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Jenness

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[54] **DISCHARGE ASSEMBLY AND METHOD OF DISCHARGING FOR ROTARY GRINDING MILL**

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[52] **U.S. Cl.** **241/24,** 241/30, 241/70

[51] **Int. Cl.** **B02c 17/04**

[58] **Field of Search** 241/24, 30, 70, 79, 71, 241/72, 171, 172, 176, 178, 181

[56] **References Cited**

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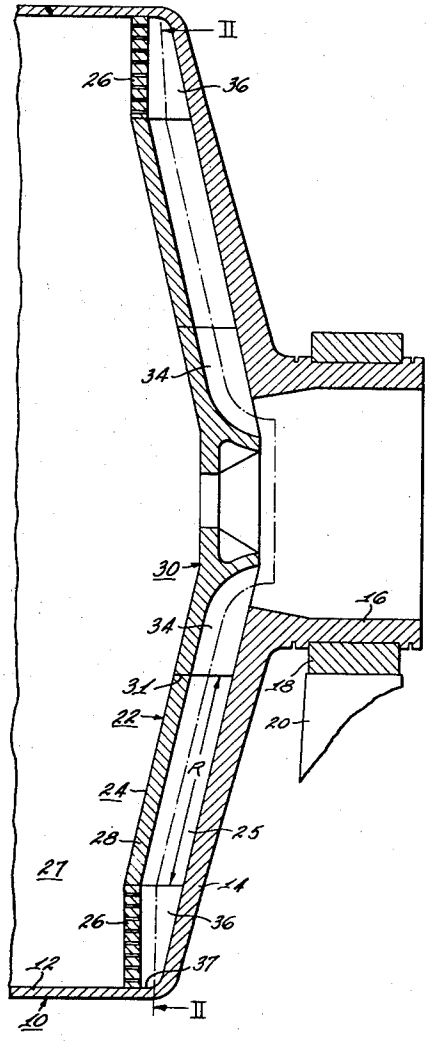
[57] **ABSTRACT**

An improved discharge assembly and method of discharging for a rotary grinding mill of the diaphragm type having a discharge cone which discharges material to a suitable exit such as, for example, a hollow discharge trunnion, characterized by an improved lifter vane construction in the discharge space between the discharge diaphragm and the end wall of the grinding mill. The respective lifter vanes of the improved construction extend from contiguous the radially inner periphery of the mill shell in a generally radial direction toward the axis of rotation of the mill for a distance substantially less than the distance in said direction from contiguous the radially inner periphery of the mill shell to the discharge cone, whereby material discharged from the lifter vanes onto the discharge cone falls through a substantial "free fall" distance before reaching the discharge cone.

15 Claims, 3 Drawing Figures



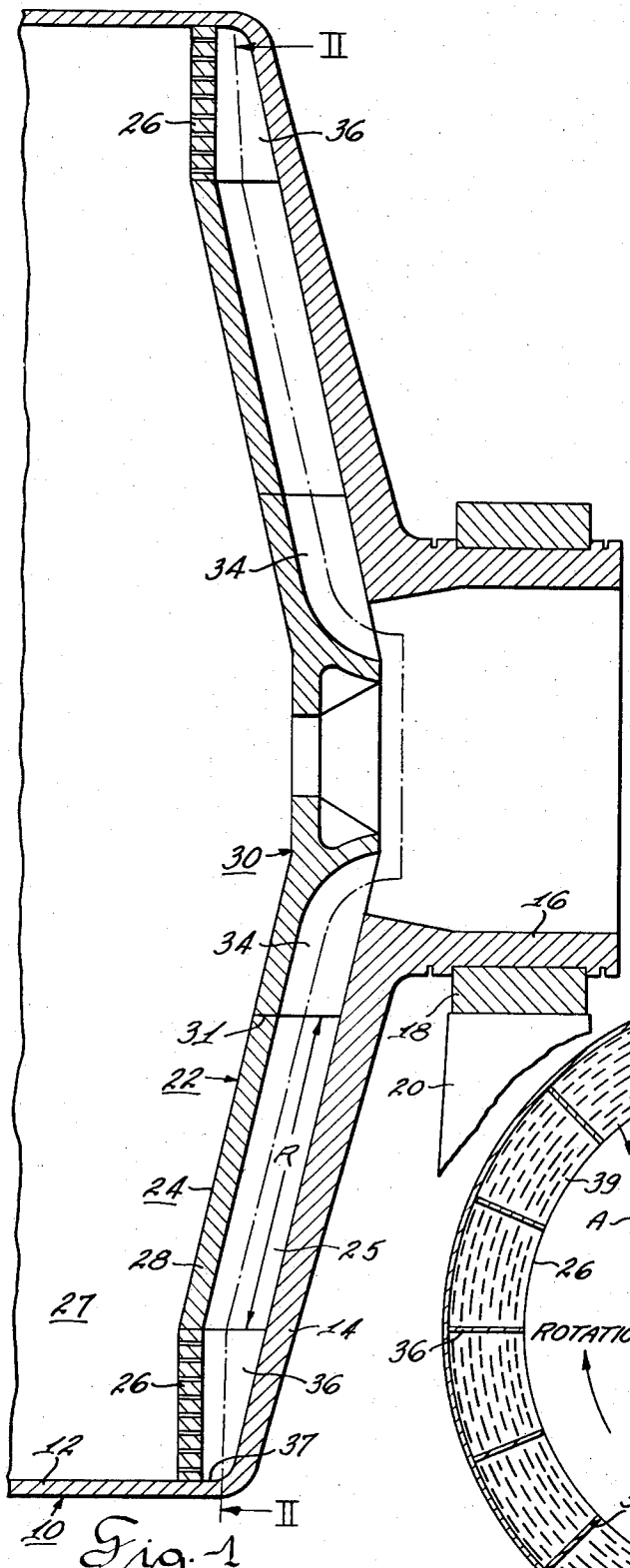


Fig. 1

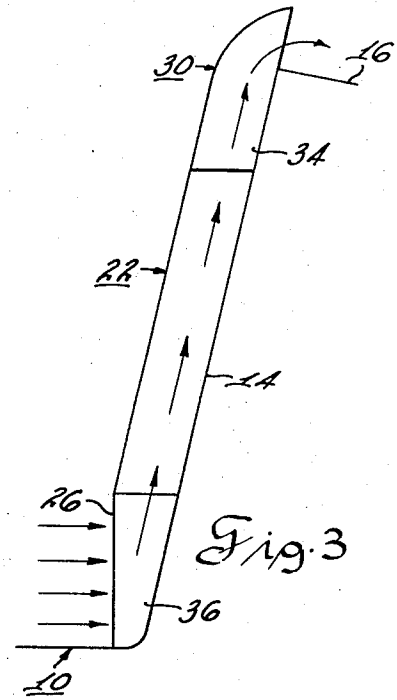


Fig. 3

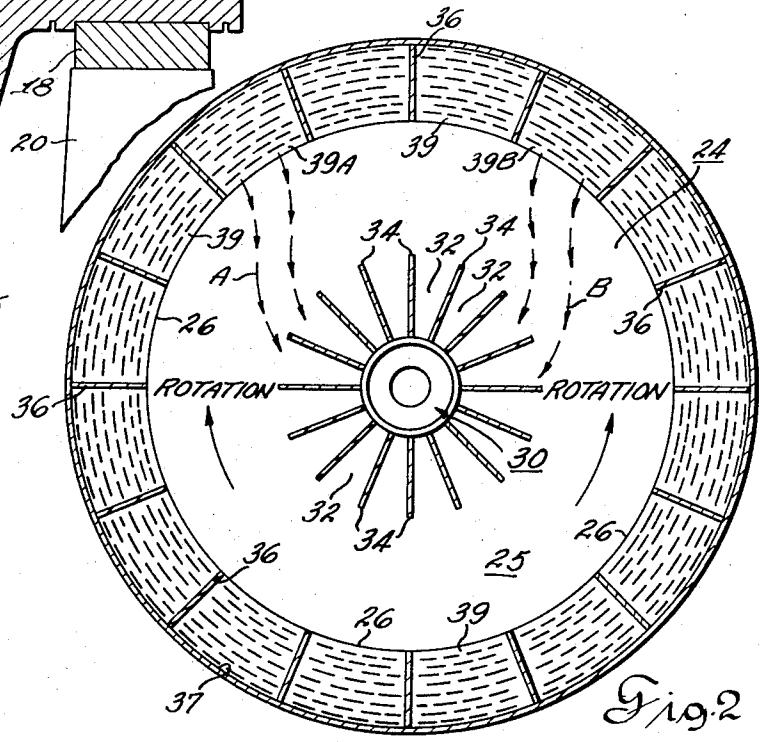


Fig. 2

DISCHARGE ASSEMBLY AND METHOD OF DISCHARGING FOR ROTARY GRINDING MILL

FIELD OF THE INVENTION

This invention relates to an improved discharge assembly for a rotary grinding mill of the diaphragm type and more particularly to a discharge assembly for a rotary grinding mill which includes an improved lifter vane construction in the discharge space between the discharge diaphragm and the end wall of the grinding mill. This invention also relates to an improved method of discharging material from a rotary grinding mill.

DESCRIPTION OF THE PRIOR ART

In rotary grinding mills of the prior art of the type provided with a discharge diaphragm, as shown, for example, in U.S. Pat. No. 3,599,882 issued to Richard E. Sabaski and Roger A. Heins on Aug. 17, 1971, it has been conventional to provide in the space between the discharge diaphragm and the end wall of the mill radially extending lifter vanes which extend continuously for substantially the entire radial distance from contiguous the radially inner periphery of the grinding mill shell to closely adjacent the radially outer extremities of the vaned flutes conventionally provided on or in association with the discharge cone of the diaphragm type grinding mill. In this prior art construction the material such as ore or the like which has passed through the gate portion of the discharge diaphragm into the space between the discharge diaphragm and the end wall of the mill is packed up by the radial lifter vanes at the lower portion of the path of rotation of the mill, the material being carried by the lifter vanes to a point above the axis of rotation of the mill where the material on the lifter vanes is delivered by the respective lifter vanes to the fluted discharge cone which, in turn, delivers the material to a suitable exit such as, for example, the hollow discharge trunnion of the mill.

In the prior art construction just described, the material which has been picked up by the lifter vanes and which is ultimately delivered by the lifter vanes to the discharge cone, is supported by the respective lifter vanes during the discharge movement of the material for substantially the entire radial distance from the radially inner periphery of the mill shell to the discharge cone, the surface of the lifter vane defining the flow path of the material for this entire distance. This causes the material being discharged to remain in the discharge compartment for a longer period of time than it is required in accordance with the construction of the present invention, thereby reducing the efficiency of the discharge of the material as compared to the construction of the present invention.

The discharge efficiency when using the prior art radial vanes which extend in a continuous path for substantially the entire distance from the inner radial periphery of the grinding mill shell to the discharge cone, decreases as a function of mill diameter and becomes an increasingly important factor in large diameter grinding mills such as those of 25 foot diameter or greater.

It has also been known in the prior art to provide lifter vanes in the discharge compartment of a diaphragm type rotary grinding mill in which the respective lifter vanes extend in a continuous curved path from contiguous the radially inner periphery of the grinding mill shell to a location contiguous the radially outer periphery of the discharge cone. Such curved discharge vanes have a greater efficiency of material discharge than do lifter vanes which lie along substantially radial lines. However, grinding mills provided with curved lifter vanes in the discharge compartment as just described are only capable of unidirectional rotation and are not capable of bidirectional rotation. Furthermore, curved lifter vanes of the type just described are more expensive to manufacture than the conventional radial lifter vanes.

STATEMENT OF THE INVENTION

Accordingly, it is an object of the present invention to provide a rotary grinding mill having a diaphragm type discharge assembly which has an improved discharge efficiency as compared to prior art constructions.

It is another object of the invention to provide a diaphragm type discharge assembly for a rotary grinding mill or the like having improved discharge lifter vanes within the discharge compartment.

It is a further object of the invention to provide a rotary grinding mill of the type having a diaphragm type discharge assembly including an improved lifter vane assembly in accordance with which material is discharged more rapidly through the discharge compartment to the exit, such as a discharge trunnion, than in accordance with the radial type lifter vane construction of the prior art, and which has the further advantage that a lower "pulp" level can be maintained in the grinding chamber of the mill for a given rate of flow through the mill.

It is still a further object of the invention to provide a rotary grinding mill of the type having a diaphragm type discharge assembly including an improved lifter vane construction requiring less parts than prior art lifter vane constructions.

It is still a further object of the invention to provide a discharge assembly of the diaphragm type which while not restricted thereto has particular utility in connection with rotary grinding mills of large diameter such as those having a diameter of 25 feet or more.

It is still a further object of the invention to provide a rotary grinding mill discharge assembly of the diaphragm type having a discharge efficiency which approaches that provided by the use of curved lifter vanes, but which is less expensive to manufacture than the curved lifter vane construction, and which further permits bidirectional rotation of the mill which is not permitted when curved lifter vanes are used in the discharge diaphragm assembly.

It is another object of the invention to provide an improved method of discharging material from a rotary grinding mill of the diaphragm type.

Accordingly, there is provided in accordance with an embodiment of this invention an improved discharge assembly and method of discharging for a rotary grinding mill of the diaphragm type having a discharge cone which discharges material to a suitable exit such as, for example, a hollow discharge trunnion, characterized by an improved lifter vane construction in the discharge space between the discharge diaphragm and the end wall of the grinding mill. The respective lifter vanes of the improved construction extend from contiguous the radially inner periphery of the mill shell in a radial or in a generally radial direction toward the axis of rotation of the mill for a distance substantially less than the

distance in said direction from contiguous the radially inner periphery of the mill shell to the discharge cone, whereby material discharged from the lifter vanes onto the discharge cone falls through a substantial "free fall" distance before reaching the discharge cone.

BRIEF DESCRIPTION OF THE DRAWING

Further objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a view in vertical section of the discharge end of a grinding mill provided with the improved lifter vane construction of the invention;

FIG. 2 is a view taken along line II—II of FIG. 1 on a reduced scale, showing the relationship of the lifter vanes in the discharge compartment to the vaned flutes of the discharge cone, and further showing the path of material discharge with respect to the rotating diaphragm assembly in both a clockwise and a counterclockwise direction of rotation; and

FIG. 3 is a schematic view in axial section of the discharge end of the mill showing the path of material flow from the radial lifter vanes to the discharge cone of the material being discharged, it being understood, of course, that the material falls from a pocket such as 39A or 39B (FIG. 2) at an elevated position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and more particularly to FIG. 1, there is shown the discharge end of a rotary grinding mill generally indicated at **10** comprising a hollow cylindrical casing or shell **12** to which is secured a discharge end wall **14** from which extends a hollow discharge trunnion **16** upon which mill **10** is supported for rotation about substantially a horizontal axis by bearing **18** mounted on bearing pedestal **20.** Suitable means (not shown) is provided for rotating the grinding mill. Inside the discharge end of the grinding mill **10,** a discharge diaphragm assembly generally indicated at **22** is provided which will now be described. The discharge diaphragm assembly comprises a partition or diaphragm generally indicated at **24** which is in axially spaced relation to end wall **14.** Diaphragm **24** in the illustrated embodiment comprises a radially outer circumferentially extending tier of grate members **26** and one or more circumferentially extending tiers of wear plates **28.** The radially inner edge of wear plates **28** abuts against the radially outer edge **31** of a discharger means in the form of a discharge cone generally indicated at **30.** Diaphragm **24** and the grates **26** and wear plates **28** of which it is formed all extend through a circumferential arc of 360°.

Grate members **26** have perforations or apertures therethrough to permit the passage of material such as ore or other material being processed therethrough from the grinding chamber **27** of the mill into the space or "discharge compartment" **25** between diaphragm **24** and discharge end wall **14.** It will be understood that a suitable discharge casting assembly (not shown) such as that indicated at **50** in the aforementioned U.S. Pat. NO. 3,599,882, issued to Richard E. Sabaski and Roger A. Heins, suitably modified to adapt it to the tapered contour of discharge end wall **14** and also suitably modified to adapt it to the reduced length lifter vane construction of the present invention, may be provided inside the space between diaphragm **24** and discharge end wall **14,** and that the reduced length radially outer lifter vanes **36** to be described, which are secured to the rotary mill **10** in any suitable manner for rotation with the mill, may be formed as part of such discharge casting subassembly. For example, the lifter vanes **36** of the present invention may extend from the discharge castings in a manner similar to the flanges (or lifters) **59** of the radially outermost tier of discharge castings **52** of the aforementioned Pat. No. 3,599,882.

The discharge cone generally indicated at **30** is of the usual type well known in the art of diaphragm type grinding mills and is suitably secured by bolts or the like to the discharge end wall **14** of the grinding mill whereby the discharge cone **30** rotates with the mill as the mill rotates. The radially outer periphery of discharge cone **30** abuts at edge **31** against the radially inner periphery of the discharge diaphragm **24** as previously mentioned. The apex or apex end of discharge cone **30** is directed axially of the discharge trunnion **16.** The discharge cone **30** may not necessarily extend to an apex since the cone may, in practice, be truncated. However, the term "discharge cone" is used in this art to designate this element which is well known per se, irrespective of whether or not it may be truncated. Discharge cone **30** is provided with or has associated therewith with a plurality of flutes **32** defined by spaced vanes **34** extending from, but not necessarily integral with, the surface of discharge cone **30.** Flutes **32** define passages which communicate at their radially outer ends with the discharge compartment **25** defined between diaphragm **24** and end wall **14,** the radially inner ends of the passages defined by flutes **32** being directed axially of the trunnion **16.**

Vanes **34** associated with discharge cone **30** are normally carried by the discharge cone, but may instead extend from or be carried by a liner or the like mounted on the inside surface of end wall **14** in the region of discharge cone **30.** In fact, vanes **34** may extend alternately in intermeshed relation from both the discharge cone **30** and from a liner or the like carried by the inside surface of end wall **14** of the mill. It will be understood that in any of these possible arrangements for supporting the vanes **34** just mentioned, the geometrical relationship of the vanes **34** to the discharge cone **30** remains the ssme, the vanes **34** extending from and being spaced about the peripheral surface of cone **30** to define material directing flutes **32** in a manner well known in the art. The vanes **34** bridge the space between the facing surfaces of discharge cone **30** and end wall **14** (or of a liner or the like mounted on the inside surface of wall **14**).

In accordance with the embodiment of the invention, a plurality of radially extending circumferentially spaced lifter vanes respectively indicated at **36** are positioned in the discharge compartment between diaphragm **24** and discharge end wall **14** and extend from contiguous the radially inner periphery **37** (or inner circumference) of the grinding mill shell for a distance in a generally radial direction which is substantially less than the total distance in the same direction from the radially inner periphery **37** of the mill shell to the radially outer extremity of discharge cone **30.** This is in contrast to the prior art construction in which the radial lifter vanes extend for substantially the entire radial distance from the radially inner periphery of the mill shell to the radially outer periphery of the dis-

charge cone. For example, in the specific embodiment shown, lifter vanes **36** may extend a radial distance inwardly from the radially inner periphery **37** of the grinding mill shell **12** for a distance substantially equal to the radial distance through which the tier of grate castings **26** extends. Thus, between the radially inner extremity of lifter vanes **36** and the radial outer extremity of discharge cone **30,** there is a considerable distance indicated at R in the view of FIG. **1** extending in a generally radial direction (as determined by the contour of the discharge compartment **25**) through which the lifter vane **36** does not extend, but through which the lifter vane of the prior art would extend.

Each pair of adjacent circumferentially spaced lifter vanes **36** defines a circumferentially and radially extending space or pocket **39** therebetween which becomes filled with material during the lower portion of the rotation of a given pocket **39.**

The material discharged from the lifter vanes **36** (or from the pockets **39** between adjacent vanes **36**) of the present invention drops in a free fall path A or B (FIG. **2**) into the flutes **32** between vanes **34** associated with discharge cone **30** as best seen in the view of FIG. **2.** The term "radially inner periphery" of the grinding mill or of the grinding mill shell, as used herein, is intended to include the radially inner periphery of any linear, discharge casting, or the like which may be used to line the inner circumference of the grinding mill. Furthermore, the expression "generally radial" as used in the specification and in the claims is intended to include a direction which is true radial, as well as a direction such as the direction "R" of FIG. **1** which is in an approximately or generally radial direction, although not in an absolutely true radial direction.

The length of the vanes **36** in a radial direction is a function of the discharge rate of the mill and the radial length of vanes **36** should be made such as to be capable of handling the maximum desired discharge rate of material from the mill.

SUMMARY OF OPERATION

In the operation of the improved lifter vane construction of the invention, the material such as ore or other material being processed which is of such size that it can pass through the apertures or perforations of the tier of grates **26** will pass into the discharge compartment **25** during the lower portion of the rotation of the grinding mill, this material being received in the space or pocket **39** between each pair of adjacent circumferentially spaced lifter vanes **36** as the mill rotates. The material which has been picked up by the lifter vanes **36** at the lower end of the path of travel of the grinding mill will rotate with the lifter vanes **36** as the mill rotates and when the material between a given pair of lifter vanes **36** has been raised a sufficient height above the horizontal plane such that the force of gravity overcomes the centrifugal force on the material due to the rotation of the mill, the material will drop out of the space between the adjacent vanes **36** and will discharge in a free fall path toward and into the flutes **32** associated with the dicharge cone **30** as indicated, for example, at A for clockwise rotation, or at B for counterclockwise rotation in the diagrammatic view of FIG. **2.** Paths A and B, FIG. **2,** indicate the path of material flow in the "free fall path" with respect to the rotating discharge diaphragm assembly. The path of the material being discharged from a given pocket **39** (FIG. **2**) is such that the material is intercepted by a vaned flute **32** which is in circumferentially trailing relationship to the given pocket **39.** Typically, the material may first begin to discharge out of the space between a given pair of lifter vanes **36** and toward flutes **32** of discharge cone **30** when the material has been rotated by the given lifter vanes **36,** for example, approximately **30°** above the horizontal plane. The paths A or B are determined to a large extent by the force of gravity on the falling material and by the horizontal component of the velocity of the material during its free fall.

Material which has been received from pockets **39** by flutes **32** associated with discharge cone **30** is then directed by flutes **32** into discharge trunnion **16,** from whence the material passes to a suitable receiving means, as is well known in the art.

The discharge diaphragm assembly hereinbefore described which is characterized by the fact that the lifter vanes in the discharge space between the diaphragm and the discharge end wall of the mill do not extend for the entire radial distance from contiguous the radially inner periphery of the mill shell to the radially outer periphery of the discharge cone, as is conventional in the prior art, but, instead, a substantial portion of the radial length of the conventional lifter vanes has been eliminated, providing a free fall space between the radially inner periphery of the respective lifter vanes of the invention and radially outer periphery of the vanes and flutes associated with the discharge cone. This construction provides a more efficient discharge for the material than constructions of the prior art, with the result that a given increment of the material remains in the discharge assembly for a shorter length of time than was required in accordance with the construction of the prior art. The construction and method of the present invention have particular advantages in improving the discharge efficiency of diaphragm type grinding mills of larger diameter, such as, for example, mills of 25 feet or more in diameter.

A further advantage of the construction and method of the present invention is that for a given rate of flow of material through the mill a lower pulp level of the material in the grinding chamber may be maintained than in accordance with the prior art. By having a lower pulp level in the grinding chamber, the energy of the tumbling particles in the grinding chamber is not reduced as much as it would be with a higher pulp level, which could promote higher mill efficiency under certain grinding requirements.

A further advantage of the reduced length lifter vane construction of the present invention is that due to the reduced radial length of the lifter vane as compared to the prior art, the number of parts required is reduced. Furthermore, the construction of the present invention essentially provides the operating advantages of curved lifter vanes known to the prior art without the disadvantages of such curved vanes, such as greater expense of construction of curved lifter vanes, and the fact that curved vanes will not permit bidirectional rotation of the mill. The construction of the present invention permits bidirectional rotation of the mill.

From the foregoing detailed description of the invention it has been shown how the objects of the invention have been obtained in a preferred manner. However, modifications and equivalents of the disclosed concepts such as readily occur to those skilled in the art intended to be included within the scope of this invention.

The embodiments of the invention in which an exclusive property or priviledge is claimed are defined as follows:

1. A rotary grinding mill comprising a hollow shell, a discharge end wall at an end of said shell, a diaphragm mounted in said shell contiguous but axially spaced from discharge end wall whereby to define a discharge compartment between said diaphragm and said discharge end wall, said diaphragm including a grate portion to permit passage of material into said discharge compartment, an exit means for material discharged from said mill, a discharger means mounted contiguous the radially inner periphery of said diaphragm and communicating with said discharge compartment and also with said exit means, said discharger means having associated therewith vanes defining passages for directing material to said exit means, a plurality of circumferentially spaced lifter vanes mounted in said discharge compartment, the respective lifter vanes extending from contiguous the radially inner periphery of said shell in a direction toward the axis of rotation of said shell for a distance substantially less than the distance in said direction from contiguous the radially inner periphery of said shell to said vanes associated with said discharger means, whereby material discharged from said lifter vanes onto said discharger means falls through a substantial "free fall" distance in an unchannelized path in said discharge compartment before reaching said vanes associated with said discharger means.

2. A rotary grinding mill as defined in claim 1 in which said exit means comprises a hollow discharge trunnion extending from said discharge end wall, said discharger means being positioned to discharge material into said discharge trunnion.

3. A rotary grinding mill as defined in claim 1 in which said discharger means comprises a discharge cone.

4. A rotary grinding mill as defined in claim 1 in which the respective lifter vanes in the discharge compartment extend inwardly from contiguous the radially inner periphery of the mill shell in a direction substantially radially of the grinding mill.

5. A rotary grinding mill comprising a hollow shell, a discharge end wall at an end of said shell, and a hollow discharge trunnion extending from said discharge end wall, a diaphragm mounted in said shell contiguous but axially spaced from said discharge end wall whereby to define a discharge compartment between said diaphragm and said discharge end wall, said diaphragm including a grate portion to permit passage of material into said discharge compartment, a discharge cone mounted contiguous the radially inner periphery of said diaphragm and communicating with said discharge compartment and with said discharge trunnion, said discharge cone having associated therewith a plurality of vanes spaced from each other about the periphery of said cone, each pair of contiguous vanes defining therebetween a flute for the passage of material from said discharge compartment to said hollow trunnion, a plurality of circumferentially spaced lifter vanes extending from contiguous the radially inner periphery of said shell in a direction toward the axis of rotation of said mill for a distance substantially less than the distance in said direction from contiguous the radially inner periphery of said shell to the vanes associated with said discharge cone, whereby material discharged from said lifter vanes onto said discharge cone falls through a substantial "free fall" distance in an unchannelized path in said discharge compartment before reaching said vanes associated with said discharge cone.

6. A grinding mill as defined in claim 5 in which each flute includes a radially outer end communicating with said discharge compartment and a radially inner end communicating with said discharge trunnion, the radially inner end of the respective lifter vanes being spaced a substantial distance in a generally radial direction from the radially outer end of the respective flutes, whereby material discharged from said lifter vanes onto said discharge cone falls down through a substantial "free fall" distance before reaching the respective flutes.

7. A grinding mill as defined in claim 5 in which the respective lifter vanes in the discharge compartment extend inwardly from contiguous the radially inner periphery of the mill shell in a direction substantially radially of the grinding mill.

8. A rotary grinding mill comprising a hollow shell, a discharge end wall at an end of said shell, and a hollow discharge trunnion extending from said discharge end wall, a diaphragm mounted in said shell contiguous but axially spaced from said discharge end wall whereby to define a discharge compartment between said diaphragm and said discharge end wall, said diaphragm including a grate portion to permit passage of material into said discharge compartment, a discharger means mounted contiguous the radially inner periphery of said diaphragm and contiguous the axis of rotation of said grinding mill, said discharger means having associated therewith a plurality of flutes defining passages which guide material from said discharge compartment to said hollow trunnion, a plurality of circumferentially spaced lifter vanes mounted in said discharge compartment, the respective lifter vanes extending from contiguous the radially inner periphery of said shell in a direction toward the axis of rotation of said shell for a distance substantially less than the distance in said direction from contiguous the radially inner periphery of said shell to said flutes associated with said discharger means, whereby material discharged from said lifter vanes onto said discharger means falls through a substantial "free fall" distance in an unchannelized path in said discharge compartment before reaching said flutes associated with said discharger means.

9. A discharge diaphragm assembly for use with a rotary grinding mill of the type comprising a mill shell, a discharge end wall at an end of said mill shell, an exit means for material discharged from said mill, and a discharger means located within said mill contiguous the axis of rotation of said mill and adapted to discharge material to said exit means, said discharger means having associated therewith a plurality of vanes defining passages for direction of material to said exit means, characterized by a diaphragm adapted to be mounted inside the discharge end of the grinding mill contiguous but in axially spaced relation to the discharge end wall of the mill whereby to define a discharge compartment between said diaphragm and said discharge end wall, a plurality of circumferentially spaced lifter vanes mounted in said discharge compartment, the resepctive lifter vanes extending from contiguous the radially inner periphery of said mill shell in a direction toward

the axis of rotation of said mill for a distance substantially less than the distance in said direction from contiguous the radially inner periphery of said mill shell to said vanes associated with said discharger means, whereby material discharged from said lifter vanes onto said discharger means falls through a substantial "free fall" distance in an unchannelized path in said discharge compartment before reaching said vanes associated with said discharger means.

10. A discharge diaphragm assembly as defined in claim **9** in which said exit means comprises a hollow discharge trunnion extending from said discharge end wall, said discharger means positioned to discharge material into said discharge trunnion.

11. A discharge diaphragm assembly as defined in claim **9** in which said discharger means is a discharge cone, and said discharge cone has associated therewith a plurality of vanes spaced from each other about the periphery of said cone, each pair of adjacent vanes defining therebetween a flute for the passage of material from said discharge compartment to said exit means.

12. A discharge diaphragm assembly as defined in claim **9** in which the respective lifter vanes in the discharge compartment extend in a direction substantially radially of the grinding mill.

13. A discharge diaphragm assembly for use with a rotary grinding mill of the type comprising a mill shell, a discharge end wall at an end of said shell, a hollow discharge trunnion extending from said discharge end wall, and a discharge cone positioned within said mill contiguous the axis of rotation of said mill and adapted to discharge material to said trunnion, said discharge cone having associated therewith a plurality of flutes defining passages which guide material being discharged to said hollow trunnion, characterized by a diaphragm adapted to be mounted inside the discharge end of the grinding mill contiguous but in axially spaced relation to the discharge end wall of the mill whereby to define a discharge compartment between said diaphragm and said discharge end wall, a plurality of circumferentially spaced lifter vanes mounted in said discharge compartment, the respective lifter vanes extending from contiguous the radially inner periphery of said mill shell in a direction toward the axis of rotation of said mill for a distance substantially less than the distance in said direction from contiguous the radially inner periphery of said mill shell to said flutes associated with said discharge cone, whereby material discharged from said lifter vanes onto said discharge cone falls through a substantial "free fall" distance in an unchannelized path in said discharge compartment before reaching said flutes associated with said discharge cone.

14. The method of discharging ground material from a diaphragm type rotary grinding mill having a discharge exit positioned contiguous the axis of rotation of said mill and a discharger means positioned within said mill contiguous said discharge exit and adapted to discharge material to said discharge exit, said discharger means having associated therewith a plurality of vanes spaced from each other about the periphery of said discharger means, each pair of contiguous vanes defining therebetween a flute for the passage of material from said discharge compartment to said discharge exit, said method comprising the steps of:

1. providing within the space between the diaphragm and the discharge end wall of the mill, and extending from contiguous the radially inner periphery of the mill shell a plurality of circumferentially spaced lifter vanes whose radially innermost ends are spaced a substantial distance in a generally radial direction from the radially outer periphery of the vanes associated with the discharger means,
2. passing material through perforations in said diaphragm into the space between the diaphragm and the discharge end wall of the mill whereby said material is picked up and raised by said lifter vanes to a location above the axis of rotation of the mill; and
3. discharging material from said lifter vanes to the flutes of said discharger means in an unchannelized free fall path in the space between said diaphragm and the discharge end wall of the mill, said material being discharged by said discharger means to said discharge exit.

15. The method defined in claim **14** in which said circumferentially spaced lifter vanes extend in a direction substantially radially of the grinding mill.

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