

H. W. HARDINGE.
 APPARATUS FOR GRINDING ORES AND OTHER MATERIALS.
 APPLICATION FILED OCT. 19, 1910.

1,115,531.

Patented Nov. 3, 1914.
 2 SHEETS—SHEET 1.

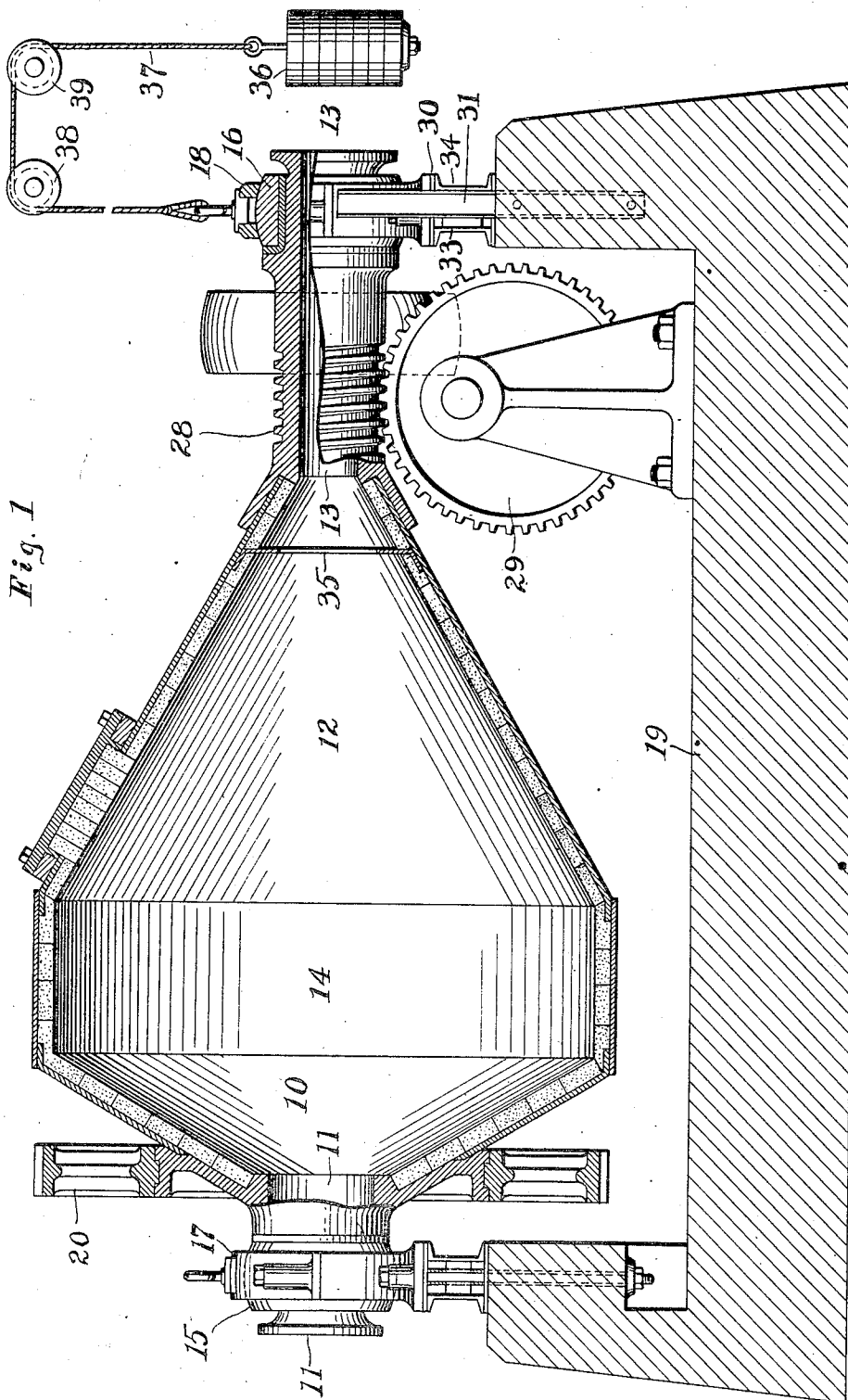


Fig. 1

Witnesses:
 Louis J. Schilling.
 S. S. Dunham.

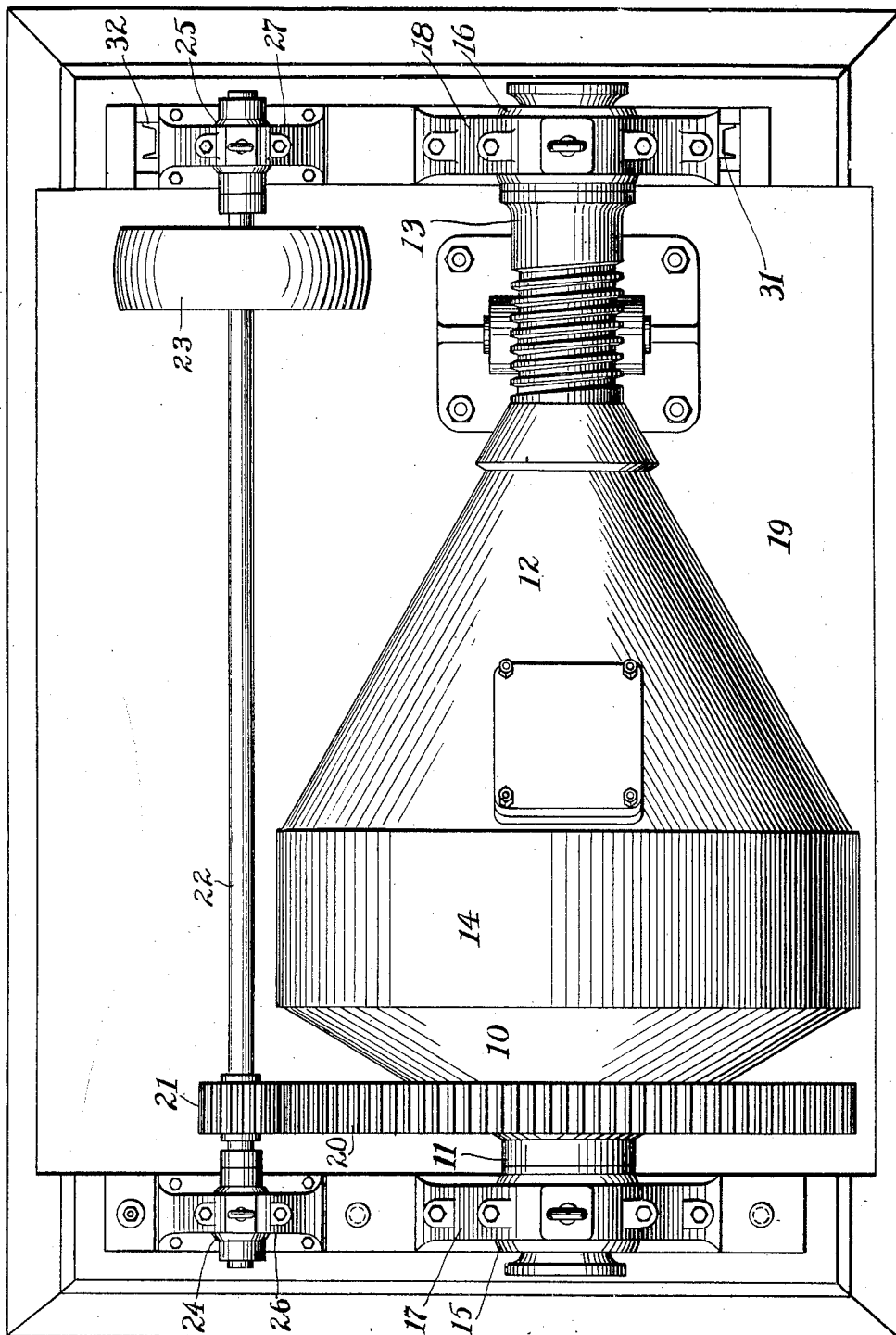
Inventor
 H. W. Hardinge
 By his Attorneys
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Fig. 2



Witnesses:

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UNITED STATES PATENT OFFICE.

HARRY W. HARDINGE, OF NEW YORK, N. Y., ASSIGNOR TO HARDINGE CONICAL MILL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

APPARATUS FOR GRINDING ORES AND OTHER MATERIALS.

1,115,531.

Specification of Letters Patent.

Patented Nov. 3, 1914.

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To all whom it may concern:

Be it known that I, HARRY W. HARDINGE, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Apparatus for Grinding Ores and other Materials, of which the following is a full, clear, and exact description.

In the operation of grinding mills, such as "tube mills", "ball mills", "pebble mills", and the like, for grinding or disintegrating ores and other materials it is usually found that the material, particularly in the case of very hard or refractory substances, in its final state of sub-division is not so nearly uniform in size as may be desired. That is, a certain percentage of the particles may be too large for the purpose desired or the subsequent methods employed for reducing the coarser particles. The utilization of this coarser portion of the ore or other material is frequently an important consideration, and it is accordingly the object of my present invention to provide improved means whereby such coarser particles shall be subjected in the mill a longer time to the grinding or reducing action so that the percentage of coarse material finally discharged from the mill will be reduced to minimum in amount.

To this and other ends the invention consists in the novel features of construction and combinations of elements hereinafter described and claimed.

In practice, my improvement may be applied to mills of various kinds, but herein I have shown it in combination with a mill of the "conical" type, described and claimed broadly in my prior Patent No. 908,861, issued January 5, 1909. As illustrated in the accompanying drawings the invention is combined with a Hardinge conical mill in which a relatively short inlet cone and a relatively long outlet cone are attached at their bases to an intermediate cylindrical portion, but it is to be understood that the invention is not limited to use with that particular type.

In the drawings, Figure 1 shows the apparatus in vertical longitudinal section, and Fig. 2 is a plan view of the same.

As stated above, the mill illustrated is of the conical type, and its barrel or drum consists of a conical inlet portion 10 having at

its apex a tubular inlet trunnion 11, a conical outlet portion 12 having at its apex a tubular outlet trunnion 13, the two portions named being attached at their bases to an intermediate cylindrical portion 14. The trunnions are revolubly mounted in bearing rings 15, 16, which have outer surfaces of spherically convex form and which are movable in correspondingly concave pillow blocks 17, 18, the latter being in turn supported by a suitable base 19. On the inlet end of the drum or barrel is a driving gear 20, meshing with a driving pinion 21 on a shaft 22, rotated by any suitable driving means, not shown, through the instrumentality of a pulley 23. The shaft 22 also is journaled at its ends in spherical bearing rings 24, 25, mounted in concave pillow blocks 26, 27, on the base 19. It will therefore be seen that the pillow blocks at either end may be raised without disengaging or straining the gear and pinion, such movement being permitted by the swivel action, so to speak, of the spherical bearing rings in their concave sockets or pillow blocks. The operation of mills of this type is fully described in my prior patent above referred to, and hence need not be described in detail herein. Suffice it to say that as the barrel revolves the pieces or lumps of material, and the grinding or crushing balls or pebbles, assort themselves according to size; that is, with the larger pieces where the barrel is of greatest diameter, and grading in size from that point toward the outlet. As the pieces are broken up they progress toward the outlet and finally issue therefrom.

If the particles discharged, or an undue proportion of them, are too large, they must be further reduced in size; either by returning them to the mill, or by suitable treatment outside, by other instrumentalities. My present invention is designed to obviate such necessity, by keeping the particles in the mill a longer time, so that they may be subjected to the disintegrating or reducing action long enough to bring them to the desired fineness. For this purpose one of the trunnions, in the present instance the outlet trunnion, is provided with a worm 28, adapted to mesh with and hence rotate an eccentrically journaled worm gear 29. It will therefore be seen that as the gear re-

volves it will alternately raise and lower the outlet end of the barrel, the frame 30, on which the pillow blocks 18 and 25 are mounted, moving between the vertical guide members 31, 32, which are embraced on opposite sides by the transverse I-beams 33, 34 constituting the side-members of said frame. The result of this oscillatory movement is that while the outlet is above the level of the material in the drum, no material will be discharged, so that the small particles will be subjected longer to the action of the mill. Moreover, the lower edge or side of the conical outlet portion being in effect made steeper by this elevation of the outlet trunnion the larger particles of the material near the outlet will in some cases be displaced a slight distance in a direction backward from the outlet, into a zone of larger pieces or particles where the grinding or reducing action is greater. Now when the outlet is lowered the material thereat, on the point of flowing out of the barrel, will have been subjected longer to the action of the mill and hence will be correspondingly smaller. The result is that only the finest particles will be discharged, and before the coarser particles can reach the outlet the trunnion will rise again and prevent their discharge. In this way the greater portion of the particles discharged will be those fine enough to be suspended in the water flowing through the mill, when the latter is used for "wet" grinding, and only a small proportion of the material discharged will be of coarser grade.

If desired, an annular flange 35 may be provided inside the barrel a short distance from the outlet, to serve as a dam for the purpose of impeding the movement of the material near the outlet, so that only pieces too small to sink into the mass of material can pass over it. In oscillating the drum about a transverse axis, particularly when the construction is such as to allow the outlet or discharge end to fall below the horizontal, there is a tendency for the coarser particles to work up to the discharge orifice and issue prematurely therefrom. There also exists in the ordinary construction a tendency for the material, both fine and coarse, to issue in excess when the discharge end is below the horizontal. The concentric annular dam 35, is provided to oppose these tendencies, and does so by impeding the travel of the coarser particles. It does not, however, interfere with the free discharge of the slime which floats on the coarser material.

A suitable counterweight 36, attached to a rope or cable 37 running over pulleys 38, 39 and connected to the pillow block 18, may be provided to reduce the friction between the worm 28 and gear 29.

The apparatus herein specifically shown and described is simple and effective, but it will be understood that the invention can be embodied in other forms without departure from its proper spirit and scope as defined by the appended claims.

I claim:

1. In a mill for the purpose described, the combination with a drum provided with inlet and outlet openings, and means for rotating the drum about its longitudinal axis, of continuously operating automatic means for raising the outlet above the inlet opening and also lowering the former while the drum is revolving.

2. In a mill for the purpose described, the combination of a drum having an end provided with a conical outlet portion provided at its apex with an outlet opening, means for rotating the drum about its longitudinal axis, and automatic means for oscillating the drum about a transverse axis at the end of the drum opposite to said outlet opening.

3. In a mill for the purpose described, the combination of a drum having a hollow outlet trunnion, means for rotating the drum about the axis of said trunnion, and automatic means cooperating with the trunnion to raise and lower the same in an arc above the horizontal axis while the drum is revolving.

4. In a mill for the purpose described, the combination of a drum, means for rotating the drum about its longitudinal axis, and means actuated by the rotation of the drum for oscillating the drum about a transverse axis.

5. In a mill for the purpose described, the combination of a drum having a conical outlet portion provided at its apex with a tubular outlet trunnion, means for rotating the drum about its longitudinal axis, and means connected with and actuated by said trunnion to raise and lower the same while the drum is revolving.

6. In a mill for the purpose described, the combination of a drum having a tubular outlet trunnion provided with a worm, means for rotating the drum about the axis of said trunnion, and an eccentrically journaled worm gear meshing with said worm, whereby as the drum revolves it will be oscillated about a transverse axis.

7. In a mill for the purpose described, the combination of a drum having a conical outlet portion provided with an outlet opening at its apex, an inner annular dam concentric with the outlet opening and mounted upon the conical portion between the ends thereof, means for rotating the drum about its longitudinal axis, and means for oscillating the drum about a transverse axis while the drum is revolving.

8. In a mill for the purpose described, the combination of a drum having a tubular outlet trunnion, and an eccentrically journaled gear meshing with means on said
5 trunnion whereby as the drum revolves it will be oscillated about a transverse axis.

In testimony whereof I affix my signature in the presence of two subscribing witnesses.

HARRY W. HARDINGE.

Witnesses:

M. LAWSON DYER,
S. S. DUNHAM.