May 26, 1942. R. O. WOOD 2,284,548

GRINDING MILL

Filed Oct. 8, 1940 2 Sheets-Sheet 1

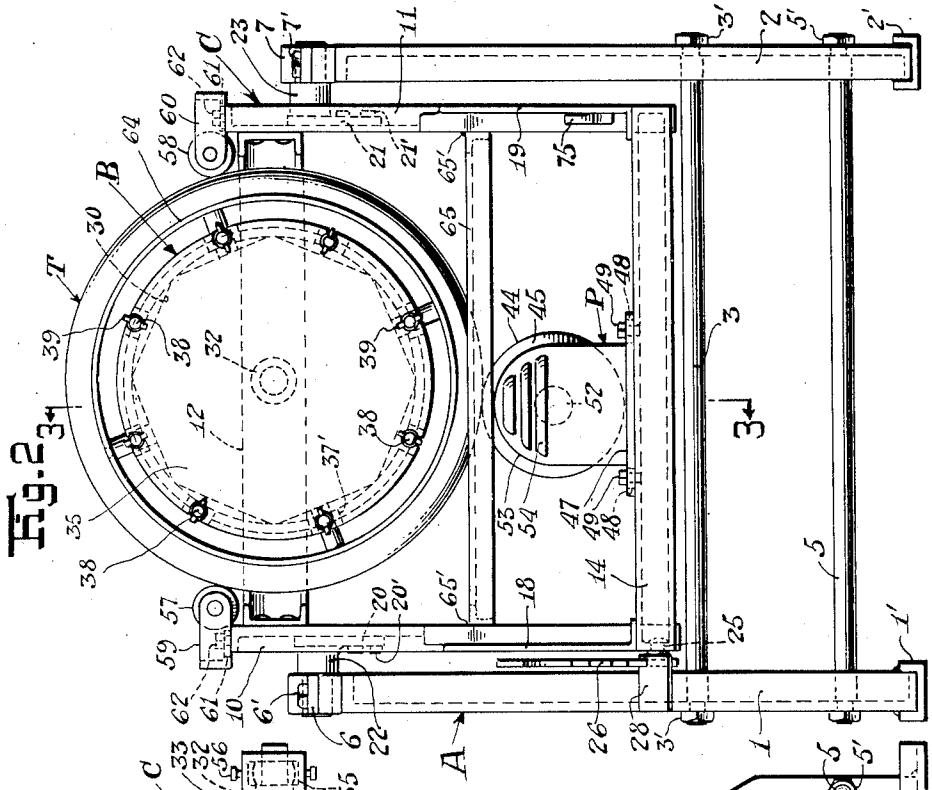


Fig. 2

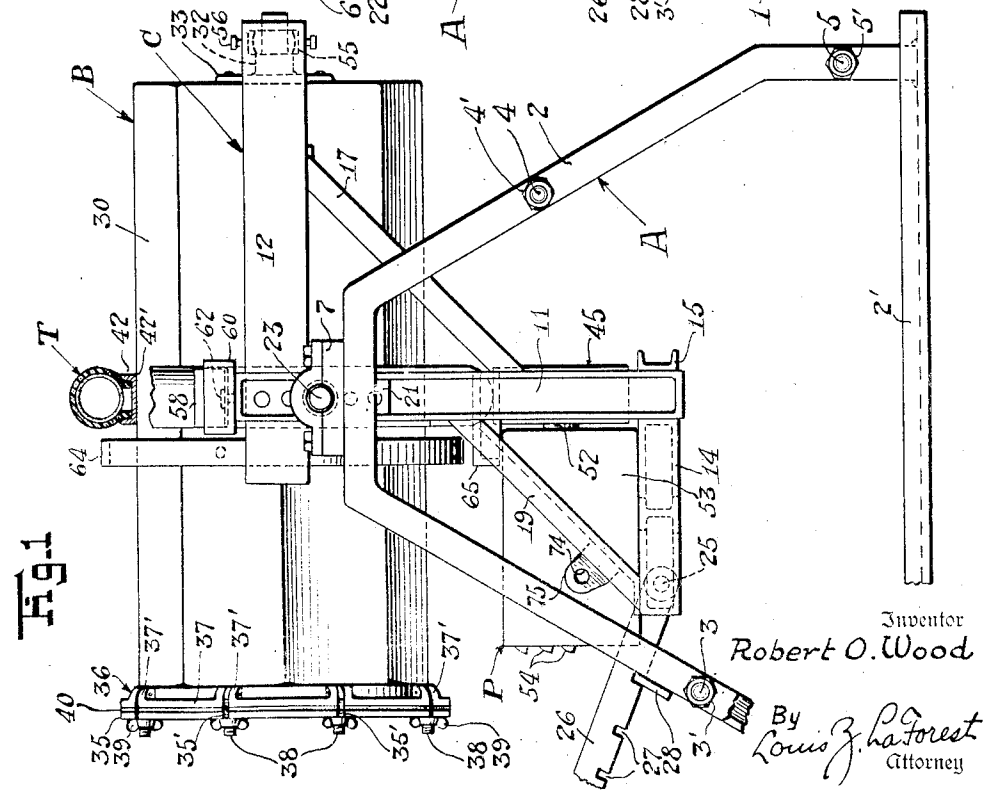


Fig. 1

Inventor
Robert O. Wood
By Louis J. LaForest
Attorney

May 26, 1942. R. O. WOOD 2,284,548

GRINDING MILL

Filed Oct. 8, 1940 2 Sheets-Sheet 2

Fig. 3

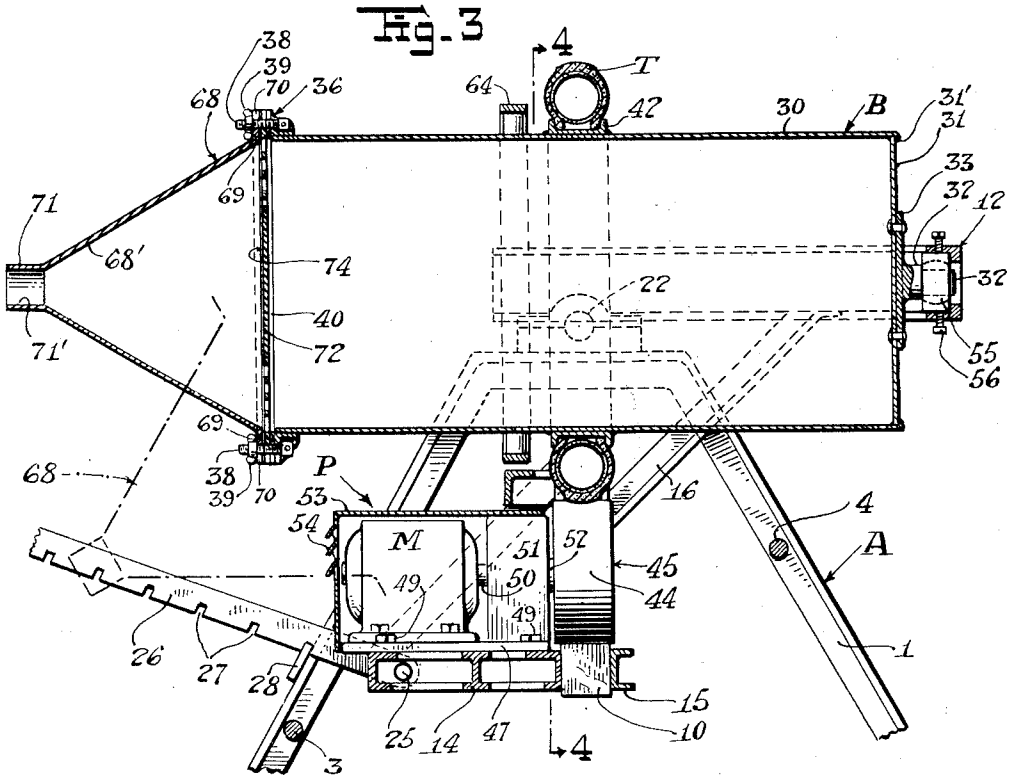
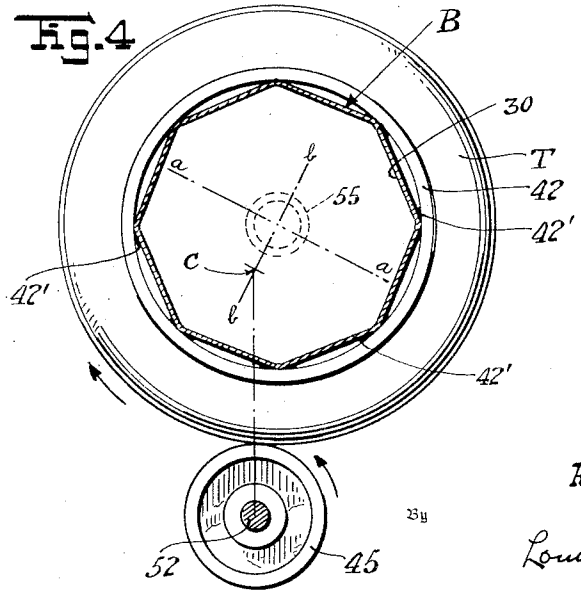


Fig. 4



Inventor

Robert O. Wood

By

Louis J. LaForest

Attorney

Patented May 26, 1942 2,284,548

UNITED STATES PATENT OFFICE

2,284,548

GRINDING MILL

Robert O. Wood, Upper Montclair, N. J., assignor to Button Corporation of America, Newark, N. J., a corporation of New Jersey

Application October 8, 1940, Serial No. 360,237

8 Claims. (Cl. 83—9)

My present invention relates to grinding mills, and more particularly to grinding, mixing and pulverizing mills of the type known commercially as pebble or ball mills.

Mills of this type generally comprise a tumbling drum or an appropriate cylindrical vessel, which is mounted for axial rotation upon a suitable standard or frame, and in which drum or cylindrical vessel there is provided a quantity of flint pebbles or hard balls. When a mill of this type is to be used, there is introduced in the tumbling drum thereof a usually predetermined amount or batch of the material to be ground; which material is, of course, intermingled or mixed with the pebbles or balls. When the drum or vessel is so loaded, it is closed tightly and then rotated at a given speed for a duration of time or until the material is thoroughly ground, mixed or pulverized by the tumbling action of the pebbles or hard balls in the drum.

Heretofore, mills of this character or class have been designed and constructed in an unusually large, heavy and cumbersome manner, and particularly so in proportion with the amount, quality or weight of the material to be treated in one single batch therein. This has been principally due to the lack of the proper arrangement for the distribution of the weight of the tumbling drum and its load, and also, because of the heavy gear-transmission type of drive used for imparting rotation to the said drum. As such, these mills have been extremely vibratory, noisy and self-destructive, requiring frequent repairs. Also, because of the usually horizontal mounting of the drum, these mills have been unhandy to load and unload, and particularly productive of a large amount of dust when unloading a batch of pulverized material therefrom.

It is a principal object of my invention to provide novel means for balancingly mounting the drum or cylindrical vessel of these mills.

It is another object of my invention to provide noiseless and vibrationless means for driving or imparting rotation to the tumbling drum or the cylindrical vessel thereof.

It is a further object of my invention to provide combined means for supporting and simultaneously driving said tumbling drum.

It is a further object of my invention to provide a mill structure, wherein the operation of the tumbling drum thereof will require a minimum of power, produce a minimum of strain upon the driving and supporting parts, and thus be very economical in operation and upkeep.

A still further object of my invention is to provide a tumbling drum mounting wherein are provided means for easily tilting said drum while either still or in rotation, and by which means convenient loading and unloading of the drum is had.

A feature of my invention is to provide a highly efficient grinding, mixing and pulverizing mill; one which is materially reduced in weight and size in proportion to the batch; very handy in operation, and yet one which retains a high degree of sturdiness and durability.

Still other objects and features of my invention will more fully appear from the following description and the appended claims.

In the description of my invention, reference is had to the accompanying drawings, of which:

Figure 1 is a side elevational view, with parts broken away, showing a pebble or ball mill constructed in accordance with my invention;

Figure 2 is a front elevational view of the mill illustrated in Figure 1;

Figure 3 is a longitudinal cross-sectional view through the tumbling drum of my improved mill, taken substantially on line 3—3 of Figure 2, but showing the end-attachment which is secured to said drum for unloading the same; and

Figure 4 is a cross-sectional view through the drum, taken along the line 4—4 of Figure 3.

Referring particularly to Figures 1 and 2, there will be seen as a main support for my present mill, a standard A, comprising two uprights or side members 1 and 2, which are secured together as by means of the tie rods 3, 4 and 5. The uprights or side members 1 and 2 may be constructed as by shaping iron bars into the form shown in the drawings. To provide sturdiness for the standard, these bars may preferably be of the common L-shape cross-section type, as is more clearly indicated in Figure 3. The tie rods 3, 4 and 5 are extended from one side member to the other and their ends are shouldered, threaded and passed through the members so as to be bolted thereto by means of the nuts 3', 4' and 5'. Each of the side members 1 and 2 of the standard A, has a respective footing in the form of a track 1' or 2'. These tracks are secured to the base portion of their respective side members as by welding, so as to provide further rigidity to the standard and also means for giving to said standard an aplomb when it is rested or set upon the floor.

The tumbling drum B of my present mill is adapted to be supported for axial rotation—usually on a horizontal axis—within a cradle-like

frame structure indicated at C. This frame or cradle-like structure is adapted to be rocked at times, so as to impart transverse movement to and for tilting the drum B. Thus, for this purpose, the cradle-like frame C is mounted for pivotal movement upon the standard A above-described. To provide the pivotal connection therebetween, there are provided at the top portions of the aforementioned side members 1 and 2 the split bearings 6 and 7, each respectively secured to its side member as by means of the respective bolts 6' and 7'.

The frame or cradle C, as best seen in Figures 1 and 2, is a sturdy, rigid structure which is open to the top and to the front thereof, and which is of an inner width sufficient to accommodate freely the girth of the tumbling drum B. To form the cradle, I provided the channelled side members 10 and 11, and connect these together, at their upper portions, by means of a relatively large U-shaped member 12, and at their lower portions, by means of a relatively wide horizontally disposed platform member 14 and a tie bar 15. In order to hold the parts of the frame just described solidly together or accurately set in their geometric position, there are provided the side braces 16 and 17 for holding the U-shaped member 12 at a true right-angle position relative to the side members 10 and 11, and the side braces 18 and 19 for holding the platform member 14 similarly positioned relative to said sides 10 and 11. The U-shaped member 12 is preferably riveted, as shown, to the upper portions of the members 10 and 11 and is, of itself, formed of a U-shaped cross-section so as to provide sturdiness to the frame and yet be light in weight. The side members 10 and 11, the platform member 14 and the tie member 15 are all preferably constructed from channelled iron bars, and preferably welded together at their intimate points of junctures. The side braces 16—17 and 18—19 are L-shaped in cross-section and welded in their respective positions shown.

In order pivotally to mount the frame or cradle C upon the standard A by way of the split bearings 6 and 7 above described, there are provided, near the top of each of the side members 10 and 11, respective plates 20 and 21, which are secured to the members as by means of the respective bolts 20' and 21'. These plates have respective right-angular outwardly projecting trunnions 22 and 23 having reduced portions fitting respectively in the bearings 6 and 7, carried on the standard A in the manner previously described. As will be hereinafter more fully understood, it is, at times, desirable to retain or hold the frame C into different angular positions relative to the standard A, and, for this purpose, there is pivotally connected to the left side of this frame, as at 25, the end of a straight iron bar 26. This bar has a series of notches 27 adapted to register with a stop member or plate 28 rigidly secured, as by welding, to the left side member 1 of the standard A. When it is desired to rotate the cradle C and to hold it into a given angular position relative to the standard A, the bar 26 is grasped and moved until the frame C is in the desired position, then the adjacent notch 27 in the bar is registered with or made to engage the plates 28, and thus the frame remains in the selected position. As illustrated in Figures 1 and 2, the frame or cradle C is in what may be termed its balanced position, that is the position wherein it is normally set for holding the drum also in an effectively balanced position during the grinding, mixing or pulverizing operation of my instant grinding mill.

As has been herein set forth, my invention particularly concerns the provision of improved means for minimizing vibration, noise and cumbersomeness of mills of the type presently introduced. I have attained these improvements in the instant disclosure by particularly constructing the aforementioned drum B, and by mounting and driving the same in a novel manner within the cradle-frame C above described. Such means will presently be described.

The tumbling drum of my mill is of a preferred cylindrical form, having a polygonal-shaped cross-section as is clearly illustrated in Figure 4, but for all intents and purposes no limitation is herein intended as to its particular form, as said vessel may well be of other formations, provided such are productive of the purpose herein stated, which is to cause, when said vessel is axially rotated, a tumbling of the pebbles or balls employed therein for grinding, mixing and pulverizing the material commingled therewith. I construct the present drum B by curvingly folding and then butt-welding a sheet of steel 30 to the cross-sectional shape shown. This sheet may preferably be of a special metal, such as of stainless steel, so as to be comparatively thin and light in weight as such metal is very strong and durable under constant pounding. The rear or bottom end of the so-formed cylinder is preferably closed by a suitably shaped plate 31, which may be of the same metal and thickness as the sheet 30, and which may be welded thereto as at 31' (see Figure 3). Centrally of its closed end or of the plate 31, the cylinder or drum B is provided with an outwardly projecting spindle 32 having integral therewith a flange 33 which is riveted to said plate. This spindle 32 as thus secured and axially located forms a shaft or axle by which the drum, as hereinafter more fully explained, may be flexibly coupled to and journalled in the cradle-frame C. The top or forward end of the drum B is closed, during its normal operation, by a removable cover 35 shown in Figures 1 and 2. Removably to secure this cover, that end of the drum is provided with a cast rim 36 having the flange 37, to which is pivotally secured, by means of slotted lugs 37' thereof, a number of bolts 38 adapted to swing into corresponding radial notches 35' made into the peripheral edge of the plate 35. For each bolt there is provided a wing nut 39, which when turned causes the plate to be drawn toward the face of the flange 37. However, in order properly to fit the cover plate to the face of the flange 37, I provide an annular flat gasket 40, made of suitable resilient material and having radial slots therein for registration with the bolts 38, so that when the cover plate 35 is drawn tightly onto the flange 37, a substantially air-tight closure is established. The purpose of the pivotally retained bolts and radial slots in the cover plate 35, is for quickly removing or interchanging said plate for one which is conical in shape and used in unloading the drum as hereinafter described.

In order to provide a resiliently balanced support and a non-vibratory drive for the drum B within the cradle-frame C, I first encircle the mid-section of the drum by means of a commonly known tire-rim 42, which rim may be fitted intimately about the outward converging points of the sheet 30 and be welded thereto as at 42'. Then I mount, in the conventional manner, upon

said rim a pneumatic tire T, as is clearly illustrated in Figures 1, 2 and 3. With the pneumatic tire T properly inflated, I rest said tire upon the peripheral edge 44 of a driving disc or pulley 45 whose axis of rotation is parallel to that of the drum and whose location is within the lower central underslung portion of the frame C. The pulley 45 is directly mounted upon and rotated by a power unit P carried upon the aforementioned platform 14 which forms the bottom-like portion of the cradle-frame C.

As seen in Figure 3, the power means or unit P comprises a bed-plate 47, which is supported upon and transversely adjustably secured to the aforementioned platform 14, as by means of transverse slots 48 and bolts 49 passing therethrough. This way of securing the plate 47 is to provide for a limited side-to-side adjusting or shifting movement of the power unit and its pulley 45 within the cradle-frame C. Mounted on the bed-plate 47, is a motor M which has its driving shaft 50 coupled to a train of speed-reduction gears (not shown) contained in a cast housing 51 which may be formed integrally with the plate 47, as shown. From said housing or train of gears, there is projecting in a rearward direction a very substantial supporting and driving shaft 52 onto which is mounted the aforementioned pulley 45. As so mounted, it will be noted that said pulley is centrally disposed in a transverse vertical plane with the pivot-bearings 6—7 or trunnions 22—23 of the cradle-frame C, altho at a substantial distance below said points. The unit P as above described, except for its pulley, may be enclosed by a cover or cowl 53 having suitable louvers 54 for ventilation of the motor M.

From what has been described above, it is clear that when the tire T is placed on the pulley 45, gravitational force will cause the underslung cradle-frame C to assume a position of equilibrium about its supports 22—23, as is shown in Fig. 1; providing that the drum is properly balanced with respect to the tire and that the weight of the load is evenly distributed along and within said drum. The distribution of the weight of the load for the above purpose is always effected automatically, inasmuch as the top layer or surface of the agitated load tends to assume a horizontal plane or level under the force of gravity resulting from the rotation of the drum. In constructing both the cradle-frame and the drum, I particularly provide that these units be truly balanced on their respective points of support; that is, with respect to the pivotal point of the cradle so that this latter may normally underhang with its side members 10 and 11 in a truly vertical position, and with respect to the mid-section of the drum so that this latter may normally balance on the point of contact of the peripheral edge of the tire T with the pulley 45.

It is evident that the drum B must be properly retained against axial endwise and sidewise movements in the cradle-frame C, so that it may remain in proper engagement with the pulley 45. To this end, I provide means for coupling the aforementioned end-trunnion 32 of the drum with the central transverse portion of the U-shaped cradle member 12. This coupling means is effected through the medium of what is known as a self-aligning thrust bearing 55, which bearing is secured, as by the set-screws 56, to the member 12 and through which said bearing the spindle 32 is fitted and retained by any suitable manner. This coupling forms a journal for the rotation of the drum and also a swivel to provide means for longitudinally adjusting said drum for support upon the driving pulley 45. I provide further the anti-friction side rollers 57 and 58 for the purpose of retaining the drum B in intimate engagement with the pulley 45 and, also, for maintaining the longitudinal alignment of said drum with said pulley. These rollers are mounted for free rotation into respective brackets 59 and 60, each respectively adjustably secured, by means of a respective slot-and-bolt connection 61—62, at the top portion of its side cradle member 10 or 11. As so mounted, said rollers are disposed in a plane considerably above that of the center of the drum or tire T, so that when these rollers are adjusted into close relation with the peripheral face of the tire they serve to hold down and simultaneously retain the longitudinal adjustment of the said drum with respect to the pulley 45.

I provide precautionary means to prevent damage being done to the drum or to the power unit if a sudden deflation or "blow-out" of the pneumatic tire T may occur during the rotation of said drum. Such means are effected by encircling the drum B with the ring 64, located in the approximate vicinity of the tire T and overlying a cross-bar 65, which is secured to the frame C as by its ends 65' thereof to the sides of said frame. The clearance between the ring 64 and the bar 65 is comparatively small, even when the tire is fully inflated for the proper driving of the drums, as will be seen in Fig. 3; it is such as will prevent appreciable axial displacement or fall of the drum and do damage to the parts, should a "blow-out" of the tire occur when said drum is rotated with a heavy load therein.

A feature of my present invention rests in the means for conveniently and safely unloading the comminuted material of the drum B. Usually such material is highly pulverized and productive of a great amount of dust when unloaded without special provision therefor. Previous to my present invention, there have been no provisions or means directly associated with the drum for effecting an abatement of the dust produced by the removal of the batch therefrom. In the construction of my present mill, I provide an end-attachment to the drum whereby this operation is performed without creating such nuisance and exposing the operator to unhealthy conditions. As seen in Figure 3, this end-attachment is in the form of a conical cover 68, adapted to be secured to the open end of the drum in a manner to replace the aforementioned cover plate 35. The conical cover 68 is provided with a flange 69, about which is provided a series of radial notches 70 corresponding with the notches 35' of the plate 35. The forwardly converging portion 68' of said cover 68 terminates in the form of a spout 71, having an opening 71' which is of a size only sufficient to accommodate the rate of discharge of the material from the drum. With this unloading attachment, means are provided for preventing the pebbles or balls of the drum from being released or removed together with the material of the batch. This means is in the form of an apertured plate or a screen 72 which is interposed between the flange 69 of the cover 68 and the flange 37 of the rim 36. Between said screen and the flange 69 a gasket 74, similar to the gasket 40, is employed to effect contiguity of said parts.

When it is desired to remove the comminuted material from the drum, the frame C is first rocked clockwise about its pivots 22—23. This is preferably accomplished by the provision of a pair of tackle-blocks (not shown) the lower of which has a hook engageable with the eye 74 of a lug 75 welded to the right-hand side of the frame, as shown. When the frame C has been rocked sufficiently to tilt the drum B to a leftward angle of substantially 45°, the cover plate 35 is replaced by the conical attachment 68, then the drum may be let down to its normal position illustrated in Figure 3. Thereafter, the operator may grasp the bar 26 and rotate the cradle-frame anti-clockwise while simultaneously causing rotation of the drum B. The anti-clockwise rotation of the cradle-frame is preferably effected slowly, such as by a gradual engagement of the notches 27 with the plate 28, so that the tilting of the drum in this direction will be gradual to effect an even rate of discharge of the material through the spout 71. It is to be understood that a complete charge in the drum B fills this vessel to its substantial half, consequently it is to be observed from a scrutiny of Figures 1 and 2, that the major portion of the drum and at least half of the charge or load rest above the pivots 22—23 of the cradle-frame C. By this arrangement the unitary rocking of the cradle and drum is effected without great effort, and these parts may be easily rocked back and forth during the unloading operation so that the comminuted material may be more completely withdrawn from the drum.

In Figure 4, I show by means of projected lines, an adjustment of the pulley 45 with respect to the longitudinal axis of the drum B and its rate of rotation, whereby a high degree of smoothness is obtainable during the operation of my present mill. Assuming that the rate of rotation is such as to cause the loose objects or load of the drum to shift leftward where the substantial level thereof is along the line *a—a*, thus the center of gravity of said load will be found along the line *b—b* at the point *c* by reason of the curvature of the drum and the level of said load. Consequently an adjustment of the pulley 45 in vertical alignment below the point *c* as indicated, will serve to provide proper frictional contact of the tire T with, and support of the drum upon said pulley, and avoid unequal bearing on rollers 57—58.

Having thus described my invention, by the way of the particular embodiment herein disclosed, what I claim is:

1. A mounting for a loaded tumbling drum comprising, a frame having upstanding sides for longitudinally retaining said drum when in rotation therein; a driving pulley journalled in said frame and axially disposed beneath said drum for peripherally supporting and simultaneously imparting rotation to said drum; and means, effected by a tangential shift of said pulley in respect to said drum, for longitudinally balancing the load when the drum is rotated, whereby to avoid unequal pressure against the sides of said retaining frame.

2. A tumbling drum mounting comprising, in combination a retaining frame; a supporting and driving member located within the lower portion of said frame; a tumbling drum provided with a pneumatic tire attached to its mid-section and having a rigid band thereabout adjacent to said tire; means for supporting and driving said drum within said frame by resting said tire upon said member; and means, carried by said frame and located closely beneath said rigid band, for preventing appreciable displacement of said drum upon a "blowing-out" of said tire.

3. A mounting for a tumbling drum, comprising in combination: a frame having retaining side members provided each with frictionless means thereof; a driving pulley located within the lower portion of said frame in substantial vertical alignment with said means; an axially rotatable tumbling drum having, intermediate its ends, a resilient band engageable with said pulley and said means; and means for swivelingly coupling one end of said drum to said frame to cause the weight of said drum to effect continuous engagement of said band with said pulley.

4. A mounting for a tumbling drum, comprising in combination: a frame having retaining side members provided with bearing portions thereof; a driving pulley located within the lower portion of said frame in substantial vertical alignment with said rollers; an axially rotatable tumbling drum having, intermediate its ends, a resilient band engageable with said pulley and said rollers; and means for swivelingly journalling one end of said drum into said frame whereby the greater portion of the weight of said drum will rest upon said pulley.

5. A machine of the character described comprising a base, a cradle-frame, a drum axially rotatably and longitudinally immovably mounted in said cradle-frame and having limited movement in axial planes, means mounting said cradle-frame on said base to rock about a horizontal axis that is disposed at right angles to the axis of the rotation of said drum and intermediate the ends of the drum, a driving element journaled in said cradle-frame beneath said drum and rotatable about an axis approximately parallel to the axis of rotation of the drum, and a tire secured to and encircling said drum intermediate the ends of the latter and held in driving engagement with said driving element by gravitational action upon said drum, whereby said cradle-frame and said drum when the drum is loaded will be balanced on the axis of rocking of said cradle-frame and said drum will be rotated by said driving element and said tire.

6. A machine of the character described comprising a base, a cradle-frame, a drum, a swivel-connection between one end of said drum and said cradle-frame to permit axial rotation of the drum and swinging of the drum about said connection in axial planes of the drum, means mounting said cradle-frame on said base to rock about a horizontal axis that is disposed at right angles to the axis of the rotation of said drum and intermediate the ends of the drum, a driving element journaled in said cradle-frame beneath said drum and rotatable about an axis approximately parallel to the axis of rotation of the drum, and a tire secured to and encircling said drum intermediate the ends of the latter and held in driving engagement with said driving element by gravitational action upon said drum, whereby said cradle-frame and said drum when the drum is loaded will be balanced on the axis of rocking of said cradle-frame and said drum will be rotated by said driving element and said tire.

7. A machine of the character described comprising a base, a cradle-frame, a drum axially rotatably and longitudinally immovably mounted in said cradle-frame and having limited move-

ment in axial planes, means mounting said cradle-frame on said base to rock about a horizontal axis that is disposed at right angles to the axis of rotation of said drum and intermediate the ends of the drum, a friction driving element journaled on said cradle-frame beneath said drum and rotatable in substantially a common plane with the axis of rocking of said cradle-frame and about an axis approximately parallel to the axis of rotation of said drum, and a resilient tire secured to and encircling said drum and frictionally resting upon said driving element under gravitational action upon said drum, whereby said cradle-frame and said drum when the drum is loaded will be balanced on the axis of rocking of said cradle-frame and said drum will be rotated by said driving element and said tire.

8. A machine of the character described comprising a base, a cradle-frame, a drum, a swivel-connection between one end of said drum and said cradle-frame to permit axial rotation of the drum and swinging of the drum about said connection in axial planes of the drum, means mounting said cradle-frame on said base to rock about a horizontal axis that is disposed at right angles to the axis of the rotation of said drum and intermediate the ends of the drum, a friction driving element journaled on said cradle-frame beneath said drum and rotatable in substantially a common plane with the axis of rocking of said cradle-frame and about an axis approximately parallel to the axis of rotation of said drum, and a resilient tire secured to and encircling said drum and frictionally resting upon said driving element under gravitational action upon said drum, whereby said cradle-frame and said drum when the drum is loaded will be balanced on the axis of rocking of said cradle-frame and said drum will be rotated by said driving element and said tire.

ROBERT O. WOOD.