

Jan 6, 1931.

J. R. KUENEMAN

1,787,788

GRINDING MILL

Filed Aug. 21, 1928

2 Sheets-Sheet 1

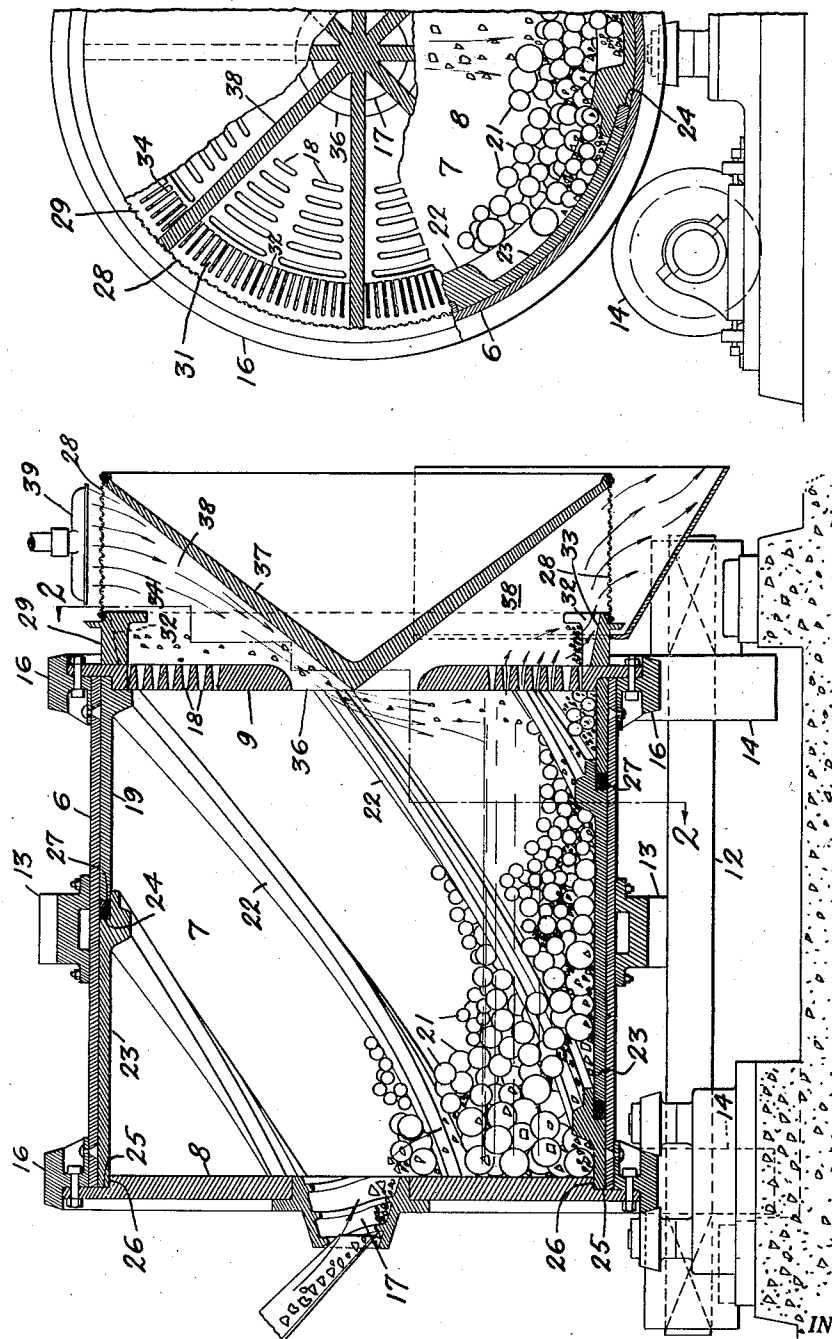


Fig. 2.

Fig. 1.

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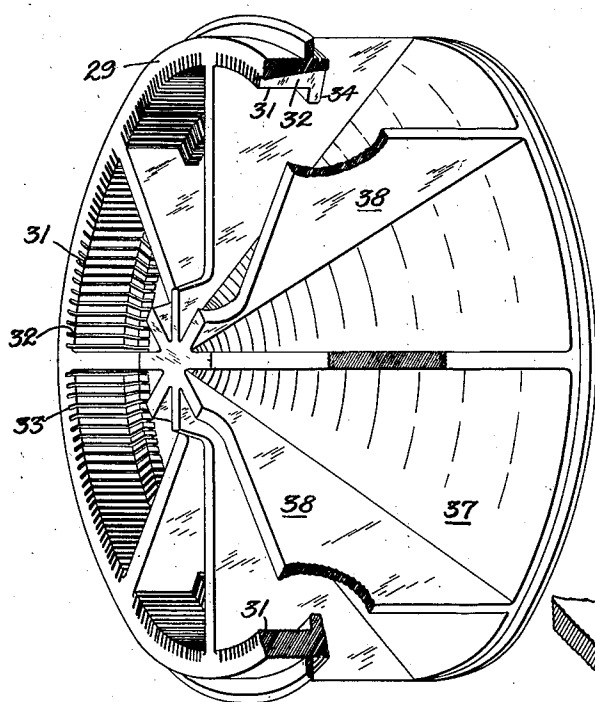


Fig. 3.

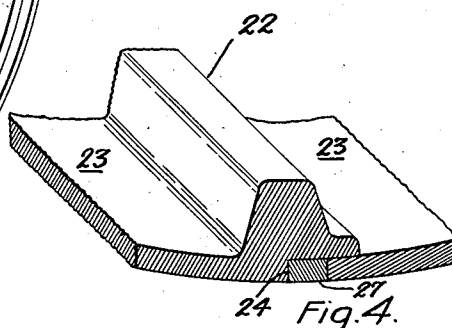


Fig. 4.

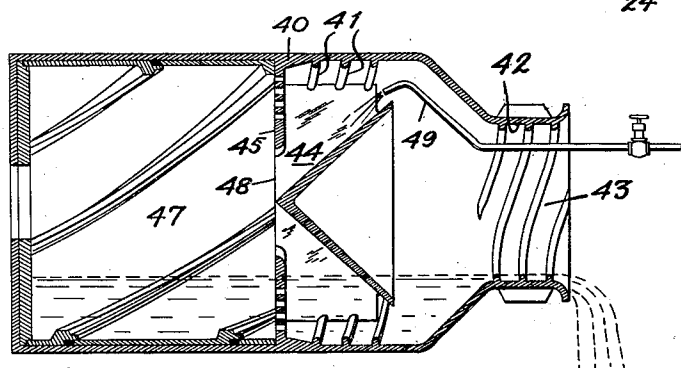


Fig 5.

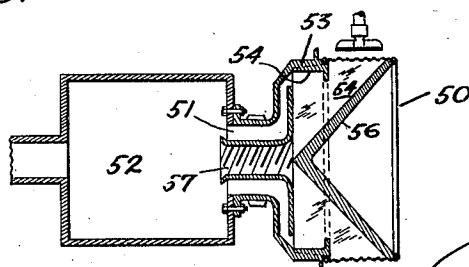


Fig. 6.

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GRINDING MILL

Application filed August 21, 1928. Serial No. 301,008.

My invention relates to means for grinding mineral ore and the like, and in the present embodiment more particularly to a grinding mill in which the grinding media and the ore are automatically graded in decreasing sizes from the inlet to the outlet whereby the grinding media will be proportional in size to the particles of material on which they act and the larger particles will be deterred from discharging and the smaller particles permitted an unhindered exit.

An object of the invention is to provide a mill of the character described which will have an extremely large capacity in comparison with the revolving weight and mass thereof.

Another object of the invention is to provide a mill of the type described in which the crushing action of the grinding media and agitation of the material may be increased without increasing the speed of the mill or involving the inclusion of apparatus therein reducing the capacity and efficiency of the mill.

A further object of the invention is to provide a mill which will not require the use of an external classifier in order to secure an output of particles of uniform size.

A still further object of the invention is to provide a mill of high efficiency in which the walls of the grinding chamber and the screens used in conjunction with the mill will be subjected to a minimum of wear.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

Referring to said drawings:

Figure 1 is a longitudinal sectional view of the mill of my invention showing the construction and operation thereof.

Figure 2 is a transverse sectional view of one half of the mill, the plane of the section

being indicated by the line 2—2 of Figure 1.

Figure 3 is an isometric view of the oversize return unit detached from the mill housing, parts of the structure being removed in order to show the hidden parts more clearly.

Figure 4 is a fragmentary perspective view of the liner construction used in the mill.

Figure 5 is a longitudinal sectional view of a unit of modified design.

Figure 6 is a longitudinal sectional view of the oversize return unit of a form particularly adapted for attachment to existing designs of mills.

As illustrated in the drawings, the mill in the preferred embodiment of the invention comprises a tubular shell 6 defining therein a cylindrical grinding chamber 7 having head plates or liners 8 and 9 disposed at the opposite ends thereof. The mill is of the rotatable type and rotation thereof is preferably effected by means of a gear 12 connected to a suitable source of power and arranged to drive an external gear 13 extending around the shell. The shell is supported for rotation on rollers 14 which engage tires 16 on the shell.

Material to be ground is fed to the chamber through an opening 17 provided in the plate 8 at the axis of rotation of the shell, while the discharge of the product from the chamber is permitted through a series of openings 18 formed in the plate 9 and extending circumferentially around same in proximity to the peripheral walls 19 of the chamber. In the form of mill here illustrated, grinding of the material is arranged to be effected by a grinding media such as a multiplicity of balls 21 of varying sizes, it being understood that rotation of the shell causes a cascading of the balls and a bombarding of the material thereby.

It will be noted that the grinding chamber is cylindrical in form, thereby permitting a maximum capacity for material and movement of the grinding media, and it is an object of my invention to provide means for effecting the aforesaid automatic grading of the grinding balls and material in such manner that not only will the full capacity of the chamber be maintained, but the effective

movement of the balls and the agitation of the material will be tremendously increased. Arranged on the peripheral walls of the chamber and extending obliquely or spirally therealong from one end of the chamber to the other are one or more ribs 22 which function during the rotation of the shell to elevate the grinding media and material, the direction of progression of the ribs with respect to the direction of rotation of the shell being such that during rotation of the shell the portions of the media and material nearer the discharge openings will be elevated in advance of the portions nearer the feed opening; in this manner the mass will be caused to move toward the feed end of the chamber, the heavier particles thrusting themselves through the mass in advance of the lighter particles and thereby bringing about the grading of the particles in decreasing sizes from the feed to the discharge. With the mass thus graded the heavier grinding media will, during the operation of the mill, confine their efforts to crushing the larger and heavier particles of material, while the small media will confine their efforts to pulverizing of the smaller particles, thereby providing for utilization of the available forces to the greatest advantage. Furthermore since the heavier grinding media are closer to the feed opening and the particles of material are of course of maximum size when first introduced into the grinding chamber, the heavy grinding media will attack the largest particles as soon as they are introduced. In addition it is to be particularly noted that by reason of the fact that the mass is being continuously thrust backward from the outlet end of the chamber and none of the larger particles will be disposed at such outlet, no clogging of the openings 18 by the larger particles of material or the balls will occur, and thus the free and ready discharge of the smaller particles from the chamber is in no way interfered with.

It will be clear that during the rotation of the shell the mass is subjected, due to the presence of the ribs, to a plow-like action which causes a thorough agitation and turn over of the material as well as a maximum exposure thereof to the action of the grinding media. Furthermore, due to the obliquity of the ribs, the balls in their cascade are projected toward the feed end plate 8 as well as toward the bottom of the chamber; in this manner a large area of said plate will be utilized, as well as the peripheral walls of the chamber, to receive the thrust of the balls in the crushing action, thereby materially increasing the capacity of the chamber for any given size thereof.

The ribs in the present embodiment of the invention are formed integral with segmental liners 23 which completely cover and are set against the inner peripheral face of the shell.

As shown in Figure 2, the ribs are formed along one of the longer edges 24 of the liners, and when the liners are in position the ribbed portion of each liner overlaps the free edge of the adjoining liner as clearly shown in Figure 4. The ends of the liners are disposed in annular pockets 25 formed between the shoulders 26 of the head plates and the inner surface of the shell and the liners are firmly held in position by means of fillers 27 which are forced between the opposed edges 24 of adjoining liners, the fillers being arranged for insertion or withdrawal at the ends of the liners with one of the head plates removed. It will be clear that the foregoing construction not only permits of cheapness in manufacture, but assures long life of the parts, this being particularly true of the means for holding the liners in position since the fillers are completely covered by the ribbed end portions of the liners.

The ground material discharged from the chamber through the openings 18 may, if sufficiently fine, pass through a screen 28 preferably of cylindrical form and positioned adjacent the discharge end of the shell for rotation therewith. In order that the relatively delicate screen will not be forced to carry the load of over-size material that is discharged from the chamber, means are provided which trap said oversize and return same to the chamber for additional grinding. In the embodiment of the invention illustrated in Figures 1 to 3 of the drawings, such means include a cylindrical apron 29 interposed between the screen 28 and discharge end of the shell and forming in appearance an axial extension of the shell. The inner peripheral face of the apron is disposed further from the axis of the chamber than are the openings 18 so that all the material escaping from the latter will discharge into the apron. Formed in such inner face of the apron are axially disposed riffles 31 defining recesses 32 narrow enough to preclude the passage therethrough of any but fine particles of material, and whose bottoms 33 taper outwardly so that in their lower positions they slope outwardly and downwardly. Preferably formed on each of the elevated portions of the riffles and extending inwardly from the forward extremity thereof are abutments 34 serving as means of retaining on the apron the oversize material deposit therein. In the operation of the mill the particles discharging from the openings 18 are deposited on the lower portions of the apron, where the finer particles are permitted to pass downwardly between the riffles onto the sloping bottoms 33 and thence to the screen. The larger or oversize particles remain on the elevated portions of the riffled surface and are deterred from escaping to the screen by means of the retainers 34. As previously mentioned the oversize material

discharged from the chamber is arranged to be reintroduced therein, and as here shown the plate 9 is provided with a centrally disposed opening 36 through which the reintroduction of the oversize material to the chamber may take place. Lying within the screen and extending through the apron is a conical member 37 having its apex disposed in the opening 36. Preferably connecting the member 37 and apron, and formed integral therewith, are one or more vanes 38 which serve during the rotation of the mill to elevate the oversize material retained on the riffles whereby said material as well as any oversize lodged on the screen will be dropped on the conical sides of the member 37 and guided through the opening 36 back into the chamber where it may again be subjected to the grinding action before redischarging through the openings 18. It will be understood that the mill of my invention may be used for dry or wet grinding, and in the latter event a stream of screen washing or feed diluting liquid is arranged to be introduced through a nozzle 39, and as clearly shown in Figure 1 such nozzle is so positioned that the stream will be projected along the surface of the conical member 37 so that the return of the oversize material is facilitated.

It is to be noted that with the mill designed as above described, the material will virtually be subjected to a number of different stages of classification. First, the classification brought about by the grading in the grinding chamber, second the separation on the riffled surface of the apron, and third the separation at the screen. With the product thus classified it will readily be understood that an output of uniform sized particles will be assured.

In Figure 5, I have shown the apparatus designed for use when an output of unsized material is desired, such as in the case of slimes. As here shown, the internal face of the apron 40 is formed with spiral riffles 41 between which the heavier particles are trapped while the lighter particles suspended in the pulp pass over the riffles and a correspondingly riffled surface 42 of the constructed discharge orifice 43. With this construction the particles trapped between the riffles 41 are elevated during the rotation of the mill by means of vanes 44, the direction of progression of the riffles with respect to the direction of rotation of the mill being such that the particles will be relayed backward toward the plate 45 from between one pair of riffles to another until finally reintroduced into the grinding chamber 47 through the opening 48. A stream of liquid to dilute the pulp feed and facilitate the movement of the material over the conical member 48 is arranged to be supplied by a pipe 49.

In Figure 6, I have shown an oversize re-

turn unit adapted for use with existing types of mills such as indicated by reference number 50. As here shown the unit is provided with an annular passage 51 through which the material may discharge from the grinding chamber 52 onto the apron 53 having a riffled inner surface 54 similar to the embodiment of the structure shown in Figures 1 to 3. The oversize material remaining on the riffles is arranged to be elevated by means of the vanes 54 fixed to the conical member 56 and discharged on the latter whence it may be guided into a passage 57 for reintroduction into the grinding chamber 52.

I claim:

1. A grinding mill comprising a substantially horizontally disposed rotatable cylinder having a grinding chamber therein provided with a feed opening adjacent one end, and a plurality of imperforated spaced ribs projecting inwardly of, and progressing spirally along and for the full length of, the peripheral walls of the chamber and arrange during rotation of the shell to elevate the portion of the material more remote from the feed opening in advance of the material nearer such opening.

2. A grinding mill comprising a rotatable shell having a horizontally disposed cylindrical grinding chamber provided with a feed adjacent the center of one end thereof and a discharge adjacent the other end, and a plurality of inwardly projecting spaced ribs progressing spirally along and for the full length of the peripheral walls of the chamber to form continuous bars from one end thereof to the other and arranged upon rotation of the shell to urge the material toward the feed end of the chamber and to elevate the portion of material near the discharge opening in advance of the portion near the feed opening.

3. A grinding mill comprising a rotatable shell having a grinding chamber with a centrally disposed feed at one end and a relatively outwardly disposed discharge adjacent the other end, a screen arranged to effect the final grading of the material, means for sizing the material discharged from the chamber before it has reached said screen, and means to reintroduce into the chamber the material retained by said last means.

4. A grinding mill comprising a rotatable shell having a grinding chamber with a material feed and discharge, a screen designed to effect the final grading of the material, sizing means fixed for rotation with the shell and arranged to receive the material discharged from the chamber, said sizing being effected before the material has reached the screen, and means rotatable with the shell and associated with said discharge and with said sizing means arranged for reintroducing into the chamber the material retained by said sizing means.

5. A grinding mill comprising a rotatable container for effecting the grinding operation and having a feed and a substantially circumferential discharge, a screen designed to effect the final grading of the material, an apron rotatable with the container and arranged to receive the material discharged therefrom, and means associated therewith and arranged to permit the escape of particles of predetermined size onto said screen and to retain the oversize particles for reintroduction into the container.

6. A grinding mill comprising a rotatable container having a material exit adjacent an end and disposed about and spaced from the axis of rotation of the container, an apron fixed to the container at said end and arranged to receive thereover the material discharged from the container, a ledge extending around said apron arranged in the path of said material and having openings therein whereby the material of predetermined size may escape thereby and oversize material will be retained on the apron, means adjacent the center of rotation of the container at said end thereof communicating with said apron and through which material may be introduced into the container, and a plurality of deflecting members for guiding the oversize material from said apron to last means.

7. A grinding mill comprising a rotatable container having a material introducing inlet adjacent one end and a material reintroducing inlet adjacent the other end, a grid having openings disposed about said second inlet through which the material from the container may discharge, an annular extension of said container into which the material from the latter is arranged to be discharged, a screen adjacent the extremity of said extension through which the fines from the extension may be discharged, a conical member extending into said extension with its apex adjacent said last inlet, a ledge member extending inwardly from the peripheral walls of said extension and having openings therein whereby the material of given size within said extension may pass through the extension to said screen and the oversize material will be retained in the extension, and means on said member arranged during rotation of the container to elevate the oversize material in the extension and guide same into said second inlet.

In testimony whereof I have hereunto set my hand at Oakland, California, 1928.

JOHN R. KUENEMAN.