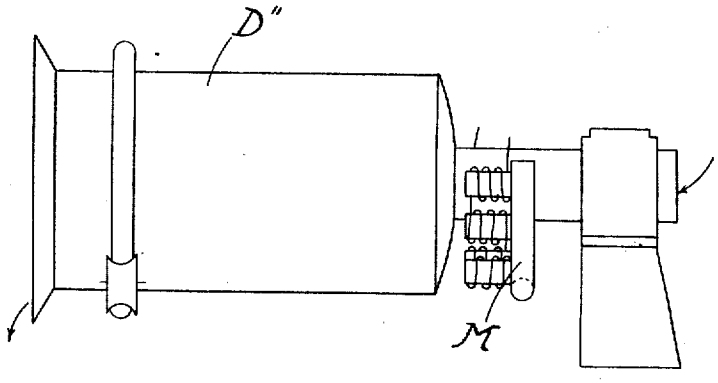



Fig. 14.




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# UNITED STATES PATENT OFFICE.

FRANK E. MARCY, OF SALT LAKE CITY, UTAH.

## ROLLER-MILL.

1,309,211. Specification of Letters Patent. Patented July 8, 1919.

Application filed January 18, 1917, Serial No. 143,078. Renewed October 19, 1918. Serial No. 258,907.

*To all whom it may concern:*

Be it known that I, FRANK E. MARCY, a citizen of the United States, residing at Salt Lake City, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Roller-Mills, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part hereof.

My invention has relation to improvements in roller-mills; and it consists in the novel features of construction more fully set forth in the specification and pointed out in the claims.

The present invention is directed to that class of crushing and disintegrating apparatus wherein the material is reduced to particles of the desired size by means of freely moving crushing bodies in the form of bars, rods or rollers acting by impact and attrition upon the charge confined within a suitable tumbling barrel, drum, or equivalent tubular container or treatment vessel rotated about a fixed axis, the opposite ends of the barrel being respectively provided with intake or feed and discharge openings for the material, as well understood in the art. A barrel or mill having the feed and discharge openings at opposite ends, is usually provided with a head at each end, the openings referred to being formed in said heads. Where the crushing bodies are in the form of longitudinally extended bars, rods or rollers, by the time they are worn down to say five-eighths of an inch cross-sectional diameter, they begin to kink and tie up the entire mass of rods. The end or head of the mill must then be removed from the shell and these bent and kinked rods are cut out with a cold chisel. The removal of the mill head and the replacing of it back on the shell consumes considerable time and entails much labor, these heads being of considerable weight even in the smallest size mill. One of the objects of the present invention is to provide a mill from which the worn down grinding bars or rods may be withdrawn without the necessity of removing the head or end as above described. This I accomplish by constructing the mill or tumbling barrel with but one head or closed end, the opposite end being left open and unobstructed so that access may at all times be had to the contents of the mill (grinding bars and material being crushed) and the worn down bars or rods removed from time to time with a minimum of effort and little or no loss of time. In the present embodiment of my invention the closed end or head is at the feed end of the mill, the head being provided with an opening for introducing into the mill the material to be crushed, the open end of the mill serving as the discharge for the finished product. Since the grinding rods would, unless prevented, pass out with the crushed material through the open end of the mill, it follows that another object of my invention is to provide means for keeping the rods in the mill during the grinding operation while permitting the free escape of the crushed material therefrom. A further object is to provide a mill the interior of which is at all times freely accessible for purposes of repair; one which at all times permits of ready inspection of the contents; one whose shape conforms itself to actual working conditions; one in which the danger of grinding rods becoming caught is minimized; one in which the ends of the rods at the feed end partake of a greater movement in a direction across the plane of rotation of the mill than at the discharge end, whereby the coarse particles entering the mill are more effectively crushed, so that here again the shape of the mill well fits the conditions and the work required of it. A further object is to provide a mill of the character referred to that is susceptible of various modifications without departure from the spirit of the invention; and finally to provide a mill possessing further and other advantages better apparent from the following detailed description in connection with the accompanying drawings in which—

Figure 1 represents the mill half in side elevation and half in vertical longitudinal middle section, the plane of section being taken between the meeting sides of two contiguous wall-liner sections; Fig. 2 is an end view looking toward the discharge end of the mill, parts being broken away; Fig. 3 is an inside plan view of one of the ribbed wall liner sections; Fig. 4 is an end view thereof looking toward the feed end. Fig. 5 is an end view of the liner section looking toward the discharge end; Fig. 6 is a diagrammatic middle longitudinal section through the mill showing the manner of operation of the grinding rods; Fig. 7 is a diagrammatic end view of the feed end looking from a point inside the mill, show-

ing the manner of operation of the grinding rods; Fig. 8 is a diagrammatic end view of the discharge end looking from a point outside the mill showing the action of the grinding rods; Fig. 9 is an inside plan view of a modified form of wall liner section; Fig. 10 is an end view thereof looking toward the feed end; Fig. 11 is an end view thereof looking toward the discharge end; Fig. 12 is a diagrammatic side elevation of a modified form of mill; Fig. 13 is a diagrammatic side elevation of a still further modification of the mill; and Fig. 14 is a diagrammatic side elevation of a third modification.

Referring to the drawings, and for the present to Figs. 1 to 8 inclusive, 1 represents a cylindrical container, drum, tumbling barrel, or equivalent tubular member, the same being closed at the intake end by a head or cover 2 provided with a hollow feed or intake trunnion 3 for the pulp as well understood in the art. The head 2 is protected by the end liner 4, the shell or cylindrical portion of the barrel being protected by a wall liner which in the present case is made up of a series of sections 5 placed in contiguous relation and extending the full length of the shell. The wall and end liners are locked against displacement when once in position by a lug 6 on the shell or in any other approved mechanical manner. The drive gear 7 in the present instance is at the feed end of the barrel. The wall liner sections 5 are provided with ribs or lifters $r$ tapering toward the discharge end and terminating a suitable distance from said end so as to leave the discharge end of the wall liner perfectly smooth.

In the present invention the discharge end of the mill is not provided with a head but is left entirely open, said open end being provided with a flaring flange or discharge funnel 8 which delivers the finished product to a launder 9 or other suitable receptacle. In the form of invention illustrated in the figures referred to, the wall liner sections gradually increase in thickness from the feed to the discharge end whereby there results a frusto-conical crushing compartment C with the narrow end of the frustum at the discharge terminal of the shell or drum, and with the base of the frustum at the feed end. The pitch or slant of the cone (that is to say the angular inclination of the elements of the cone to the axis of the cone) in no wise interferes with the free advance of the material through, or its final discharge from, the mill, said pitch being however sufficient to prevent the discharge of the grinding bars or rods 10 employed as the crushing or attrition bodies in the present mill. Necessarily, the plane of discharge of the pulp or other material as it leaves the drum is below the bottom of the feed opening in the head 2. The inclined walls of the crushing compartment not only prevent the discharge of the grinding rods from the open end of the mill but serve to hold them to the closed end, this being specially true of the lower portions of said walls, since the rods tend to slide down the walls toward the head 2. The walls of the crushing compartment converging as they do toward the discharge end of the mill, permit the grinding bars 10 to be expanded more at the feed end by the coarser particles $m$ of the charge entering said end, the bars gradually converging toward the discharge end with the progressive diminution in the size of the particles as the charge approaches said end; and when the discharge end is reached, the fine particles $m'$ permit the ends of the rods at said end to come closer together than at the feed end, as illustrated in Fig. 6 of the drawings. In order to crush these relatively coarse particles $m$ entering the feed end it follows that the ends of the grinding bars at said end must travel farther than the opposite ends which have only the fine particles $m'$ to contend with, the work involved in breaking the coarse particles being greater. In other words the travel or movement of the grinding rods across the plane of rotation of the mill is greater at the feed end than at the discharge end, the movement between two bars being akin to that between a pair of hinged jaws; and since this action of the bars is due to the shape of the grinding compartment of the mill, and since effective attrition or grinding requires just such action, it follows that the shape of the present mill (that is to say with crushing compartment converging toward the discharge end) is ideal, conforming as it does to the conditions and work required of it.

In mills of the general class here alluded to, the ribbed surface of the wall liner (or even in structures which have no ribs or lifters) operates as a conveyer to carry the grinding bars or rods up to the point of discharge or precipitation indicated at $x$ in Fig. 7. The rods indicated by light circles are practically stationary with respect to the mill itself, whereas there is a continual cataract or precipitation of rods rolling down the incline represented by the heavy circles. The conical crushing compartment being narrower at the discharge than at the feed end of the mill, it follows that in rolling down the incline aforesaid the distance traveled by a rod at the discharge end is less than that traveled at the feed end. When therefore the end of a rod at the discharge end of the mill has its fall arrested by the upwardly sloping wall of the mill the opposite end of the rod is still rolling down the incline toward the downwardly sloping wall of the mill (the

bottom elements of the cone sloping up toward the discharge end and sloping down toward the feed end); and until this end of the rod is itself arrested by striking the bottom of the mill, that end will keep on rolling and rotating about the axis of the rod causing the arrested end to likewise rotate about said axis. The action is akin to that of a car axle when the car is going over a curve in the rails. The outer wheel of the axle rolls over the outer rail which is considerably longer than the inner rail, causing the inner wheel to slip on its rail. The inner wheel therefore merely turns on its axis not having the room to roll as has the outer wheel. The same is true of the grinding bars 10 in the present mill, that is to say as the rods approach the bottom of their fall or drop, the action of the rod at one end is a rolling and rotating one, whereas at the opposite end it is merely a rotating one, the rotating end slipping over the adjacent rods. This combined rolling and rotating and slipping action is very effective in the grinding of the ore or other material, and constitutes a material contribution to the efficiency of the mill. The rods or grinding bars for the major portion of their drop fall vertically and substantially parallel to the axis of the mill so that their ends do not strike the end liner or head of the mill (see dotted rods in Fig. 6). The mill is operated the same as any other mill of its class and requires no description in the present connection. The direction of rotation of the mill is indicated by the curved arrows in Figs. 2, 7, and 8. A mill of the character described grinds extremely fine, the finest particles being uniform; it is superior to the conventional ball or pebble mill in that it does not produce the objectionable impalpable pulp made by these mills. The reason of it is that grinding rods or bars do not get as close together as the balls or pebbles, and hence impalpable powder does not result.

The form and length of lifter or rib $r$ may be varied and I do not wish to be limited to the type shown in the figures above referred to. Thus, in the modification shown in Figs. 9, 10, and 11, the liner section 5′ is provided with a rib or lifter $r'$ extending the full length of the liner, the rib tapering to and disappearing at the discharge end of the mill.

In the form of mill above described, the conical form is imparted to the crushing compartment C by the wall liner, the inner walls of said liner converging toward the discharge end of the mill. I may however, make the shell of the barrel conical in which case the wall liner would be of uniform thickness throughout. Such a conical shell is shown in the modified barrel or drum D in Fig. 12. Again in lieu of a conical shell, I may employ a cylindrical shell such as D′ shown in the modification in Fig. 13, in which case however the mill is mounted with the axis of the drum inclined to the horizontal so as to cause the grinding rods or bars to be held toward the closed end or head of the drum. In the mills above referred to, gravity is of course depended on to maintain the rods against discharge from the mill, and to hold the same toward the closed end thereof. I may however resort to magnetism to hold the rods in their proper place in which event a cylindrical mill D″ may be employed with its axis disposed horizontally as shown in the modification in Fig. 14. In that case I employ an electro-magnet M to attract the grinding rods and prevent the same from discharging through the discharge end of the mill. In all the forms described, excepting of course that shown in Fig. 14, the bottom or lower portions of the walls of the crushing compartment incline permanently upward toward the discharge end, said inclination causing the grinding rods to operate in the manner previously described in connection with Figs. 6, 7, and 8 of the drawings. This inclination must not of course be excessive; that is to say it must not be so steep as to cause the grinding rods to thump (with their ends) against the end liner 4 or head 2, but it should be sufficient to prevent the rods from working through the discharge end of the mill. The mill being open at the discharge end, that is to say, having no head or its equivalent closing said end, it necessarily follows that the discharge opening will be larger than the feed opening in the head at the opposite end, the boundaries of the discharge opening being substantially commensurate with the circumferential measurement of the terminals of the inner walls of the crushing compartment at the discharge end of the mill. In other words, the discharge opening and the discharge end of the inner wall of the crushing compartment of the mill are coincident. I do not however wish to exclude from my invention a mill in which the discharge opening is not larger than the feed opening, as certain features of the invention are not necessarily dependent on the size of the discharge opening. The mill is obviously susceptible of modification in particulars not herein referred to without a departure from the nature or spirit of the invention. Features shown but not alluded to are well understood in the art and require no description in the present connection.

Having described my invention what I claim is:—

1. A mill of the character described comprising a tumbling barrel and longitudinally extended grinding rods therein, said barrel

having one end closed by a head, the opposite end of the barrel being open and unobstructed for the discharge of the material and the direct withdrawal of the rods therethrough, said grinding rods being disposed with one end adjacent the head and with their opposite ends adjacent the open end of the barrel, the inner walls of the barrel being formed to confine the rods against discharge through said open end during the rotation of the barrel.

2. A mill of the character described comprising a tumbling barrel and longitudinally extended grinding rods therein, said barrel having one end closed by a head provided with a feed opening, the opposite end of the barrel being open and unobstructed for the discharge of the material and the direct withdrawal of the rods therethrough, said grinding rods being disposed with one end adjacent the head and with their opposite ends adjacent the open end of the barrel, the inner walls of the barrel being formed to confine the rods against discharge through said open end during the rotation of the barrel.

3. In a mill of the character described, a tumbling barrel having an outer shell, a feed-intake head closing one end of the shell, the opposite end of the shell being open for purpose of discharge, and a wall liner on the shell increasing in thickness from the feed to the discharge end of the shell whereby the inner walls of the liner sustaining the charge converge toward the open end.

4. In a mill of the character described, a tumbling barrel having one end closed by a head provided with a feed opening, the opposite end of the barrel being open for the discharge of the material, suitable grinding rods confined loosely in the barrel and adapted to be withdrawn through the open end thereof, the inner walls of the barrel being inclined upwardly at the bottom from the feed to the discharge end to prevent the grinding rods from working out through the discharge end while permitting the flow of the material through the barrel from the feed to and through the discharge end.

5. In combination with a tumbling barrel, longitudinally extended loose grinding rods therein, said barrel having a feed end provided with a head, the opposite end of the barrel being normally open for the discharge of the material and the permanent exposure to, and direct withdrawal of the grinding rods through, the opening at said end, the inner walls of the barrel forming means for confining the grinding rods against discharge through said open end during the rotation of the barrel.

6. In combination with a tumbling barrel provided with grinding bars loosely confined therein and disposed in the general direction of the rotation axis of the barrel, the barrel having a feed end and a discharge end, means on the inner walls of the barrel for causing the ends of the bars nearest the feed end to participate in movements across the plane of rotation in excess of the movements of the opposite ends of the bars, during the grinding operation.

7. In a mill of the character described, a tumbling barrel having one end closed by a head provided with a feed opening, the opposite end being open for the discharge of the finished product, suitable grinding bars confined loosely within the barrel, the inner walls of the barrel being pitched or inclined to the rotation axis thereof sufficiently to prevent the grinding bars from working out through the discharge end while permitting the flow of the material through the barrel from the feed to the discharge end.

8. In combination with a tumbling barrel, longitudinally extended loose, and freely moving grinding rods therein, said barrel having a feed end provided with a head, the opposite end of the barrel having an unobstructed opening for the discharge of the material and the permanent exposure to, and direct withdrawal of the grinding rods therethrough, and means on the inner walls of the barrel for maintaining the grinding rods against discharge while the same are tumbling opposite the opening at the discharge end during the rotation of the barrel.

9. A mill of the character described comprising a tumbling barrel and longitudinally extended loose grinding rods therein, one end of the barrel being closed by a head provided with a feed opening, the opposite end being normally open to discharge the material, the inner walls of the barrel being inclined upwardly at the bottom from the feed to the discharge end to cause the rods to lug the feed end.

10. A mill of the character described comprising a tumbling barrel and longitudinally extended loose grinding rods therein, one end of the barrel being closed by a head provided with a feed opening, the opposite end being normally open to discharge the material, the inner walls of the barrel being inclined upwardly at the bottom from the feed to the discharge end to cause the rods to lug the feed end, the plane of discharge being below the bottom of the feed opening.

11. A mill of the character described comprising a tumbling barrel and longitudinally extended loose grinding rods therein, said barrel being closed at one end by a head, the opposite end being normally open to discharge the material and permit the withdrawal of the grinding rods, the inner walls of the barrel being inclined upwardly at the bottom from the closed to the open end to cause the rods to lug the closed end of the barrel.

12. In a mill of the character described, a tumbling barrel having one end closed by a head provided with an opening for the passage of the material therethrough, the opposite end of the barrel having an opening for the discharge of the material, freely moving grinding rods in the barrel extended substantially the length of the barrel, said rods being disposed with one end opposite and adjacent to the head, and with the other end permanently opposite and adjacent to the discharge opening.

13. In a mill of the character described, a tumbling barrel, longitudinally extended loose grinding rods therein, said barrel being closed at one end by a head provided with a feed opening, the opposite end having an unobstructed opening for the discharge of the material and the permanent exposure to, and direct withdrawal of the grinding rods therethrough, the inner walls of the barrel being inclined upwardly at the bottom from the feed to the discharge end to cause the rods to hug the feed end of the barrel.

In testimony whereof I affix my signature, in presence of two witnesses.

FRANK E. MARCY.

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**Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."**