Jan. 9, 1923. 1,441,584.

J. F. ISBELL.

BALL MILL.

FILED NOV. 3, 1919. 2 SHEETS—SHEET 1.

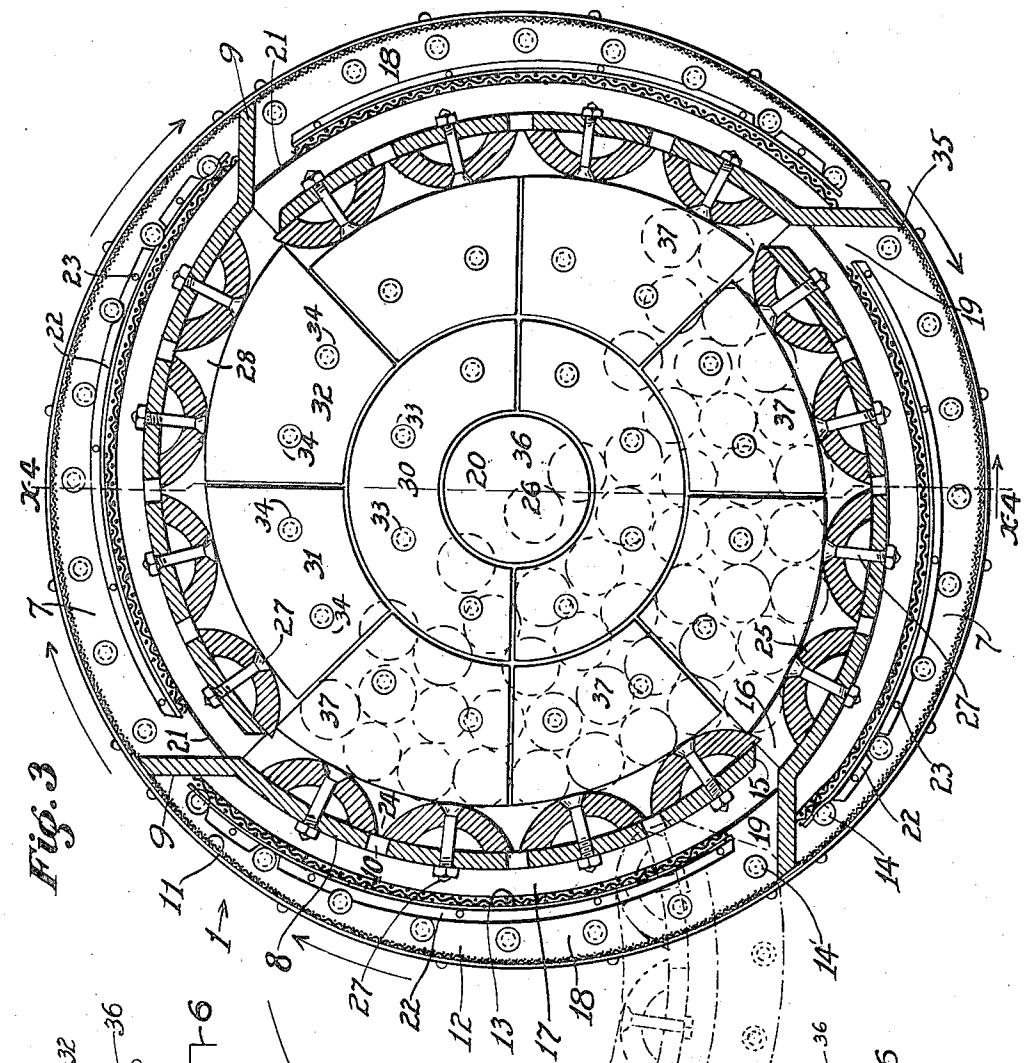


Fig. 3

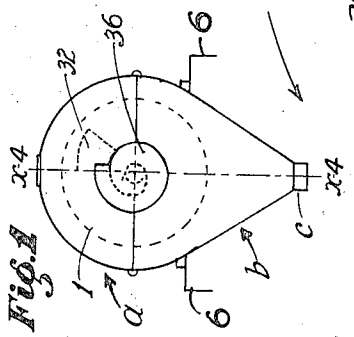


Fig. 4

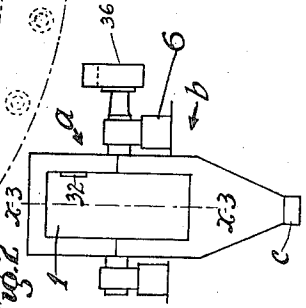


Fig. 2

Witness
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2 SHEETS—SHEET 2.

Fig. 4

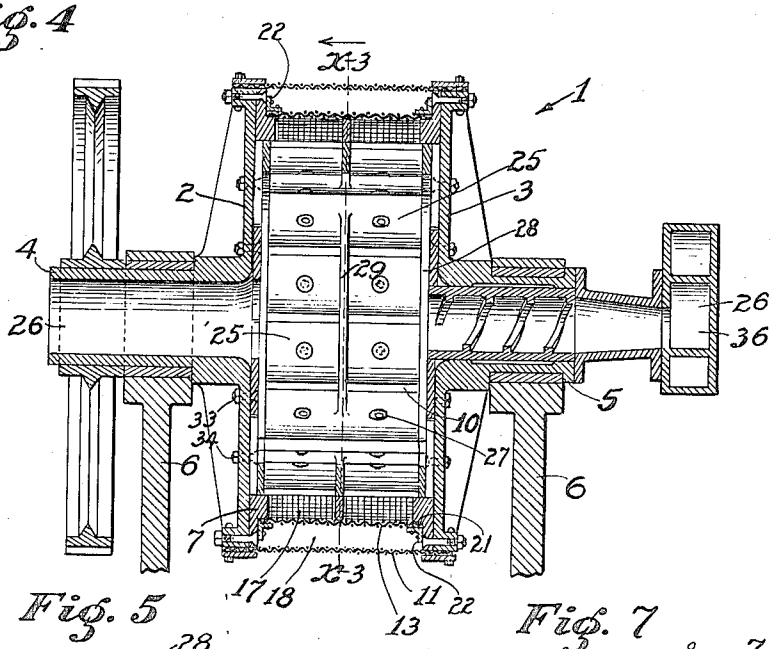


Fig. 5

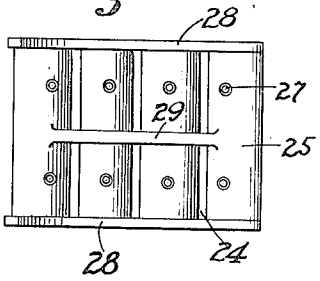


Fig. 7

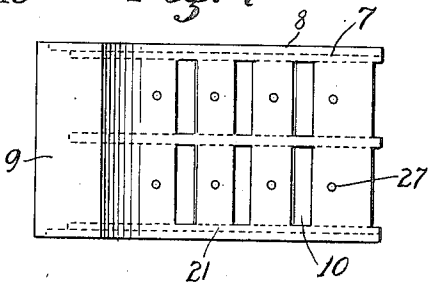


Fig. 8

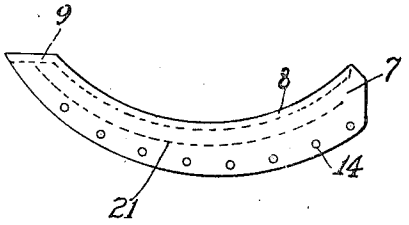
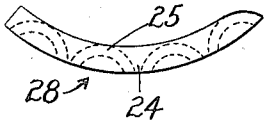


Fig. 6



Witness

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Patented Jan. 9, 1923. 1,441,584

UNITED STATES PATENT OFFICE.

JOHN F. ISBELL, OF ALHAMBRA, CALIFORNIA, ASSIGNOR OF ONE-HALF TO FRANCIS M. TOWNSEND, OF LOS ANGELES, CALIFORNIA.

BALL MILL.

Application filed November 3, 1919. Serial No. 335,547.

To all whom it may concern:

Be it known that I, JOHN F. ISBELL, a citizen of the United States, residing at Alhambra, in the county of Los Angeles and State of California, have invented new and useful Improvements in Ball Mills, of which the following is a specification.

This invention is adapted to both wet and dry reduction and relates to that character of ball mills in which the barrel is provided externally with a screen through which the fines are discharged, and within which screen a series of plates are arranged to sustain the liners, the balls and the uncrushed material; there being intermediate screens between the plates and the outer screen, and passages between the plates through which the oversize or rejections are returned to the interior of the barrel to be again subjected to the action of the balls.

This invention relates to that class of grinding mills designed to reduce ore and its gangue to the required size for concentration purposes, and particularly embraces means for permitting the ready discharge of the ground material from the mill immediately after it has been reduced to the proper size; thereby avoiding repeated grinding and consequent reduction of the ore to extreme fineness or slime condition.

In mills of this character as heretofore constructed there has been an undesirable feature in the operation in that a large percentage of the material which has already been reduced to proper fineness is retained by the plates and is subject to reducing action after the proper fineness has been reached; and a further objection has been that pieces of ore would become jammed into the outlets provided through the plates, thus clogging the mill.

A further inconvenience and expense has been common to these mills owing to the difficulty of opening the barrel to gain access to worn or broken interior parts of the barrel.

An object of this invention is to so construct the mill as to avoid all of the said objections and to immediately discharge the pulp which has been reduced to the required fineness as determined by the outer screen.

A feature of this invention is the construction of the plates with outlet openings of comparatively large size so that when the reduced material reaches the openings it will immediately pass through to the screen.

This invention is an improvement in the art in that the ball and material supporting surface inside the plates is constructed with corrugations, the depressions between which extend to form passages opening into the outlets through the plates. Said corrugations may be constructed of bars respectively extending in parallelism with the axis of the barrel, and the inner faces of which bars are reduced inwardly from the outer edges of the bars, so that passageways are formed between the bars to the outlets through the plates and are reduced outwardly. Such bars are preferably cylinder segments fitted against and bolted to the plates; and the outlets through said plates are preferably slots extending lengthwise of the barrel and wider than the outlets between the bars.

The bars are fixed to the plates by suitable means and are preferably constructed in sections comprising two or more bars held together by suitable means for the purpose of avoiding separate parts, and also for convenience in manufacture and repair. Sections respectively comprising a plurality of bars united in a single casting may be employed.

Preferably each plate is provided with a plurality of bars and is secured to the heads of the barrel by means adapted to allow the plates to be separately swung outward, respectively, for the purpose of gaining access to the interior of the barrel from any side.

An object is to provide a cheap and simple construction whereby the barrel can be opened and the liners removed one independent of the other, and replaced with minimum expenditure of time and labor.

One object of my invention is to provide a mill of the class named with discharge means that will permit the escape from the mill of the materials reduced to the required size, without liability of being again subjected to further grinding.

An object of my invention is to provide a mill of the class described which will be simple and cheap of construction, accessible in all parts for replacement of liners and screens and which will have a greater capacity for grinding ores and their gangue.

This invention is an improvement in the art in that the rotary drum or barrel is

formed of segmental parts which are easily disconnected or pivotally moved to an open position for the purpose of repair or replacement of broken or worn parts. Also in the internal grating and means for the discharge of the pulp at the periphery of the drum the moment it has been reduced to a desired fineness thus to avoid sliming of the ore by over reduction thereof.

An object is to make provision whereby all ore and its gangue is reduced to practically uniform size, thereby to produce a superior product suitable for gravity concentration by the action of water.

Other objects, advantages and features of invention may appear from the accompanying drawings, the subjoined detail description and the appended claims.

The accompanying drawings illustrate the invention.

Figure 1 is a diagrammatic elevation of the feed end of a ball mill constructed in accordance with this invention.

Fig. 2 is a diagrammatic side elevation with the housing of the mill in vertical midsection, thus showing the barrel in elevation.

Fig. 3 is an enlarged cross-section on line x^3, Fig. 2.

Fig. 4 is an axial section on line x^4, Fig. 1.

Fig. 5 is an inside view of one of the liner sections removed.

Fig. 6 is an end view of the liner section shown in Figs. 1, 3 and 4.

Fig. 7 is an inside view of one of the shell segments which carry the liner sections and which go to make up the shell of the barrel.

Fig. 8 is an end view of the shell segment shown in Fig. 7.

In Figs. 1 and 2 of the drawings the barrel 1 is shown enclosed in a housing comprising the cap *a* and the funnel *b*, which are indicated as constructed of sheet metal for the purpose of retaining the dust or splatter from the machine and to direct the product through the outlet *c* to a receptacle not shown.

The barrel is constructed with two heads 2, 3 provided respectively, with trunnions 4, 5 journaled in a well known manner upon the frame 6 which may be of any desired or well known construction.

The heads are circular and the shell of the barrel is made up of segmental sections comprising flanges 7, fitting the inner faces of the heads and connected by a web comprising a segmental plate 8, eccentric to the heads, and a tangential apron 9 integral with flange 7 and extending from one end of the plate toward the rim of the plate 8 at the periphery of the barrel. The eccentric plates 8 are provided with outlet openings 10 which are preferably in the form of slots extending longitudinally of the barrel. The external screen 11 is made up of sections fastened to the rims of the heads 2, 3, and engaging the outer ends of the aprons 9 and the edges of the flanges 7 to form a screening chamber 12. Each screening chamber is partitioned into two compartments by means of an inner screen 13 which is preferably of coarser mesh than the external screen 11. The flanges 7 of each segment extend from the outer face of the web 8 and apron 9, and are gradually widened from the apron to the rear of the segment and are conformed at their rear ends to the apron 9 of the succeeding segment so that when the segments are in place, the rims of the flanges 7, together with the outer edges of the aprons 9, conform to the periphery of a cylinder coaxial with the heads.

The means for connecting the segments to the heads preferably comprises bolts 14, 14′ extending through the flanges and the heads.

The flanges widen from their aprons rearwardly so that when the segments are fastened to the heads, the inner rear edges 15, of the plates 8, are spaced apart from the forward edges respectively of the succeeding plates and the aprons 9, thereof, to form a return-way 16 for rejections to pass from the inner screen chamber 17 into the interior of the barrel. The partition screen 13, of each segment is preferably concentric to the curvature of, and cooperates with the plate and apron and the flanges of such section to separate the main portion of the space between the plate and the external screen 11 into the inner and outer compartments or screen chambers 17, 18. The partition screen 13 of each segment terminates short of the apron 9 of the succeeding segment so as to leave an open passageway 19 from the outer compartment of the screen chamber to the passageway 16 so that rejections from the screen chamber may all flow freely into the main chamber 20 of the barrel.

In practice each shell segment may be cast of a single piece and may be provided with the eccentric shoulders 21 upon which the inner screens 13 are fastened by means of curved angle irons 22 fixed by bolts 23 to the flanges.

The internal crushing or grinding faces of the segments are respectively provided with projections or corrugations 25 between which are open spaces or orifices 24 communicating with the outlet openings 10 through the plates 8; said projections are shown in Figs. 3, 4, 5 and 6 as being cylinder segments or convex bars 25 that extend in parallelism with the axis 26 of the barrel and are detachably fixed to the plates 8 by bolts 27. Said cylinder segments 25 are preferably connected together at their ends by ribs 28 so that a single section compris-

ing a plurality of cylinder segments is provided for each plate. An intermediate rib 29 connects the bars 25 between their ends to strengthen said bars. Said bars terminate in knife or sharp edges as at 25'.

The inner faces of the heads are protected by liners 30, 31, 32. The liners 30 are fastened to the heads by bolts 33 and the liners 31, 32 by bolts 34.

The segment-securing bolts 14, 14' are arranged in a circle and the rearmost bolt 14' of each segment is so arranged with relation to the rear outer corner 35 of the flange that when all of the bolts 14, of any shell segment are removed, said segment is free to swing outward upon the bolt 14' as a pivot, as indicated in dot and dash lines, in Fig. 3. By this arrangement, access to the interior of the barrel is readily gained through the side of the barrel. By then removing the angle irons 22 and screen 13, bolts 27 are made accessible, and, upon their removal the cylinder segments may be removed. By removing the bolt 14' peripheral segment may be entirely withdrawn.

In practice, the barrel structure is first charged with balls 37, and is then closed as indicated in Fig. 3 and is revolved in the direction indicated by the long curved arrows. The material to be reduced to proper fineness is fed through the usual feeding means, a form of which is indicated at 36. The balls which are indicated in broken lines at 37 in Fig. 3 are carried up by the irregularities or projections 25 and roll down over the mass of balls in the usual way and pound against the material to be reduced, and crush the same against the irregular convex surfaces formed by the cylinder segments 25. The barrel will be revolved at an appropriate speed varying with the diameter of the barrel.

With barrels of three feet diameter a speed of about 30 to 33 revolutions per minute may be most desirable. With a diameter of 6 feet the speed may be about 24 revolutions per minute.

The mill may be used to crush either wet or dry material.

The heads, segments and liners are preferably hard cast iron or manganese or other suitable hard material and are adapted to be fastened together without being machined.

The convex crushing surfaces and the outlets for crushed material between the edges of the successive surfaces, which convex surfaces are formed by the cylinder segments or bars 25, are effective to avoid any wedging of pieces of material in the outlets 24; and when any adjacent two bars 25 reach the upper side of the crushing chamber as the barrel revolves, the outlet between them is entirely freed by gravity from any pieces of material.

Since the slots 10 in the plate are wider than the outlets 24; all material which passes the outlets 24 will pass freely through the slots.

By making the inner projections convex I not only avoid wedging of broken material in the open spaces 24 leading to the outlets 10, but I also present to the balls and material to be crushed, an irregular surface that is highly resistant to breakage and wear.

The edges of the cylinder segments extend over the outlet orifices and are sharp, being knife edges so as to form an outlet having a ledge so that immediately any piece of material passes such edge it is free from the shell, and said ledge serves as means to prevent said material from returning to the main chamber through the outlets.

I claim.

1. In a ball mill, a plurality of heads adapted to revolve; a shell formed of eccentric, spaced segments having flanges provided with shoulders thereon, and being removably secured to said heads, and there being longitudinal outlets in said segments; screens secured against said shoulders and forming an inner screen chamber; and another screen secured to the outer edge of said flanges and forming an outer screen chamber; said inner and outer screen chambers being in open communication with the chamber of the barrel inside of said segments.

2. A ball mill comprising a barrel having a shell provided with outlet openings, and convex bars arranged adjacent to each other on the inside of said shell and with open spaces between the adjacent edges of the successive bars; said open spaces communicating with, and of less width than the outlet openings through the shell.

3. In a ball mill, a barrel comprising a shell having longitudinal slot-like outlets and convex bars arranged on the inner periphery of said shell and in parallelism with said outlets to form open spaces at said outlets of less width than the outlets; said bars being reduced in width toward the axis of the barrel so that the open spaces between said bars widen toward the axis of the barrel.

4. In a ball mill, a barrel comprising a shell having longitudinal slot-like outlets and bars arranged on the inner periphery of said shell and in parallelism with said outlets to form open spaces at said outlets; said bars being reduced in width toward the axis of the barrel so that the open spaces between said bars widen toward the axis of the barrel.

5. In a ball mill, a barrel provided with a shell having outlets and sectional grates fixed to the inside of the shell and provided with inwardly rounding bars spaced apart where they contact with the shell, the open spaces between the adjacent edges of said bars being narrower than the outlet spaces

through the shell and communicating with said outlet spaces.

6. In a ball mill, a barrel having a shell provided with outlets, a grate bar section conforming to a portion of the shell and comprising convex segments arranged longitudinally of the barrel and connected together by ribs, and bolts through the bars and shell to secure the sections and shell together.

7. A ball mill comprising a barrel having a series of spaced eccentric plates provided internally with spaced lining bars forming convex longitudinal corrugations.

8. A ball mill comprising a barrel having a series of spaced eccentric plates provided respectively with spaced lining bars forming convex longitudinal corrugations and there being outlets between said corrugations.

9. A ball mill comprising a series of eccentric plates provided respectively with a lining having corrugations extending in parallelism with the axis of the barrel and said lining having outlets between the corrugations; said outlets being narrowed intermediate their admitting and discharging orifices.

10. In a ball mill, a shell formed of spaced segments, a lining for each segment; said linings having thereon a plurality of convexed bars terminating in knife edges, and there being discharge openings between said knife edges.

11. In a ball mill, a shell formed of spaced segments, convexed bars on said segments, said convexed bars terminating in knife edges, there being discharge openings between said knife edges, and screen means enclosing said discharge openings.

12. In a ball mill, a shell formed of spaced segments, rounded bars on said segments, said rounded bars terminating in knife edges, there being discharge openings between said edges, plates having slots that are wider than, and that register with the discharge openings; screens enclosing said discharge openings and slots, and means for moving said screens to move the material discharging thereon.

13. In a ball mill, a plurality of heads adapted to revolve, a shell formed of eccentric spaced segments having flanges provided with shoulders thereon, and being removably secured to said heads, and there being longitudinal outlets in said segments, screens secured against said shoulders and forming an inner screen chamber, another screen secured to the outer edge of said flanges and forming an outer screen chamber, said inner and outer screen chambers being in open communication with the chamber of the barrel inside of said segments, a lining for each segment, each of said linings having thereon a plurality of cylinder segments the edges of which extend over said outlets so as to form ledges.

14. In a ball mill, a plurality of heads adapted to revolve, a shell formed of eccentric spaced segments having longitudinal outlets; and a lining for each segment, each lining having thereon a plurality of cylinder segments the edges of which extend over said outlets so as to form ledges.

15. In a ball mill, a barrel having a shell provided with outlets; and convex bars extending in parallelism with the axis of the barrel and arranged in parallelism with said outlets to form open spaces; the adjacent edges of said convex bars extending over said outlets so as to form ledges.

In witness whereof, I have hereunto set my hand at Los Angeles, California, this 22nd day of October 1919.

JOHN F. ISBELL.

Witness:
JAMES R. TOWNSEND.