N. L. HALL.

BALL OR TUBE MILL.

APPLICATION FILED NOV. 26, 1917.

1,315,770.

Patented Sept. 9, 1919.

4 SHEETS—SHEET 1.

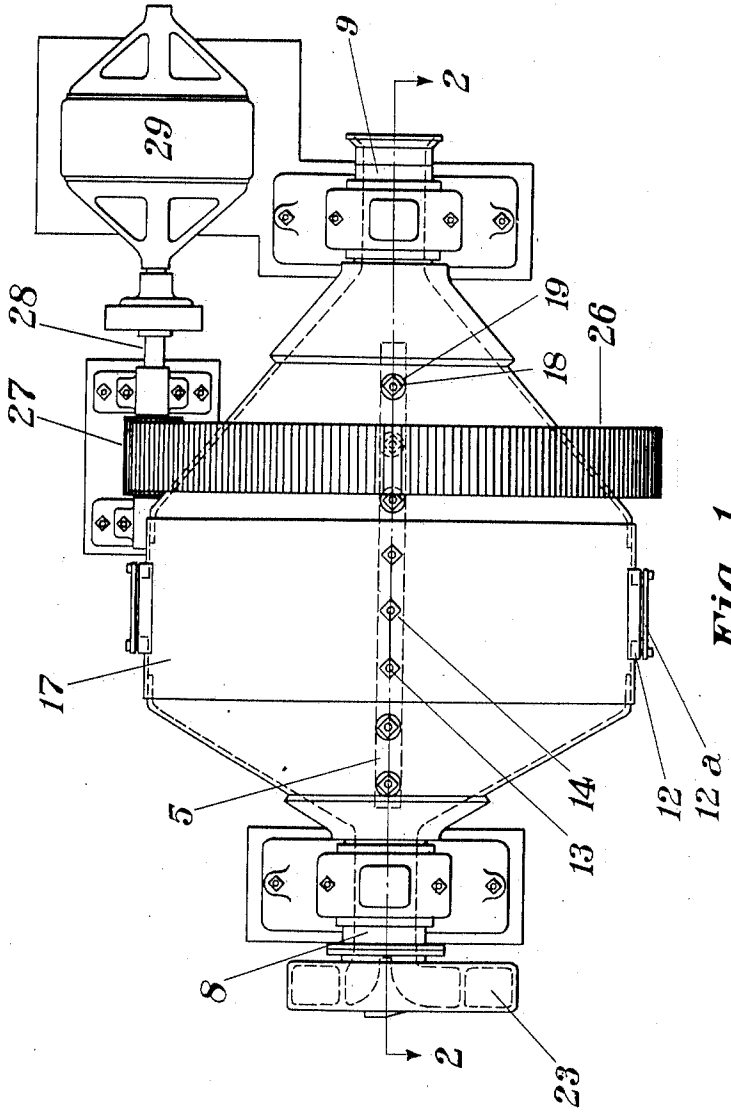


Fig. 1.

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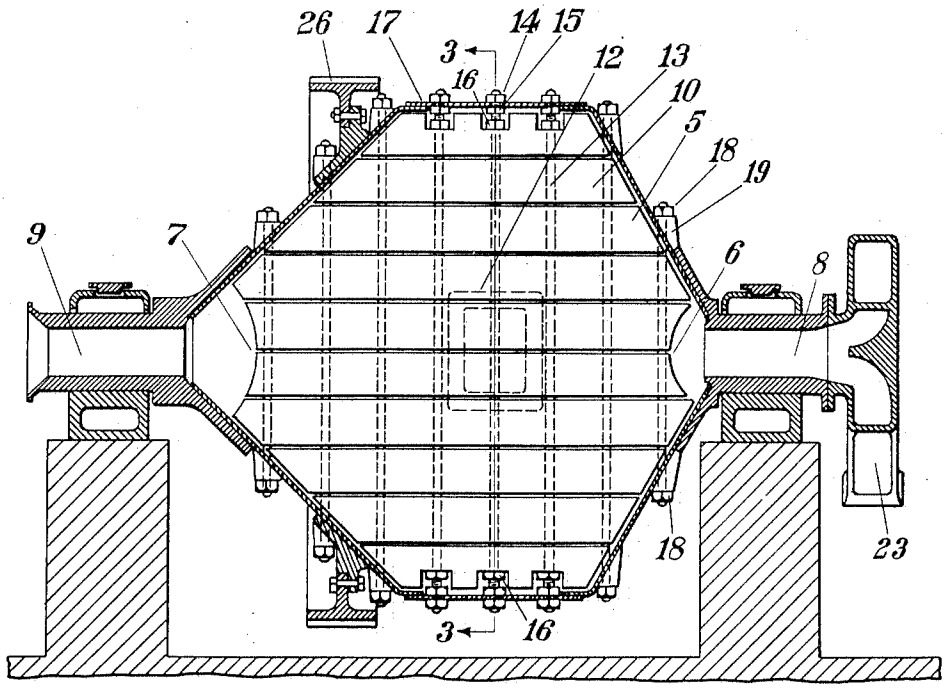


Fig. 2.

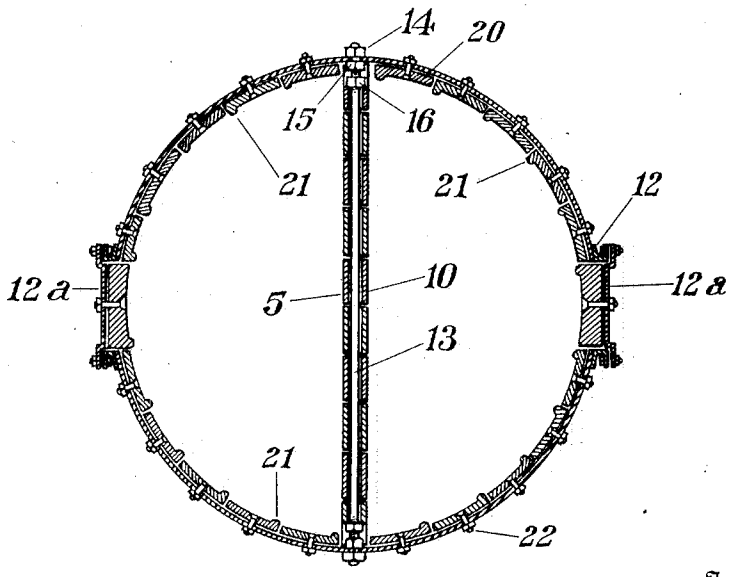


Fig. 3.

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4 SHEETS—SHEET 3.

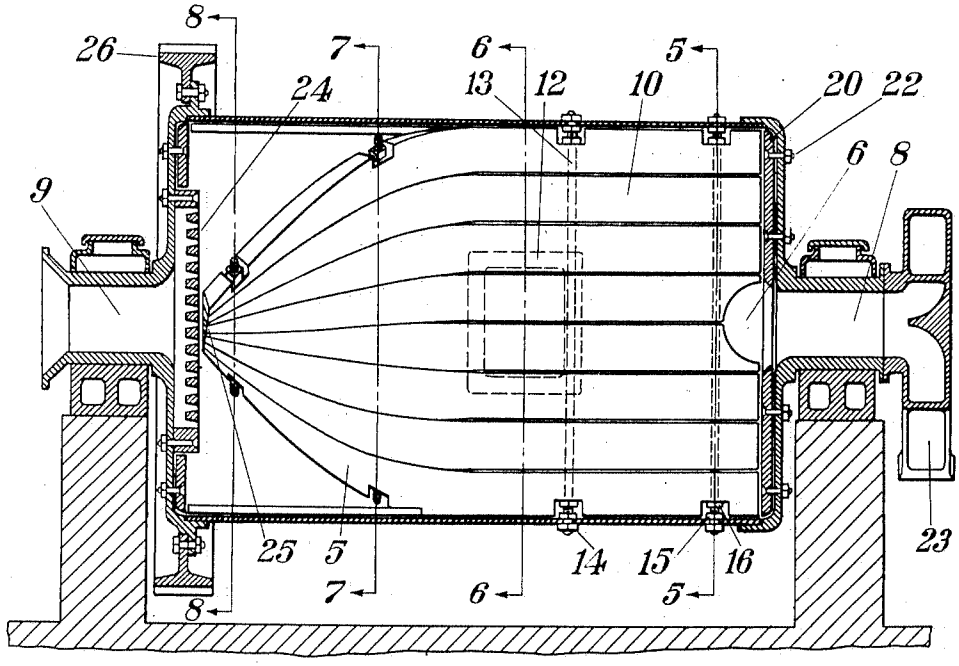


Fig. 4.

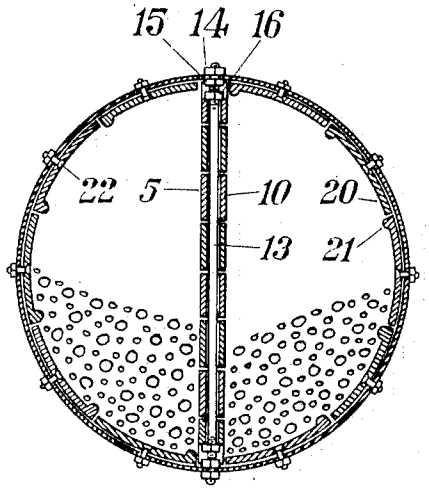


Fig. 5.

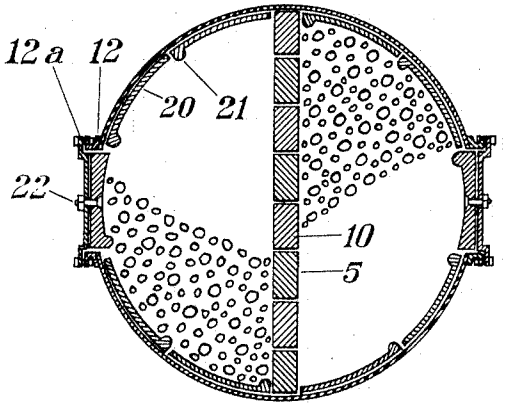


Fig. 6.

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4 SHEETS—SHEET 4.

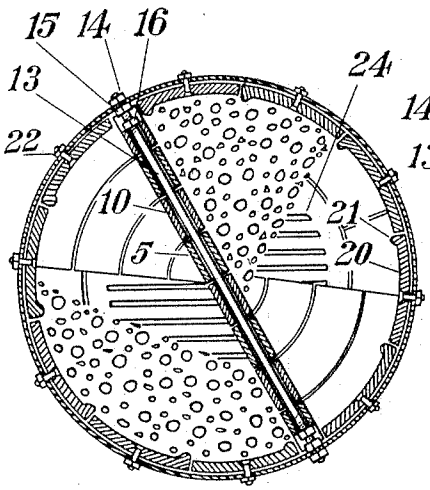


Fig. 7.

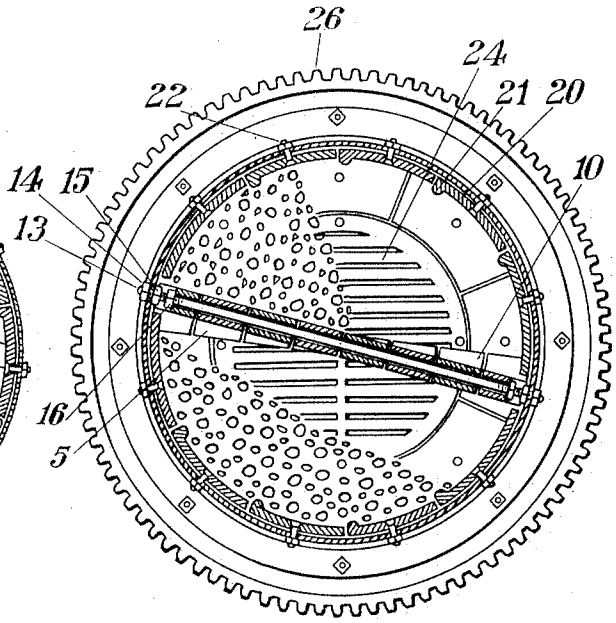


Fig. 8.

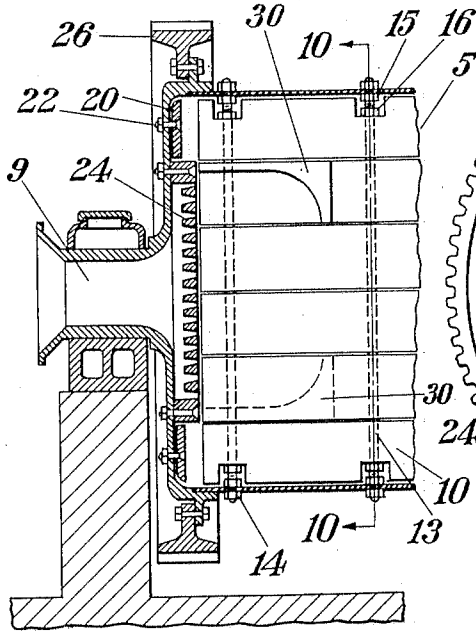


Fig. 9.

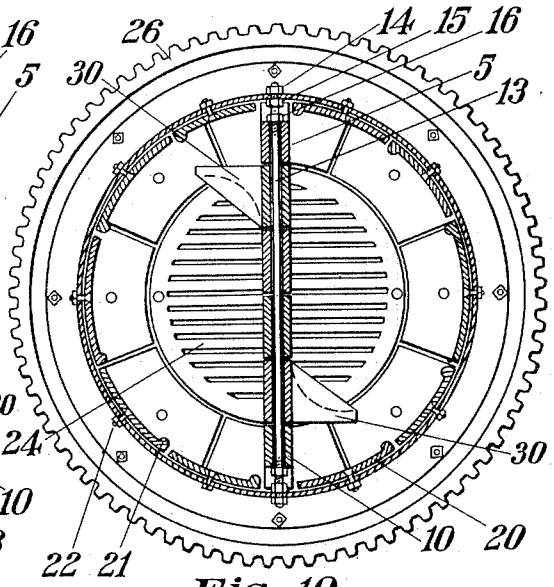


Fig. 10.

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UNITED STATES PATENT OFFICE.

NEWTON L. HALL, OF ANACONDA, MONTANA.

BALL OR TUBE MILL.

1,315,770. Specification of Letters Patent. Patented Sept. 9, 1919.

Application filed November 26, 1917. Serial No. 203,937.

To all whom it may concern:

Be it known that I, NEWTON L. HALL, a citizen of the United States, residing at Anaconda, county of Deerlodge, and State of Montana, have invented certain new and useful Improvements in Ball or Tube Mills; and I do 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, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

My invention relates to a class of grinding or pulverizing mills known as ball or tube mills used for the grinding of rock, ore or cement. In this class of mills the ore or other material is subjected to a tumbling or falling action in a drum or other rotating receptacle as distinguished from machines in which the material is broken up by the crushing action of stamps, jaws, rolls or similar crushing elements. The chief feature of my present invention consists of the revolving drum, cylinder or revolving receptacle of other suitable design, which is divided along its longitudinal axis by a diaphragm or wall extending on a diametrical line from wall to wall of the cylinder, or other receptacle, so that the receptacle is effectively divided into two substantially equal compartments; and while more than two walls could be used in my improved mill, it is believed that the ideal design is met by a single wall forming two compartments. At the feed and discharge ends of the cylinder the diaphragm is cut out or discontinued so as to allow the feed to be uniformly distributed to each compartment and to allow the pulp at the discharge end to join or mix in common before being delivered from the tube mill.

In my design I use any shape of revolving receptacle, either cylindrical or conical, or partially cylindrical or partially conical, and by placing a row of rods diametrically through the mill to support a wall I decidedly change conditions from those heretofore in vogue. In my improvement, when the wall meets the load, that is to say, one-half of the total load of the mill, it arrests the attrition effect and starts to lift the load to the apex of the mill, and then when the zenith is reached it drops the half load in a body through the maximum space within the mill. As this load falls, it drops in its entirety, the mixture of ground ore, water and balls being substantially uniformly distributed. The load falls with a decided impact, of a general mixture and through the maximum space within the mill.

In a plain mill the load is lifted on the concave surface of the receptacle, while in the compartment mill the load is lifted on the flat surface of the division wall. As noted before, the compartment mill can be used regardless of the shape of the receptacle, either cylindrical, conical, tubular or other geometrical shape, and any mill can be modified to form a compartment mill without changing its main or regular features.

The compartment mill seeks to reduce the attrition effect and increases the impact effect. It is accepted that extreme fines are produced more through attrition than through other effects and in present day practice of milling ore the desire is to crush to the required grade of fineness, and no finer. Extreme fines are difficult of recovery and yet are high in values. The ideal is to crack ore and then divide it again, then subdivide until the proper size is secured. This feature is best gained through impact.

The division wall may be of volute curvature, either way, that is right or left. I may find that a propelling action at right hand will leave the large parts of the load near the feed end, and the light parts at the screen, thereby producing a classification which effects a grading of the load and in consequence a grinding on a classified load as well as providing a medium for the longitudinal movement of the load. The curvature of the wall provides a positive medium for the advancement of the load and I assume it will be more effective upon the more mobile portion of the load as the water and fines. As the load is in the bottom of the cylinder, the liquid of the load has a small space of time in which to seek its level, even though it has been advanced through the propeller action of the wall.

The wall should not be curved so much that it throws the entire load against the

screen, but it should be so adjusted that it has sufficient effect to advance the load so that its time within the mill is not excessive and whereby overcrushing is avoided. It is accepted that excess crushing is due to the fact that the pulp is left too long a time in the mill without an avenue for its escape. The curvature of the wall may be of such nature as to keep the charge within the mill or to delay the escape of portions of the load rather than to effect their advance.

A plain mill has the cascade on the exposed portion of the load only, while the compartment mill has the entire half load on cascade if sliding from a low revolution and on a fall if on a higher revolution.

In present day milling practice most mills are being operated at a high state of efficiency as far as percentage of extraction is concerned, but there is a wide field for increasing the capacity of the milling equipment. This the compartment mill aims to do. If either a conical or cylindrical mill be changed to a compartment mill, the impact effect will be increased as will also the effective work and capacity of the machine. The compartment mill will not require as large a receptacle to do the same work as a plain mill, or in other words by changing a plain mill to a compartment mill there is an increase in its effectiveness or capacity, as heretofore indicated.

While the diaphragm or division wall may be formed in a variety of shapes, as thicker at one end than at the other to effect a classifying action, the plain diaphragm as herein described is the basic form.

Having briefly outlined my improvement as well as the function it is intended to subserve, I will proceed to describe the same in detail, reference being made to the accompanying drawing in which is illustrated an embodiment thereof. In this drawing:

Figure 1 is a top plan view of a conical mill equipped with my improvement and showing the arrangement for a motor drive, the interior of the scoop at the left being indicated by dotted lines, as is also the diaphragm.

Fig. 2 is a section taken on the line 2—2, Fig. 1 looking in the direction of the arrows, whereby the feed scoop is indicated at the right.

Fig. 3 is a cross section taken on the line 3—3, Fig. 2.

Fig. 4 is a longitudinal section through a mill of cylindrical shape, the diaphragm wall having been given a quarter turn for the left half of its length, the wall being shown in elevation.

Figs. 5, 6 and 7 are cross sections taken on the lines 5—5, 6—6, and 7—7, respectively of Fig. 4, showing the load in place.

Fig. 8 is a section taken on the line 8—8, Fig. 4 and shows the position of the division wall at this section and also the interior view of the mill showing the end liners and screen as well as the gear at the end of the machine. The load is also shown in this view.

Fig. 9 is a fragmentary longitudinal section of the mill showing a modified form of construction.

Fig. 10 is a cross section taken on the line 10—10, Fig. 9 looking toward the left.

The same reference characters indicate the same parts in all the views.

Let the numeral 5 designate the division wall or diaphragm of my improvement. In the form shown in Fig. 2, the diaphragm has curved recesses 6 and 7 formed respectively at its feed and discharge ends, so that the material fed into the trunnion 8 may be discharged equally into the two compartments formed by the diaphragm or division wall, and also so that the discharge through the opposite trunnion 9 from both compartments may be equal. In other words, the feed enters on both sides of the compartment in common and discharges from both sides in the same way. The wall or diaphragm as illustrated is composed of sections 10 which can be passed through a manhole 12 to the interior of the mill. The wall parts set over the diametral rods 13, which have three nuts 14, 15 and 16 at each end, the nuts 16 being used to clamp or bind the parts of the division wall tightly together, while the other nuts 14 and 15 at each end are used to lock the rods to the wall of the cylinder. Where the construction of the mill is as illustrated in Figs. 1 and 2, the arrangement of the nuts at the opposite ends of the rods just mentioned is employed where the rods pass through the cylindrical central part 17 of the mill. Beyond this part or at the cone shaped portions of the mill, a single nut 18 only at each end need be employed, these nuts being exteriorly located and coöperating with washer lugs 19 whose inner surfaces are shaped to fit the adjacent surface of the mill.

As illustrated in the drawing (see Figs. 3, 5, 6, 7, 8, 9 and 10) the lining of the mill is composed of sections 20 which are provided with small lifting lugs 21, the said sections being secured to the wall of the mill by bolts 22. The mill is preferably equipped with two manholes 12 and corresponding closures 12^a suitably secured in any well known or practicable manner. As shown in the drawing, the diametral rods pass through perforations formed in the sections 10 of the division wall.

In construction shown in Fig. 4 the feed scoop 23 is at the right, while there is a screen 24 at the left through which the pulverized material discharges into the exit trunnion 9.

In this view the division wall is given a

quarter turn for the left half of its length. One reason for making a portion of this wall of volute or propeller shape is to prolong the length or fall of the load. That is, if a complete revolution were made of the twist of the wall, then the load would fall continuously at points along the length of the cylinder. Most mills can discharge their load only from the fact that more of a load is fed to the mill and in consequence, some of the load must be discharged by displacement. Now this volute wall acts as a propeller to the load and the resultant of the effect of turning throws the load toward the screen 24. It is evident that the diaphragm may be voluted in either direction, that is twisted either way, or the mill may be revolved in the opposite direction. The amount and direction of twisting of this wall should be determined in practice in each case. Attention is called to the fact that the left hand extremity of the wall is beveled, as shown at 25, which is for the purpose of avoiding a packing of pulp or balls between the wall and the screen 24.

As the novel feature of my improved mill consists of the division wall as heretofore explained, further description in detail is not deemed necessary, since in other respects the construction may be of any suitable or ordinary type. As illustrated in Figs. 1, 2 and 4, the mill is provided exteriorly with a circumferential gear 26 which an operating pinion 27 engages (see Fig. 1), said pinion being fast on the shaft 28 of the motor 29.

When the mill is in operation, the material is delivered to a receptacle from which it is taken by the scoop 23 and delivered to the inlet passage of the trunnion 8 from which it is discharged into both compartments of the mill formed by the division wall 5. As the mill rotates the material, as the ore, to be treated is carried upwardly by the diaphragm on the upwardly moving side of the mill until it reaches the highest point approximately, when it falls with the result that the so-called sliding effect is largely avoided, the ore being reduced by the cascade, and impact or concussion of the fall. After the material has been sufficiently reduced, it discharges from both sides of the division wall into the outlet trunnion 9, whence it passes into any suitable receptacle.

In Figs. 9 and 10 I have shown the partition 5 provided on opposite sides with projections or flights 30 having curved surfaces to divert the falling load toward the screen or grate 24. This construction of wall or partition is for use more particularly in those mills whose screens do not reach to the full diameter of the interior and consequently it is desirable to force the ground pulp through the screen. This can be done by providing the partition with the angular projections or flights 30 which intercept the portion of the load near the screen in its fall and divert it toward the screen or grate, as heretofore explained.

Having thus described my invention, what I claim is:

1. A ball or tube mill having a substantially horizontal axis and inlet and outlet openings, and a relatively stationary imperforate partition wall having opposite edges, said edges being placed longitudinally within the mill, said edges being secured to the sides of the mill to divide the latter into compartments, each of which extends substantially the full length of the mill and is in communication with the inlet and outlet openings, said partition wall extending approximately the full length of the mill.

2. A ball or tube mill, comprising a horizontal, rotary imperforate shell with end openings and having a relatively stationary diametral partition disposed longitudinally within the mill and forming within the same two similarly shaped compartments extending approximately the length of the mill, each of which is open at both ends to receive and discharge material.

3. A ball or tube mill comprising an imperforate shell having a relatively stationary partition extending longitudinally and diametrically of the interior of the mill, the edges of the partition engaging the interior wall of the mill at opposite sides of the latter, the mill having inlet and outlet openings.

4. A ball or tube mill having a substantially horizontal axis and comprising an imperforate cylindrical shell having a plain imperforate partition extending longitudinally within and approximately the full length of the mill and on a chord of an arc thereof and fixedly connected to the walls thereof.

5. A ball or tube mill provided with a partition wall longitudinally disposed to form compartments, each of which is open at both ends to receive and discharge material, the partition being voluted at one extremity.

6. A ball or tube mill provided with a partition wall longitudinally disposed to form compartments, each of which is open at both ends to receive and discharge material, the partition being voluted at one extremity to facilitate discharge, the mill having a screen at the volute end of the partition through which the material passes on its way to the discharge trunnion.

7. A ball or tube mill having a substantially horizontal axis and comprising an imperforate shell and a longitudinally extending partition wall within said shell extending approximately the full length of the mill and having opposite edges, said edges being secured to the walls of said shell and dividing the interior of the mill into a plurality

of longitudinally extending compartments each of which extends substantially the full length of the mill and is open at its ends for the introduction and discharge of material.

8. A ball or tube mill provided with a partition longitudinally disposed to divide the mill into two compartments respectively open at both ends to receive and discharge material, said partition comprising sections and rods connecting said sections, the partition being secured to the walls of the mill.

9. A ball or tube mill having a substantially horizontal axis and comprising an imperforate shell and a single imperforate partition wall extending longitudinally within and approximately the full length of the mill and on a chord of an arc thereof, the edges of the partition wall being fixedly secured to the interior wall of the shell.

10. A ball or tube mill provided with a partition wall voluted at its discharge end and longitudinally disposed to form compartments which are open at both ends for feed and discharge respectively.

11. A ball or tube mill provided with a partition wall longitudinally disposed to form two compartments, each of which is open at both ends for feed and discharge respectively, the partition wall being equipped at the discharge end of the mill with flights for the purpose set forth.

12. A ball or tube mill having inlet and discharge openings and a partition extending longitudinally within the mill, the edges of the partition engaging the interior wall of the mill, the partition being equipped at the discharge end with flights to divert the falling load toward the discharge opening.

13. A ball or tube mill having a horizontal axis and a relatively stationary diametral partition coöperating with and disposed longitudinally within the mill to form two approximately semicylindrical compartments, each of which is open at both ends to receive and discharge material, said partition extending approximately the full length of the mill.

14. A ball or tube mill comprising an imperforate shell having a horizontal axis and an imperforate diametral partition extending longitudinally of the interior of the mill, the edges of the partition engaging the interior wall of the mill at opposite sides of the latter, the mill having inlet and outlet openings, said partition extending approximately the full length of the mill.

In testimony whereof I affix my signature.

NEWTON L. HALL.