

July 29, 1947.

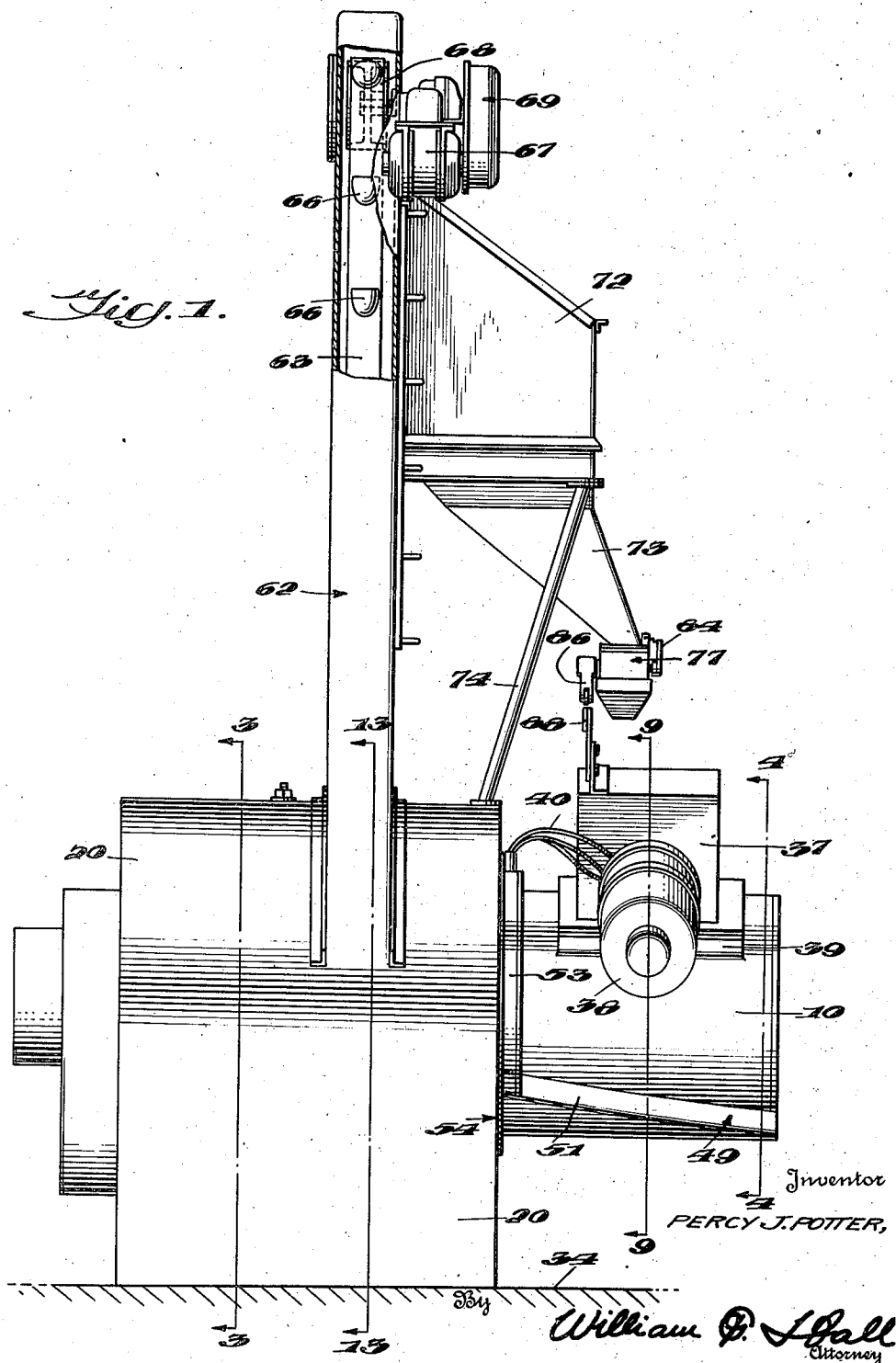
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TUMBLING MILL

Filed Sept. 26, 1944

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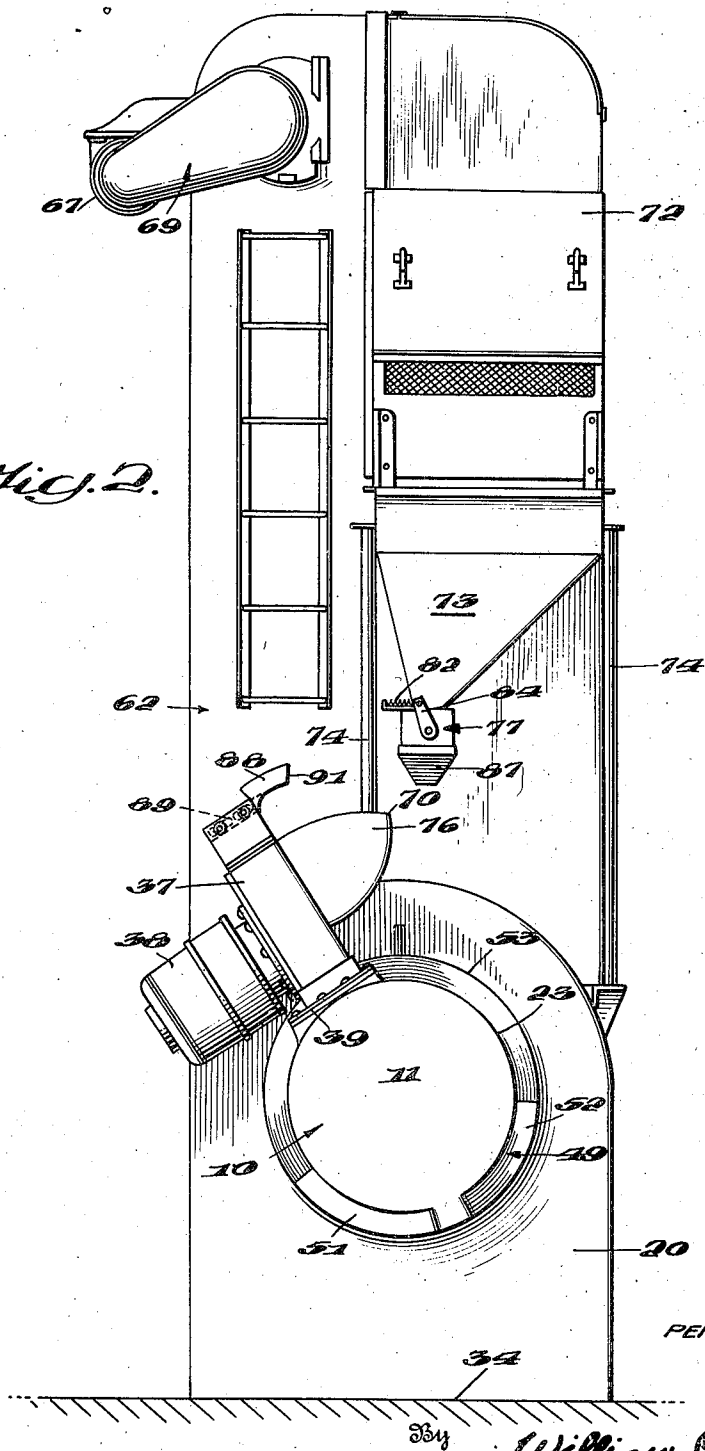
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TUMBLING MILL

Filed Sept. 26, 1944

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Fig. 2.



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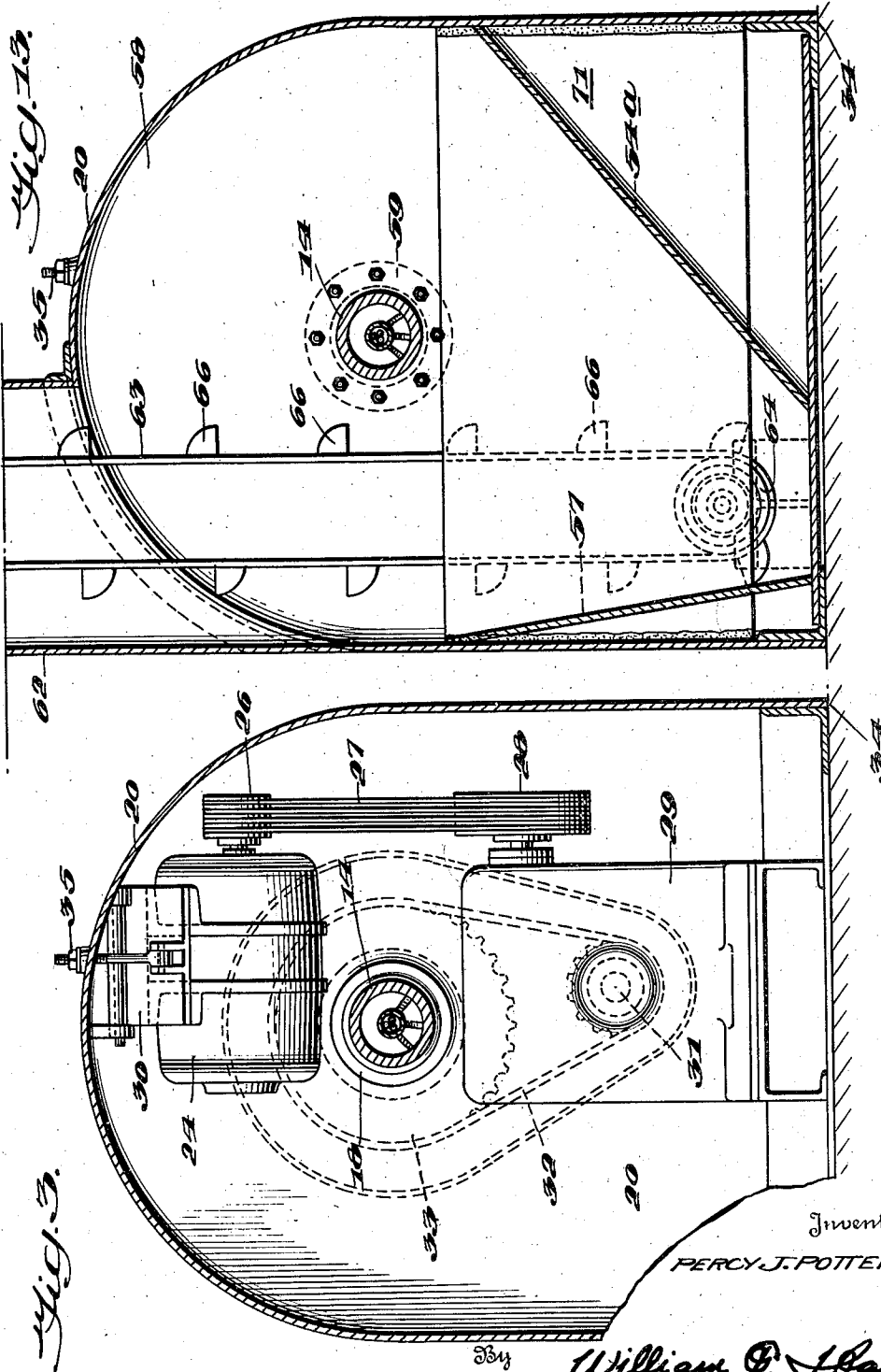
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TUMBLING MILL

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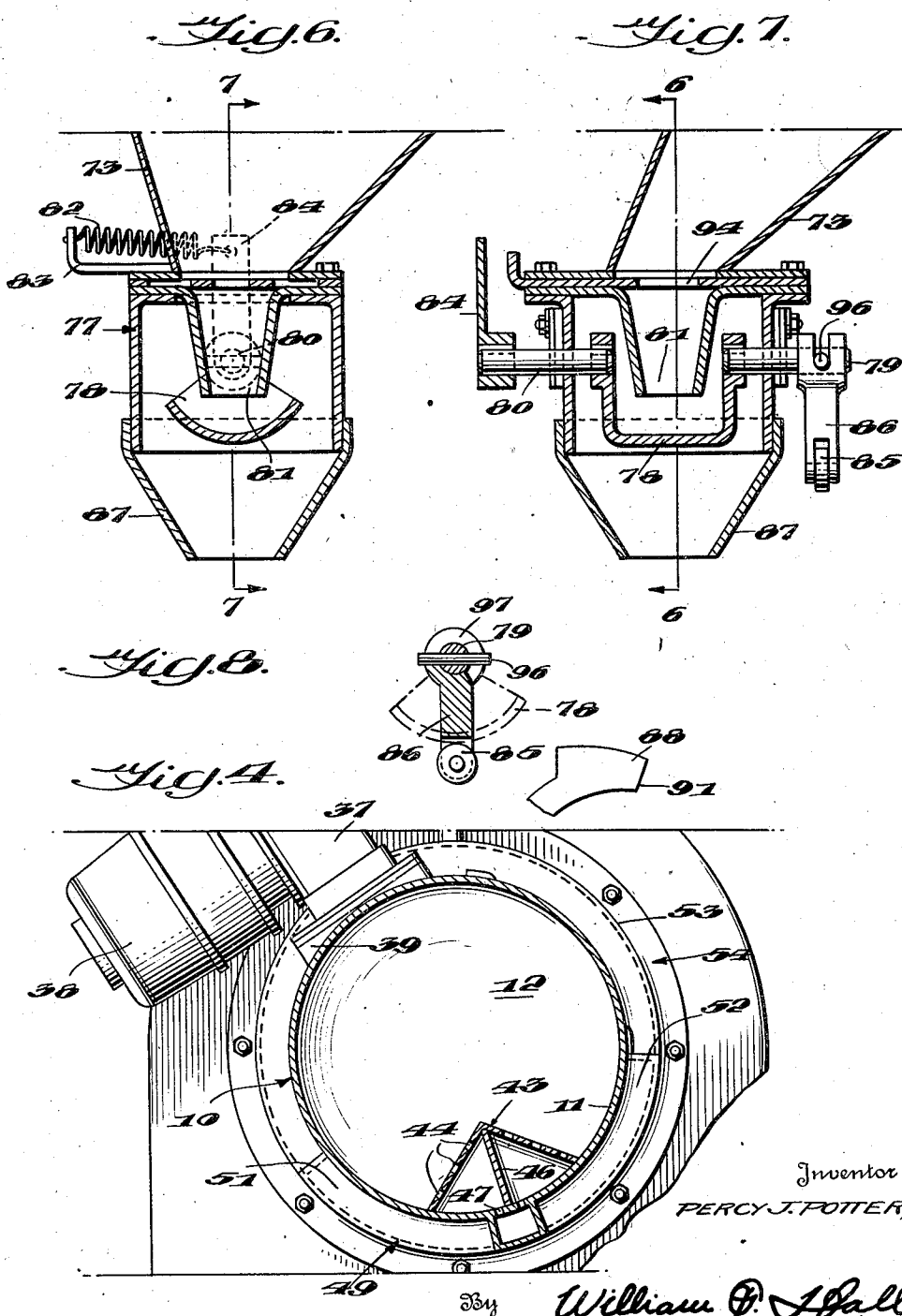
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TUMBLING MILL

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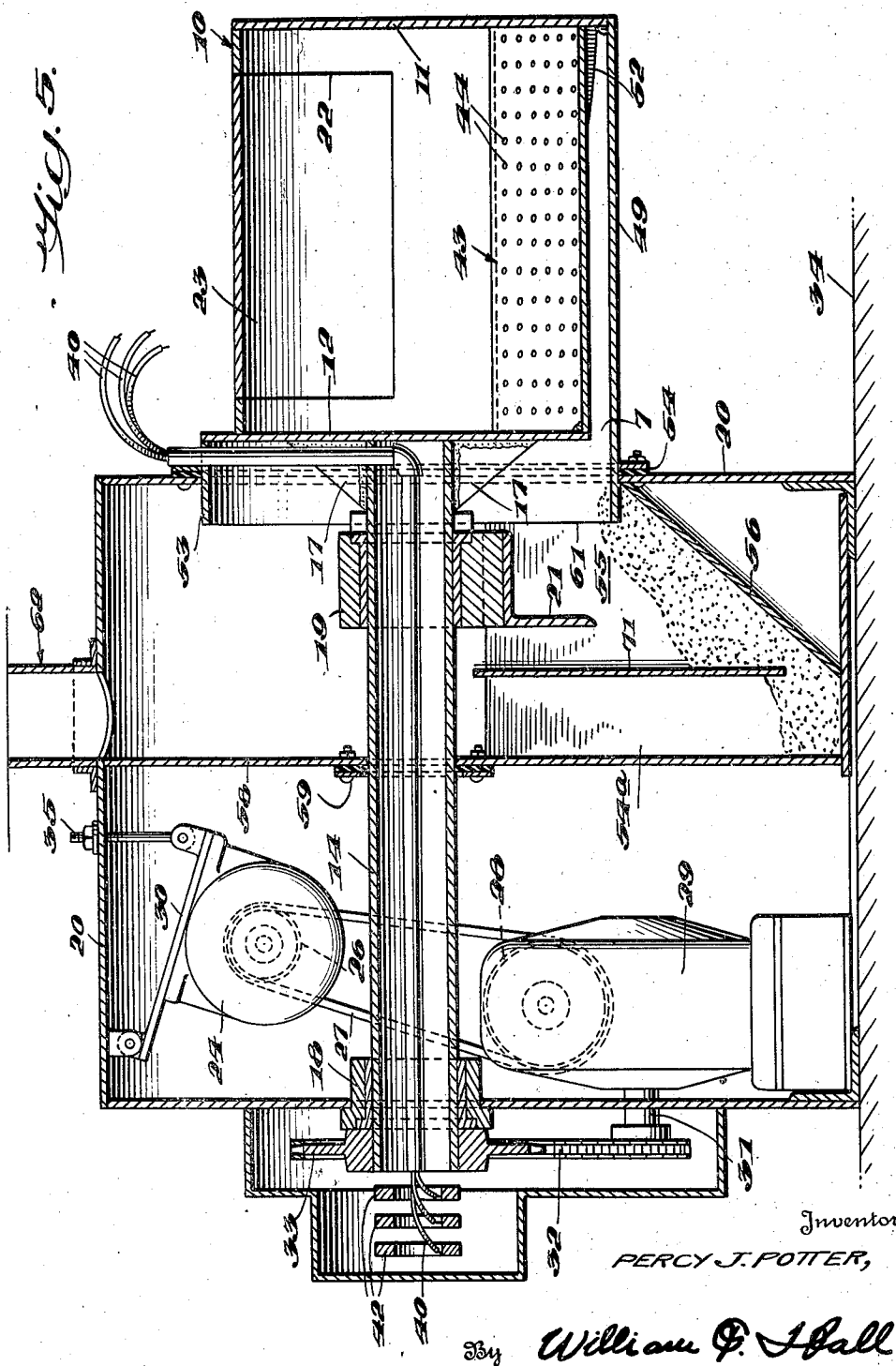
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TUMBLING MILL

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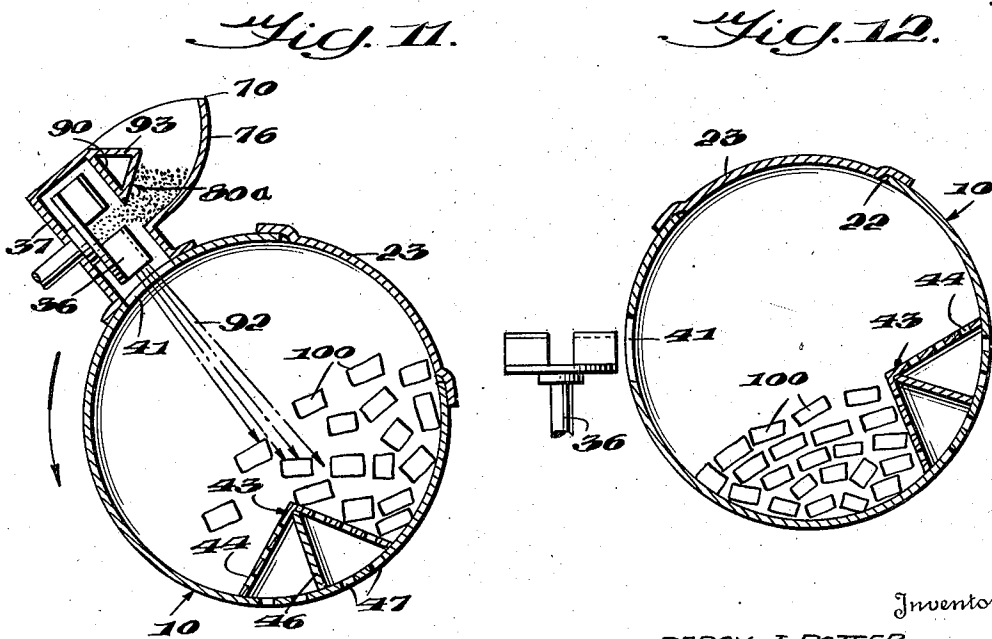
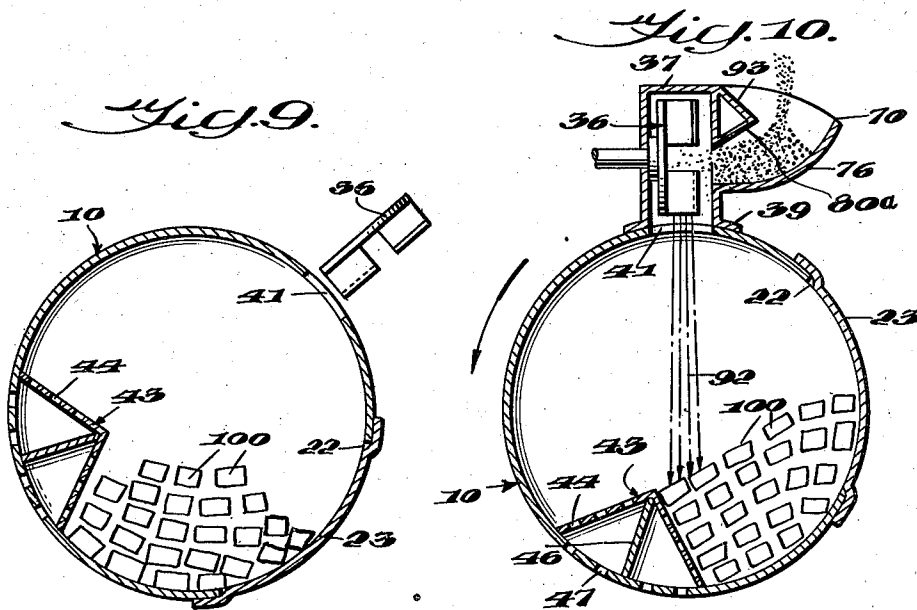
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TUMBLING MILL

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6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

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TUMBLING MILL

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12 Claims. (Cl. 51—9)

1

The present invention relates to tumbling mills and more specifically pertains to apparatus of this type wherein articles are tumbled and subjected to the action of a forceful stream of abrasive particles.

An object of the present invention resides in providing a tumbling mill wherein the disadvantages attendant the use of an endless conveyor for moving the articles to positions for tumbling downwardly are completely avoided and to provide apparatus for handling a group of articles to be blasted wherein the moving parts of the tumbling mill are reduced to a minimum.

Another object of the invention resides in providing a tumbling mill wherein a blast stream is established and the articles to be subjected to the blast stream are shifted and elevated as a group to a position laterally of the blast stream and permitted to cascade through the blast stream whereby the abrasive particles moving at blasting velocities efficiently impinge on the surfaces of the articles passing through the blast stream.

A more specific object of the invention resides in providing a tumbling mill wherein the articles to be blasted are arranged within a rigid drum which is oscillated through a limited arc to tumble the articles therein, including means for projecting a blast stream into the drum provided with novel means for controlling the operative period of the blasting means.

A more detailed object of the invention resides in providing a tumbling mill formed of a rigid drum for receiving and tumbling the articles therein, including an abrasive throwing wheel mounted on the drum so as to move therewith during the oscillation of the drum, including means for controlling the feeding of abrasive to the throwing wheel and the quantity of abrasive supplied to the wheel to thereby control the initiation and interruption of the blast stream projected by the abrasive throwing wheel.

Other objects and features of the invention will be apparent as the present disclosure proceeds and upon consideration of the accompanying drawings and the following detailed description wherein an exemplary embodiment of the invention is disclosed.

In the drawings:

Fig. 1 is a side elevational view of a tumbling mill embodying the invention and showing means for returning the spent abrasive to a position for re-use in the apparatus.

Fig. 2 is an end elevational view of the apparatus shown in Fig. 1.

Fig. 3 is a sectional view taken on the line 3—3

2

of Fig. 1 showing the driving mechanism for the drum.

Fig. 4 is a sectional view of the drum taken on the line 4—4 of Fig. 1.

Fig. 5 is a sectional view in side elevation taken along the axis of the drum and the supporting shaft therefor.

Fig. 6 is a sectional view of the valve mechanism for controlling the flow of abrasive from the storage hopper and taken on the line 6—6 of Fig. 7.

Fig. 7 is a sectional view of the valve mechanism taken on the line 7—7 of Fig. 6.

Fig. 8 is a sectional view of the connection between the operating arm and the shaft of the valve mechanism.

Fig. 9 is a diagrammatic sectional view of the drum taken approximately on the line 9—9 of Fig. 1 illustrating one operating position.

Fig. 10 is a similar diagrammatic sectional view of the drum showing an exemplary operating condition when the blast stream is initiated.

Fig. 11 is another diagrammatic sectional view illustrating an operating characteristics when the articles cascade in the drum.

Fig. 12 is a diagrammatic sectional view illustrating another position of the drum in an exemplary operating cycle.

Fig. 13 is a sectional view taken on the line 13—13 of Fig. 1 showing a portion of the hopper for receiving the abrasive discharged from the drum.

A tumbling mill exhibiting the invention is so designed that the articles to be blasted may be introduced into a drum through an opening in the periphery thereof after which the drum is oscillated about the axis thereof through a limited arc whereby the articles are moved with the drum to a position for cascading downwardly therein. In apparatus embodying the invention the oscillating movement is automatic and the drum is reciprocated until the blasting operation is completed. In an exemplary operating cycle the drum oscillates through an arc of approximately one hundred and forty degrees, but it will be appreciated that the extent of the oscillating movement may be adjusted without departing from the metes and bounds of the invention hereinafter described in detail and defined in the claims. In the exemplary operating cycle, the abrasive projecting device is operable during a portion of the oscillating movement of the drum, and the blast stream is maintained during approximately a ninety degree movement of the drum, but it will be appreciated that this oper-

3

ating characteristic is merely illustrative and may be altered without departing from the scope of the invention.

Referring to the drawings, there is shown generally at 10 a drum which may be of cylindrical shape mounted with the axis thereof in a substantially horizontal position. The drum may be provided with wear plates (not shown) on the interior surfaces thereof so as to be readily replaced and thereby provide protection for the walls of the drum. The imperforate end walls 11 and 12 of the drum are secured to the cylindrical portion in any well known manner so as to completely close the drum. The drum may be supported for rotation about its axis in any suitable manner and in the embodiment illustrated the drum 10 is provided with a hollow shaft 14 extending axially from the end wall 12. The connection between the shaft 14 and the end wall 12 is reinforced by means of brackets 17, as shown in Fig. 5. The shaft 14 is rotatably mounted in bearings 18 and 19. These bearings are suitably supported so as to sustain the load of the drum 10 and the castings therein. The bearings 19, for example, may be supported by means of a transverse beam 21 extending through a housing 20 enclosing the driving mechanism for the drum.

The drum 10 is provided with an opening 22 in the periphery thereof through which the articles to be treated or blast cleaned are introduced into the drum. The opening 22 is closed by means of a door or arcuate plate 23 which conforms to the curvature of the drum. The door 23 may be securely maintained in the closed position in any conventional manner and the details of the clamping means are well known in the art. The drum 10 may be rotated so as to position the opening 22 in a generally upper position whereby articles to be treated within the drum may be introduced downwardly through the opening 22. Such a position of the drum 10 is shown in Fig. 12.

The drum 10 is oscillated by rotating the shaft 14. Any suitable driving arrangement may be provided for rotating the shaft 14 and oscillating the drum. In the embodiment illustrated, the shaft 14 is driven by means of an electric motor 24 mounted within the housing 20. The motor 24 may be provided with a pulley or sheave 26 about which a plurality of V-belts 27 are trained, and which drive a suitable sheave or pulley 28 of a speed reducing mechanism 29. The speed reducing mechanism is mounted in a lower portion of the housing 20 and may be of any conventional type. The output shaft 31 of the speed reducing mechanism drives a chain 32 which is trained about a sprocket wheel 33 secured to the shaft 14. The motor 24 is mounted in the upper portion of the housing 20 so as to be moved and tighten the belt or belts 27. In the arrangement illustrated the motor is secured to a base plate 30. This plate is hinged to the housing 20 and may be caused to swing upwardly so as to tighten the belt or belts 27 by means of bolt arrangement shown at 35.

The motor 24 is of the reversible type and may be controlled in a conventional manner so as to rotate the drum 10 in one direction through an arc of approximately one hundred and forty degrees, whereupon the direction of rotation of the motor is reversed and the drum 10 rotates in an opposite direction through an arc of approximately one hundred and forty degrees. The electric control for the motor 24 may be so designed

4

as to permit movement of the drum 10 to a loading station with the opening 22 in a generally upper position and arresting the drum in such a position to permit loading of the drum. After the articles to be blast treated are ready for removal from the drum, the motor 24 may be rotated beyond the normal oscillating limits to move the drum 10 to a position with the opening 22 in a downward direction whereby the articles will drop therefrom. It will be observed that the drum 10 is mounted above the floor or supporting base indicated at 34, so that a tote box or other conveyance may be positioned under the drum 10 for receiving the articles discharged therefrom through the door opening 22.

The invention includes any means for projecting a blast stream into the drum. In the embodiment illustrated, the abrasive projecting means takes the form of an abrasive throwing wheel represented diagrammatically at 36 in Fig. 10. The abrasive throwing wheel may be of a conventional directional control type for projecting abrasive particles from the periphery thereof, and the details of such abrasive throwing wheel are disclosed in the patent to Keefer, No. 2,320,364.

The abrasive throwing wheel is enclosed within a protecting housing 37. The wheel 36 is supported for rotation in any suitable manner. In the embodiment illustrated, an electric motor 38 is rigidly attached to the protecting housing 37 and drives the wheel. This housing 37 is rigidly secured to the periphery of the drum 10. The base portion of the housing 37 is accordingly provided with a flange assembly 39 which may be bolted or otherwise secured to the drum 10. The periphery of the drum is provided with an elongated slot or aperture 41, as shown in Fig. 10, through which the abrasive projected by the throwing wheel 36 enters the drum 10.

The wheel 36 is driven by the motor 38 and both bodily move with the drum 10 since the housing 37 encasing the wheel and supporting the motor, is rigidly attached to the drum. The motor 38 may be supplied with electrical energy in any appropriate manner, and in the illustrated embodiment electrical conductors 40 extend through the hollow shaft 14, and power is supplied to these conductors through slip rings 42 arranged at the free end of the shaft 14 to rotate therewith. This arrangement simplifies the problem of supplying electrical energy to the moving motor 38, and in view of the fact that the motor 38 moves with the shaft 14, no problem of cable wear is encountered since there is no flexing of the conductors 40 which extend through the hollow shaft 14.

The drum 10 is provided with a projection or lug extending inwardly from the arcuate wall so as to positively move the entire load or group of articles with the drum during rotation thereof. Such a projection is shown at 43 in the drawings and is preferably of an inverted V-shape and extends inwardly from the inner wall of the drum 10 so that the apex thereof defines a lip positioned inwardly from the periphery of the drum at a point approximately one-half the radius of the drum. The projection 43 is accordingly formed with the flat sides which merge with the inner wall of the drum and may be welded thereto.

The lug or projection 43 extends throughout the length of the drum 10 as will be apparent from a consideration of Fig. 5. The apex portion of the projection terminates in a lip which defines the innermost edge of the projection. Thus

all of the articles forming a normal load within the drum are positively moved with the drum and the projection forms a part of the support for the articles when the drum moves into the position shown in Fig. 10. It will be observed that all of the articles are moved and supported as a group in this elevated position. As the drum continues to rotate, the angle of repose of the articles is exceeded for some of the articles and these cascade downwardly in the drum to the opposite side of the projection 43 as shown in Fig. 11. Further rotation of the drum causes the projection 43 to move therewith until eventually all of the articles are supported on an inclined surface provided by one of the flat sides of the projection 43 whereupon these articles cascade downwardly to the opposite side of the projection as illustrated in Fig. 12.

The projection 43 is hollow for the purpose of receiving the spent abrasive from the drum. The flat walls of the projection 43 are therefore provided with openings 44 through which the spent abrasive particles move to a position within the hollow projection. A partition 46 is arranged within the projection 43 to limit circumferential shifting of the abrasive upon oscillation of the drum. The drum periphery is provided with apertures 47 through which the abrasive within the hollow protuberance 43 may escape through the periphery of the drum. The abrasive disposal arrangement includes a trough 49 attached to the drum outwardly of the apertures 47. This trough may be welded to the outside of the drum and extends from one end thereof to the other, as shown in Fig. 1. The trough 49 is provided with inclined end walls 51 and 52 which diverge away from each other in proceeding towards the end wall 12 which is adjacent the housing 20. The trough 49 extends beyond the end wall 12 of the drum 10, as will be apparent from a consideration of Fig. 5, so as to convey the abrasive to a position within the housing 20. This end portion of the drum is also provided with an annular flange 53 of substantially the same circumference as the periphery of the trough 49, so as to provide for a continuation of the drum beyond the end wall 12. The annular flange 53 is concentric with the axis of the shaft 14, and this portion extends through an opening in the housing 20. The housing is provided with an annular gasket assembly shown at 54 for sealing the periphery of the drum with respect to the stationary housing 20.

The abrasive projected into the drum escapes through the openings 44 to a position within the hollow projection 43. The abrasive then moves through the apertures 47 into the trough 49. As the drum is rotated, the abrasive shifts circumferentially within the trough 49 and engages one of the end walls 51 or 52 so as to be supported on one of these walls. The trough 49 when arranged laterally of the axis of the drum provides that one of the end walls 51 or 52 presents an inclined surface down which the abrasive moves so as to be conveyed axially of the drum and into the housing 20.

A hopper 55 for receiving the abrasive is provided within the housing 20. This hopper is formed by inclined plates 54a and 56, as shown in Figs. 13 and 5. A further inclined side wall 57 may be provided within the housing 20. The abrasive deposited in the hopper 55 is isolated from the driving mechanism by means of a partition 58 which extends substantially vertically through the housing 20. A hole is provided in the partition 58 through which the driving shaft 14

extends. The periphery of the shaft 14 may be sealed with respect to the partition 58 by means of a gasket assembly shown at 59. Thus the abrasive and the dust escaping from the drum 10 through the trough 49 is confined to that portion of the housing 20 encasing the hopper 55. The abrasive discharged over the end 61 of the trough 49 drops onto the inclined side wall 56 of the hopper 55 and moves downwardly therealong and downwardly along the inclined side wall 54a.

The apparatus includes means for returning the abrasive within the hopper 55 to a position for flowing to the abrasive projecting means or abrasive throwing wheel 36. An elevator is shown generally at 62 and includes an endless band or belt 63 which is trained about a pulley 64 mounted for rotation in the lower portion of the hopper 55. The endless belt or band 63 is provided with buckets or cups 66 for carrying the abrasive upwardly with the belt 63. This belt may be driven by means of a motor 67 which drives a pulley 68 rotatably mounted at the top portion of the elevator through a suitable transmission mechanism indicated generally at 69. The hopper 55 may be provided with a shield member 71 so as to prevent the abrasive from obstructing movement of the endless belt 63 of the elevator. The shield 71 terminates short of the bottom of the hopper as shown in Figs. 5 and 13 so that the abrasive may pass thereunder to a position for being scooped up by the elevator buckets 66. The abrasive is discharged from the buckets or cups 66 and passes downwardly into a separator 72 which functions to remove foreign matter from the abrasive, and the cleaned abrasive particles move downwardly from the separator 72 into a storage hopper 73. The storage hopper 73 may be supported in any suitable manner above the drum 10, such as by means of standards 74.

A tumbling mill exhibiting the invention includes means for controlling the movement of abrasive from the hopper 73 to the abrasive projecting device. Any control arrangement may be provided for permitting the abrasive to move from the hopper 73 to the wheel 36 in timed relationship with the oscillation of the drum. An efficient mechanism requires that a minimum quantity of abrasive should be projected onto the articles within the drum, and it has been found that the blast stream need only be established immediately prior to the tumbling or cascading of the articles so that these articles fall through the blast stream to provide good blast cleaning. This limited projection of the abrasive reduces the quantity of abrasive projected and thereby reduces the power required to propel the abrasive and the power required to elevate the spent abrasive. An exemplary arrangement for controlling the initiation of the blast stream projected by the abrasive propelling device includes the feature of supplying a limited quantity of abrasive to the wheel 36 so that the blast stream projected thereby is interrupted when the measured quantity of abrasive supplied to the wheel is exhausted. An arrangement embodying these features includes a unique feed spout 76 for the wheel for receiving a limited quantity of abrasive. It will be observed that the feed spout 76 is formed with a relatively large opening at the top so as to receive abrasive from the hopper 73 as the wheel assembly passes the outlet for the abrasive. The feed spout 76 is arranged to supply abrasive at the axis of the wheel 36 whereby the abrasive is pro-

jected from the periphery in a well known manner as is described in the patent to Keefer No. 2,320,364.

The abrasive control includes a valve assembly shown at 77 for permitting the escape of abrasive from the storage hopper 73 into the feed spout 76. This valve assembly comprises a sector shaped member 78 which is mounted for swinging movement by means of two axially aligned shafts 79 and 80 which are journaled in the side walls of the valve assembly. The sector shaped member 78 is so designed that the abrasive escaping downwardly from the hopper 73 through the outlet opening 81 will be interrupted when the sector shaped member 78 is in the position shown in Fig. 6. The shaft 80 is biased so as to move the sector shaped valve member 78 to the valve closing position by means of a spring 82 which is attached at one end to a fixed bracket 83 and attached at the other end to a lever 84 rigidly secured to the end of the shaft 80. The shaft 79 is provided with an arm 86 for the purpose of moving the valve to an open position against the action of the spring 82 and thereby permitting the abrasive to escape downwardly into the feed spout 76 when this feed spout is positioned under the discharge spout 87 of the valve assembly.

The invention includes means for actuating the arm 86 so as to open the valve when the feed spout 76 is in a position to receive abrasive from the hopper 73. Such means may comprise a cam 88 mounted on the top portion of the wheel housing 37 so as to move therewith. The cam 88 is preferably provided with elongated slots 89 so that the position of the cam may be adjusted in relation to the wheel housing 37. The operative portion of the cam 88 may be adjusted in length by replacing the cam shown with one having a longer or shorter cam portion to thereby vary the period during which the valve is open. As the drum 10 rotates in a counter-clockwise direction, the cam 88 will engage the lever arm 86 and turn the shaft 79 and the shaft 80 against the action of the spring 82, so as to move the sector shaped valve member 78 to an open position and thereby permit abrasive to flow from the funnel 87. The arm 86 is provided with a roller 85 for being engaged by the cam 88. In the embodiment illustrated, the wheel housing 37 is then in a substantially vertical position, as shown in Fig. 10, and the abrasive will drop into the feed spout 76. This flow of abrasive will continue as long as the cam 88 remains in engagement with the arm 86. After the terminal portion 91 of cam 88 passes beyond the arm 86, the spring 82 will return the sector shaped valve member 78 to the closed position and interrupt the flow of abrasive from the funnel 87. The cam 88 is therefore short enough to permit closure of the valve before the enlarged feed spout 76 passes to a position laterally of the funnel 87.

The wheel 36 is accordingly supplied with abrasive when the cam 88 opens the valve 78 and a blast stream 92 will be initiated when the drum arrives approximately in the position shown in Fig. 10 in moving in a counter-clockwise direction. The abrasive throwing wheel 36 will propel the abrasive and maintain the blast stream 92 after the valve 78 is closed, since a quantity of abrasive will be stored in the enlarged feed spout 76. The drum 10 in moving further in a counter-clockwise direction to the position shown in Fig. 11 will cause the wheel 36 to move therewith and the abrasive within the feed spout 76 will be supplied to the wheel and the abrasive blast stream

92 will be maintained. The blast stream 92 will be interrupted when the abrasive within the feed spout 76 has all passed through the wheel 36. The point at which the blast stream 92 is interrupted in relation to the oscillated position of the drum 10 may be varied by adjusting the quantity of abrasive supplied to the feed spout 76. The quantity of abrasive supplied to the feed spout 76 may be altered by varying the area of the orifice 94 provided in the valve assembly 77 and other parts of the valve assembly. The length of the cam 88 may likewise be varied to control the quantity of abrasive supplied to the hopper 76 and accordingly the duration of the blast stream 92. It is desirable that this blast stream be interrupted at the earliest possible moment during the counter-clockwise rotation of the drum 10 in order to reduce to a minimum the quantity of abrasive projecting into the drum 10, and this blast stream may be interrupted when the batch of articles have all cascaded over the projection 43. Thus when the drum 10 arrives in the position shown in Fig. 12, the blast stream has been interrupted.

The tumbling mill herein disclosed provides but one abrasive projecting device in the form of abrasive throwing wheel 36 and during the clockwise rotation of the drum 10 no abrasive is projected into the drum. As the cam 88 passes the arm 86, the valve member 78 is not moved from the closed position and this operating condition is made possible by means of a one-way clutch arrangement between the shaft 79 and the arm 86. This one-way driving arrangement includes a pin 96 extending through the shaft 79 and extending through a slot 97 in the arm 86. This slot 97 is so shaped and dimensioned that when the arm 86 is turned in a counter-clockwise direction in Fig. 8, the shaft 79 is not rotated and the valve 78 remains closed. Thus no abrasive is supplied into the feed spout 76 as the drum moves in a clockwise direction.

During this clockwise rotation of the drum 10 the articles or castings represented at 100 in Fig. 12 are all positively moved in a clockwise direction with the drum, and the projection 43 then acts as a pushing member. The articles or castings are eventually elevated so as to tumble or to cascade over the edge of the projection 43 and then assume the position shown in Fig. 9 where the drum 10 has arrived in its extreme clockwise position. The drum 10 is then reversed and the projection 43 causes the articles 100 to be moved with the drum as shown in Fig. 10. In other words, the projection 43 extends inwardly from the wall of the drum for a distance sufficient for forming a pusher member when the drum is in the position shown in Fig. 9, and all of the articles must move with the drum. As the drum 10 moves in a counter-clockwise direction into the position shown in Fig. 10, the projection 43 and one of the flat sides thereof still act as a pusher member and partly supports the load represented by the articles.

The wheel 36 is continuously rotated during the treatment of the articles in the drum 10, and when the drum has rotated into the position shown in Fig. 10, the cam 88 engages the arm 86 and turns the shaft 79 so as to move the valve member 78 to an open position permitting the abrasive to fall downwardly into the enlarged feed spout 76. This operating condition is shown in Fig. 10, and the abrasive blast stream 92 is established. At this time the articles have assumed the position shown in Fig. 10, and it will be noted that

the blast stream 92 passes approximately through the center of the drum and engages the surfaces of the articles. As the drum 10 continues to move in a counter-clockwise direction the articles are further shifted as a group to a position laterally of the axis of the drum and then are supported principally by the flat side of the projection 43. The apex edge portion of the inverted V-shape projection 43 then defines the limits of the supporting base for the articles. The articles therefore remain supported laterally of the axis of the drum until the angle of repose is exceeded and thereafter the castings 100 fall or cascade through the blast stream 92, as shown in Fig. 11. It will be noted that when the drum is in this position some of the articles have not yet exceeded their angle of repose and are therefore still supported by the side of the projection 43. Additional counter-clockwise rotation of the drum 10 will cause these articles to be further elevated before cascading through the blast stream. The cascading operation is thus protracted and the articles pass through the blast stream in a separated relationship with respect to each other whereby the articles are more efficiently exposed to the impingement of the abrasive particles thereon.

During the oscillation of the drum the spent abrasive particles sift through the openings 44 and through the apertures 47 into the trough 49, and these abrasive particles are then conveyed into the hopper 55 by one of the inclined side end walls 51 or 52 of the abrasive trough. The spent abrasive particles arriving in the hopper 55 are moved upwardly by the conveyor 62 and are returned to the hopper 73 for re-use.

The enlarged feed spout 76 is rigidly supported on the protective housing 37 of the abrasive throwing device, and the feed spout 76 thus bodily moves with the drum 10. As hereinabove described the flow of abrasive from the storage hopper 73 is interrupted before the outermost edge 70 of the feed spout passes beyond a vertical plane extending through the outlet in the funnel 87. Thus all of the abrasive escaping from the storage hopper when the valve assembly 77 is open is supplied into the feed spout 76. The wheel 36 being thus supplied with abrasive continues to project the blast stream represented at 92 into the drum during counter-clockwise rotation thereof from the position shown in Fig. 10 until the measured or limited quantity of abrasive within the feed spout 76 is exhausted. In view of the fact that the feed spout 76 moves with the wheel 36 and with the drum 10, a partition 93 is arranged within the feed spout having an inclined side wall 80a so that all of the abrasive in the feed spout will be delivered to the center of the wheel as the drum moves into the position shown in Fig. 11. The partition 93 and the inclined side wall 80a thereof prevents abrasive from lying on the side wall 90 of the housing 37 and all of the abrasive is thus efficiently delivered to the abrasive throwing wheel 36.

While the invention has been shown and described in connection with specific structural details of the tumbling mill it will be appreciated that changes may be made in the apparatus such as alterations in the driving mechanism and variations in the operating cycle such as the arc of oscillation of the drum 10, and variations in the duration of the blast stream during rotation of the drum. Such modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. In a tumbling mill, a substantially cylindrical drum, means supporting said drum for rotation about the axis thereof, an abrasive throwing wheel, means carried by the periphery of the drum supporting said abrasive throwing wheel for rotation, means supplying abrasive to said abrasive throwing wheel, said drum having an opening in the periphery thereof through which the abrasive projected by the wheel enters the drum, and means controlled by the movement of the drum for interrupting the supply of abrasive to said wheel.

2. A tumbling mill comprising, a drum mounted for rotation about the axis thereof, an abrasive throwing wheel, means supporting said abrasive throwing wheel on the periphery of the drum, means rotating the abrasive throwing wheel, a stationary hopper for a supply of abrasive particles, and means for admitting a limited quantity of abrasive particles from said supply hopper to the presence of the wheel during rotation of the drum.

3. A tumbling mill comprising, a drum, means for rotating said drum, an abrasive throwing wheel, means carried by the periphery of the drum supporting said wheel for rotation, means rotating the abrasive throwing wheel, a feed spout movable with the wheel, a hopper for storing a supply of abrasive particles, valve means normally obstructing the flow of abrasive from said hopper, and means actuated by movement of the drum for opening said valve means when said feed spout is in a position to receive abrasive from said hopper.

4. A tumbling mill comprising a drum, means for rotating said drum, an abrasive throwing wheel, means carried by the periphery of the drum supporting said wheel for rotation, means rotating the abrasive throwing wheel, a feed spout movable with the wheel, a hopper for storing a supply of abrasive particles, a valve normally obstructing the flow of abrasive from said hopper, a cam movable with the drum for opening said valve when the feed spout is in a position to receive abrasive from the hopper, and means returning said valve to a closed position before said feed spout moves beyond the path of the abrasive flowing from said hopper.

5. A tumbling mill comprising, a drum, means for rotating said drum, an abrasive projecting device mounted on the periphery of the drum so as to move therewith and direct a stream of abrasive substantially diametrically into the drum, means for supplying abrasive to said abrasive projecting device, and means for interrupting the supply of abrasive controlled in accordance with the position of the drum during the rotation thereof.

6. In a tumbling mill, a substantially cylindrical shaped drum, an abrasive projecting device mounted on the drum and movable therewith so as to direct a blast stream into the drum, a projection carried by the drum and extending inwardly from the peripheral wall thereof terminating in a lip located sufficiently inward from the peripheral wall to positively move a group of articles with the drum, means for rotating the drum, and means controlled in accordance with the position of the drum for initiating the blast stream projected by said abrasive projecting device.

7. In a tumbling mill, a substantially cylindrical shaped drum, an abrasive projecting device mounted on the drum and movable therewith so

as to direct a blast stream into the drum, a projection carried by the drum and extending inwardly from the peripheral wall thereof terminating in a lip located sufficiently inward from the peripheral wall to positively move a group of articles with the drum, and means rotating the drum whereby the projection in cooperation with the drum moves the articles as a group to an elevated position where they cascade downwardly through the blast stream.

8. In a tumbling mill, a drum, means for projecting abrasive particles into the drum, said drum having apertures therein through which the spent abrasive particles may escape from the drum, a trough carried by the periphery of the drum receiving the abrasive particles passing through said apertures, end walls for said trough diverging from each other in proceeding towards one end of the drum for conveying the abrasive therein to one end of the drum, a housing, an annular flange around the drum intermediate the end walls of the trough, and a gasket assembly sealing the housing with respect to the peripheral portion of the trough and with respect to said annular flange.

9. A valve assembly for controlling the supply of abrasive to a projecting device of a tumbling mill comprising, a movable valve member, a shaft for moving the valve member, an operating arm, and a one-way clutch between the operating arm and said shaft.

10. A valve assembly for the storage hopper of a tumbling mill comprising, a sector-shaped valve member for obstructing an outlet of said hopper, a shaft supporting said valve member for swinging movement to an open position, resilient means biasing said valve to a position obstructing said hopper outlet, an operating arm rotatable on said shaft, a pin carried by the shaft, and said operating arm having a slot therein of limited circumferential extent whereby an end wall of the slot engages the pin upon swinging movement of the operating arm in one direction to rotate said shaft and swing the closure in the valve member to an open position.

11. In a tumbling mill, a drum for receiving

articles, means for rotating the drum, a projection extending inwardly from the arcuate wall of the drum to a position for positively moving substantially all of said articles with the drum, an abrasive projecting device carried by the drum directing a blast stream in a chordal direction into the drum to one side of the projection whereby the blast stream moves with the drum and the articles cascade through the blast stream when they exceed their angle of repose with reference to the inner edge of said projection.

12. In a tumbling mill for blasting a batch of articles and in combination, an oscillating drum, an abutment projecting inwardly from the inner wall of the drum and extending from end to end thereof and of a width substantially the same as the depth of the batch of articles placed in the drum for treatment, means movable in synchronism with the drum for propelling into the drum, in a chordal direction, a blast stream having an oblong impingement pattern with its longer axis substantially parallel to the axis of the drum, and means for moving the drum about its axis for causing the abutment to move laterally and upwardly the batch of articles to successively bring portions thereof above the angle of repose and cause the same to progressively cascade through said stream.

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