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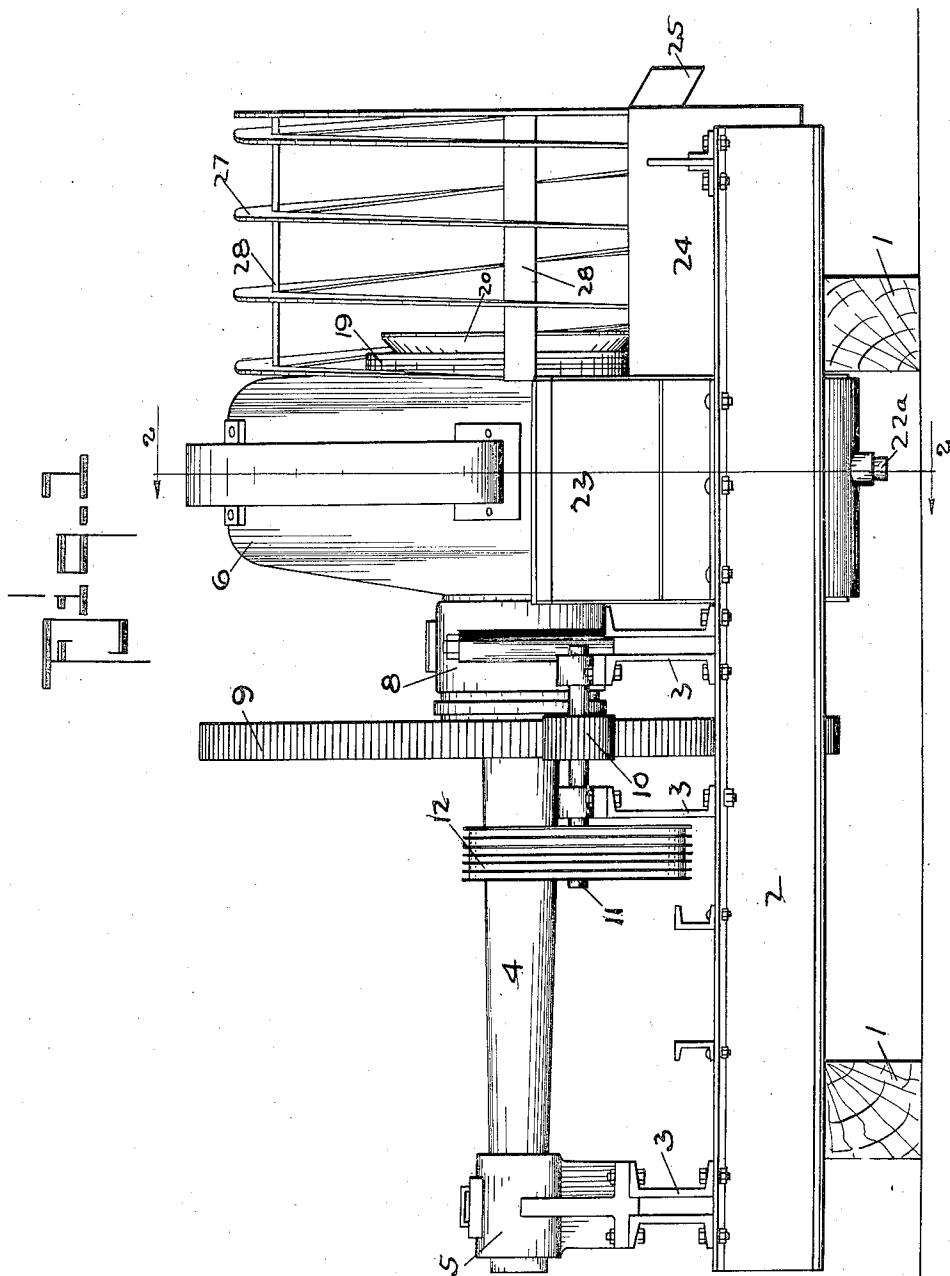
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2,031,697

GRINDING MILL

Filed April 27, 1934

4 Sheets-Sheet 1



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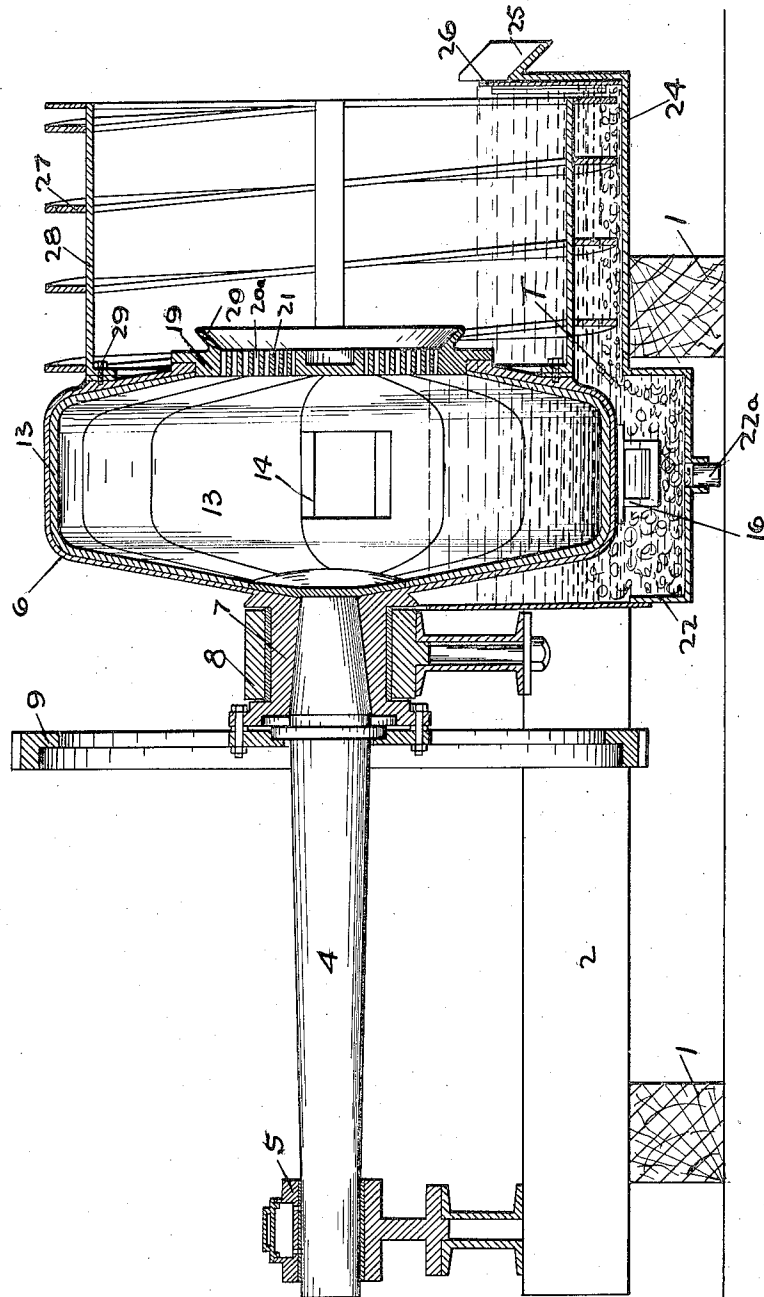
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Filed April 27, 1934

4 Sheets-Sheet 2



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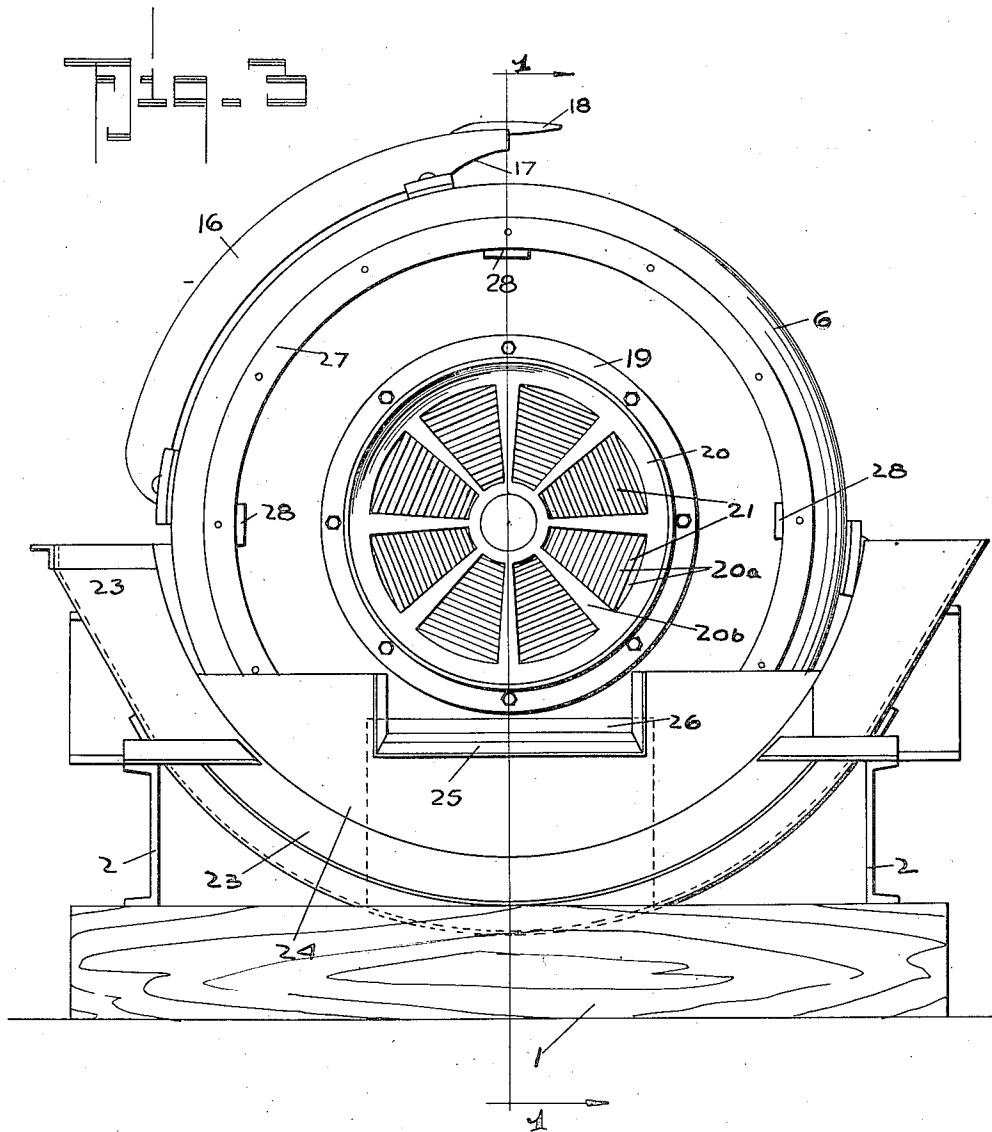
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4 Sheets-Sheet 3



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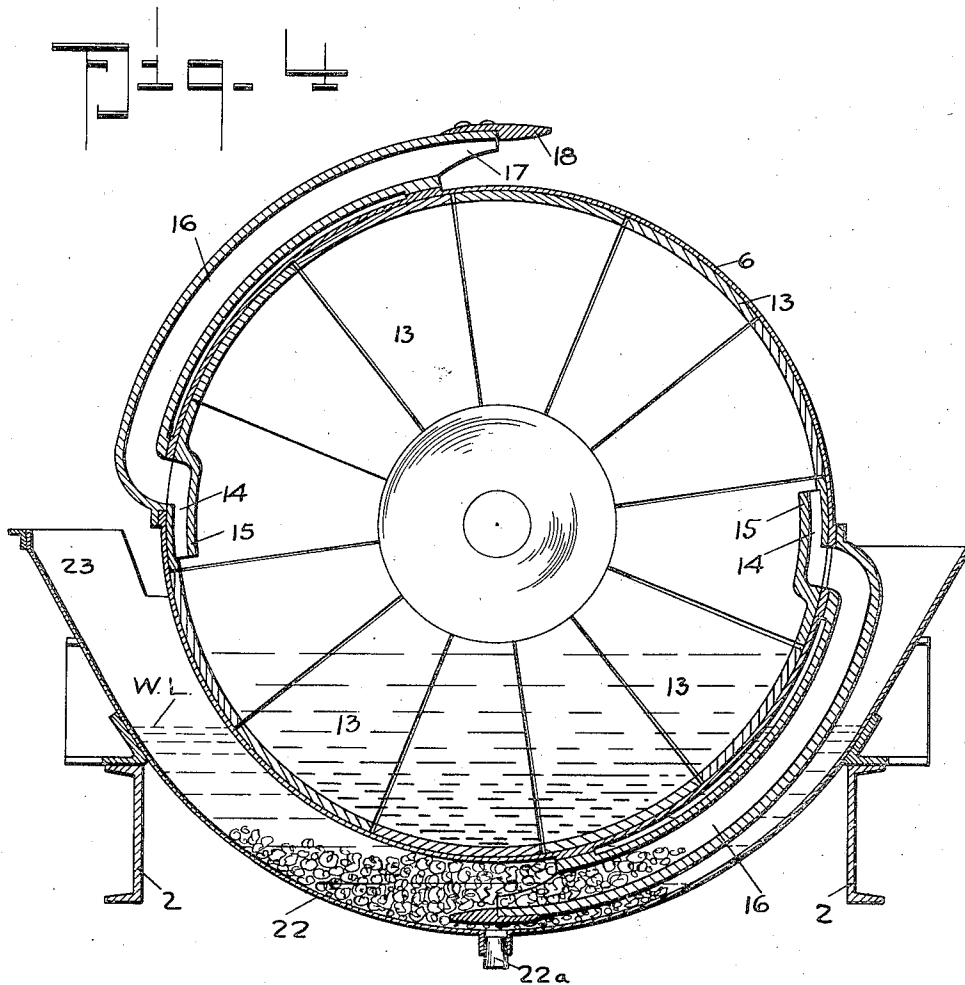
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Filed April 27, 1934

4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,031,697

GRINDING MILL

Arthur W. Fahrenwald, Moscow, Idaho

Application April 27, 1934, Serial No. 722,718

5 Claims. (Cl. 83—9)

My present invention relates to improvements in grinding mills in which the functions of grinding or pulverizing by impact, and classifying or separating, are performed. These improvements are here exemplified in a rotary ball mill with which is embodied a classifier or separator, and by means of which classifier, the unclassified material from the grinding chamber is returned to the grinding chamber for pulverization, to insure a complete grinding of the material that passes through the mill.

In carrying out my invention the grinding and classifying functions are performed on a fluid ore pulp, as for instance a pulp of reduced ore, and the material is fed to the grinding chamber with a substantially constant peripheral feed and discharged to the classifying tank through an axial outlet from the grinding chamber. A rotary conveyor or rake operating with the rotary ball mill is employed for returning the course or unclassified material to the feed tank for re-entry to the grinding chamber, and these parts are combined and arranged in compact manner to insure efficiency in operation, together with rapidity in the passage of the material through the mill, and at comparatively low cost of production and operation of the mill.

The invention consists in certain novel combinations and arrangements of parts as will hereinafter be more fully set forth and claimed. In the accompanying drawings I have illustrated one complete example of the physical embodiment of my invention wherein the parts are combined and arranged according to one mode I have thus far devised for the practical application of the principles of my invention, but it will be understood that various changes and alterations may be made in the exemplifying structure, within the scope of my claims, without departing from the principles of my invention.

Figure 1 is a view in elevation at the front or feed side of the machine in which my invention is embodied.

Figure 2 is a vertical, longitudinal, sectional view of the machine of Figure 1, as at line 2—2 of Figure 3.

Figure 3 is a view in elevation at the discharge end of the machine.

Figure 4 is a transverse, vertical sectional view through the ball mill, as at line 4—4 of Figure 1.

In the physical embodiment of my invention I have shown the use of foundation sills 1, 1, and beams 2, 2, on which the main frame 3 is supported, and the horizontally disposed power shaft 4 is journaled at one end in bearings 5. The

rotary drum or shell 6 is provided with an axial hub 7 by means of which the shaft and the drum are rigidly joined, and the hub is journaled in bearing 8, to provide for the turning of the drum with the shaft 4.

By means of a ring gear 9, which is bolted to the hub of the drum, power is applied for revolving the drum through the instrumentality of a small pinion 10 mounted on the drive shaft 11, and the latter is driven through the use of a pulley 12 and appropriate power transmission means. The drum or shell is thus mounted rigidly on one end of the power shaft 4, and the latter is supported and journaled in the bearings 5 and 8, to insure a smooth operation of the mill and equality in the balance of the rotary drum or shell of the mill.

As shown, the drum or shell is of flattened, cylindrical shape, having tapering heads, which tend to guide the grinding balls or other grinding media, and the material to be pulverized, toward the transverse center of the revolving drum, to insure the required pulverizing impact and grinding of the wet ore pulp and suitable liner plates 13 are provided on the interior of the drum or shell to compensate for wear.

The interior of the drum forms the grinding chamber for the material, and the material is fed to the interior of the drum through two diametrically arranged, peripheral inlet ports 14, 14 in the circumferential wall of the drum, said ports being protected by means of lips or plates 15 which guide the material down the side of the drum as it is fed to the interior of the drum.

Each port is provided with an intake scoop 16 of arcuate shape, mounted on the exterior of the drum, and the intake end of the scoop is fashioned with an overhanging mouth 17, and a shovel-ledge 18 at the outer side of the mouth, for use as will be described.

The outlet from the interior of the drum, or from the grinding chamber thereof, is through a central or axial screen or grate in the head of the drum opposite to that of the shaft-head of the drum. This outlet from the grinding chamber comprises a comparatively large ring 19 that is bolted to the head of the shell and the ring fits into the circular wall of an opening in the drum as best seen in Figure 2. The ring is fashioned with an integral, outwardly flaring, discharge flange 20 over which the outflowing material pours, and the material passes through spaces 20a that are formed by spokes 20b of the ring, as the drum revolves. These spaces are filled with tangentially arranged louvres 21, arranged in

series in the spaces, and the louvres are spaced apart to permit the wet slime or pulp to slide therethrough to the exterior of the drum.

The revolving drum is located in a feed tank 22, which as indicated encloses the lower portion of the drum, with the upper edge of the tank extending approximately to the longitudinal axis of the drum.

The reduced ore, or other crushed material, together with sufficient water to provide a wet ore pulp is fed in suitable manner to the feed hopper or mouth 23 of the tank 22, and the quantity of fluid pulp is governed or regulated to provide a water level, as indicated at W L in Figure 4. By an inspection of Figure 4 it will be apparent that the two scoops 16, 16, revolving with the drum, successively pass through the feed tank along the bottom thereof, and a charge of pulp is scooped from the tank and picked up as the drum revolves clockwise. As the scoop ascends with the revolving drum and the port 14 passes the bottom median line of the tank, the charge in the scoop begins to slip through the port. By the time the scoop with its charge reaches the position of the scoop indicated at the upper left hand side of Figure 4, it will be apparent that the charge has slipped through the nozzle 14—15, down the ascending side of the lower part of the drum, where it will mix with the tumbling grinding-media within the grinding chamber.

The quantity of material scooped in charges and passed to the grinding chamber from the feed tank is governed by the capacity of the scoops, as to size and number, and the capacity of the drum, to insure the maximum quantity with maximum efficiency of the grinding mill, and the two diametrically arranged intake ports or nozzles 14—15 evenly distribute the material to the grinding chamber for pulverization by the grinding media or balls.

The speed of rotation of the rotary drum is also a factor in controlling the pulp or slime level in the grinding chamber, and by proper regulation the grinding action of the tumbling balls may be retarded or increased conforming to the speed of rotation of the drum and consequent feed of successive charges of slime to the grinding chamber.

In any event, the level of the wet pulp in the grinding chamber reaches a point where the pulverized material together with an undetermined quantity of coarse material will flow through the louvres of the outlet screen of the drum, and it will of course be understood that the screen prevents passage of the grinding media.

This overflow through the side screen of the drum falls into a classifier or separating chamber 24, which as indicated is a part of the feed tank, with the bottom of the classifying or separating chamber elevated a suitable distance above the bottom of the feed tank, and as indicated in Figure 2 the water level of the feed tank is also maintained in the classifying or separating compartment of the feed tank.

In the classifying chamber the finer particles, from which the coarser and heavier material is separated, together with the overflow of water, pass over a discharge outlet 25, and the level of this outlet or final discharge may be governed by the use of a vertically adjustable gate 26.

The ground material in suspension, at an elevation above the feed tank, is prevented from returning to the feed tank, but is floated off continuously at or near the surface of the water

in the classifying chamber, and passes through the outlet 25 for further treatment.

The unclassified material or coarse sand entering the classifying chamber sinks to the elevated bottom of the chamber, and from there is returned to the feed tank, mixed with the material to be ground and fed to the tank, and eventually passed through the mill until properly classified.

This unclassified material is returned to the feed tank by means of a spiral or screw conveyer 27, fashioned as a continuous blade, and of substantially the diameter of the drum, which latter as seen in Figure 2, has its bottom line disposed slightly above the bottom of the classifying chamber. The drum is spaced from the bottom of the classifying chamber a sufficient distance to provide an elevated throat T between the classifying chamber and the feed tank, and the screw conveyer operates to pass the unclassified material along the bottom of the classifying chamber and to empty this material into the bottom of the feed tank.

The screw conveyer is supported on the outer side of the revolving drum by means of a number of laterally projecting arms 28 that are bolted at 29 to the exterior of the drum, and the lower portion of the conveyer is submerged in the water and pulp of the classifying chamber in order that the unclassified material may continuously be moved toward the throat T and be emptied into the bottom of the feed tank.

In addition to the natural flow of water from the louvres toward the lowered edges of the outlet trough 25, the passage of the spiral conveyer or rake-blade 27 tends to create circulation of water in the classifying chamber that assists in carrying the classified material in suspension toward the outlet, and this circulation is accomplished without undue turbulence or agitation of the water.

As the submerged blade or rake moves the coarse material across the bottom of the classifying tank or pan toward the throat T, the spiral blade also tends to move the water at the bottom of the classifying chamber toward the throat. Thus, in Figure 2 the water at the bottom of the classifier is urged by the spiral rake to the left, and therefore a current at or near the surface of the water in the classifying chamber is induced to move to the right from the louvres toward the outlet trough, carrying with it the finely pulverized material. During this movement of the water toward the outlet, the coarse and heavier material sinks to the bottom of the classifying chamber in the path of the spiral rake, and the latter moves this material toward the throat T and into the feed tank. The outer edge of the spiral rake moves in close proximity to the bottom of the classifying chamber in order to rake the material therefrom and to continuously return this coarse sand to the feed tank.

The arcuate-shaped bottom of the classifying chamber is of course concentric with the semi-circular shape of the feed tank, and the latter is provided with a drain 22a at its lowest point for use in emptying the classifying chamber and the feed tank when desired or necessary.

The appliance or mill, by means of which the fluid ore pulp is both pulverized and classified, is especially adapted for use in the reduction of ore, as for instance lead-zinc ore, and by the employment of the combined pulverizer and classifier in the treatment of the ore after it comes from the crushing machine, considerable time is

5 saved in the steps necessary for the preparation of the finished or classified product; the use of a separate classifier is dispensed with; and the classified material coming from the mill is of the required fineness for subsequent milling operations.

10 The machine of my invention thus provides a most satisfactory unit that performs the required services with comparatively slight wear and tear and under comparatively low maintenance costs, and while I have referred to the pulverization and classification of reduced ore as the product of the machine, it will be understood that the machine may be employed in other industries for the performance of its functions.

15 It will be understood that various changes and alterations may be made in the exemplifying structure of my invention, within the scope of my appended claims without departing from the principles thereof.

20 Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:—

25 1. In a wet pulp grinding mill, the combination with a feed tank having a lateral classifying chamber, of a rotary drum partially submerged in said tank, said drum having a peripheral intake, and an axial outlet opening to said classifying chamber, and a conveyer rotatable with the drum for returning unclassified material from said chamber to the tank.

30 2. In a wet pulp grinding mill, the combination with a feed tank having a lateral classifying

chamber, of a rotary drum having a peripheral intake and an axial outlet opening to the classifying chamber and partially submerged in said tank, and means mounted on and rotatable with the drum for conveying unclassified material from the chamber to said tank.

3. In a wet pulp grinding mill, the combination with a feed tank having a lateral classifying chamber, of a rotary drum partially submerged in said tank and having a peripheral intake and axial outlet to said chamber, and a spiral conveyer mounted on said drum for conveying unclassified material from the chamber to said tank.

4. In a wet pulp grinding mill, the combination with a feed tank having an elevated classifying chamber, of a rotary drum partially submerged in said tank and having a peripheral intake and an axial outlet, and a spiral conveyer-blade mounted at the outlet to said chamber side of the drum for returning unclassified material from said chamber to said tank.

5. In a wet pulp grinding mill, the combination with a feed tank having a lateral, elevated, classifying chamber, of a rotary drum partially submerged in said tank, said drum having an intake port and an exterior, arcuate, scoop for delivering charges through said port, said drum having an axial outlet to said chamber, and spaced louvres mounted in said outlet, and a spiral conveyer-blade mounted at the outlet side of the drum for returning unclassified material from said chamber to said tank.

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