March 30, 1943. C. O. SMITH 2,315,281

ORE MILL

Filed Oct. 3, 1941 3 Sheets-Sheet 1

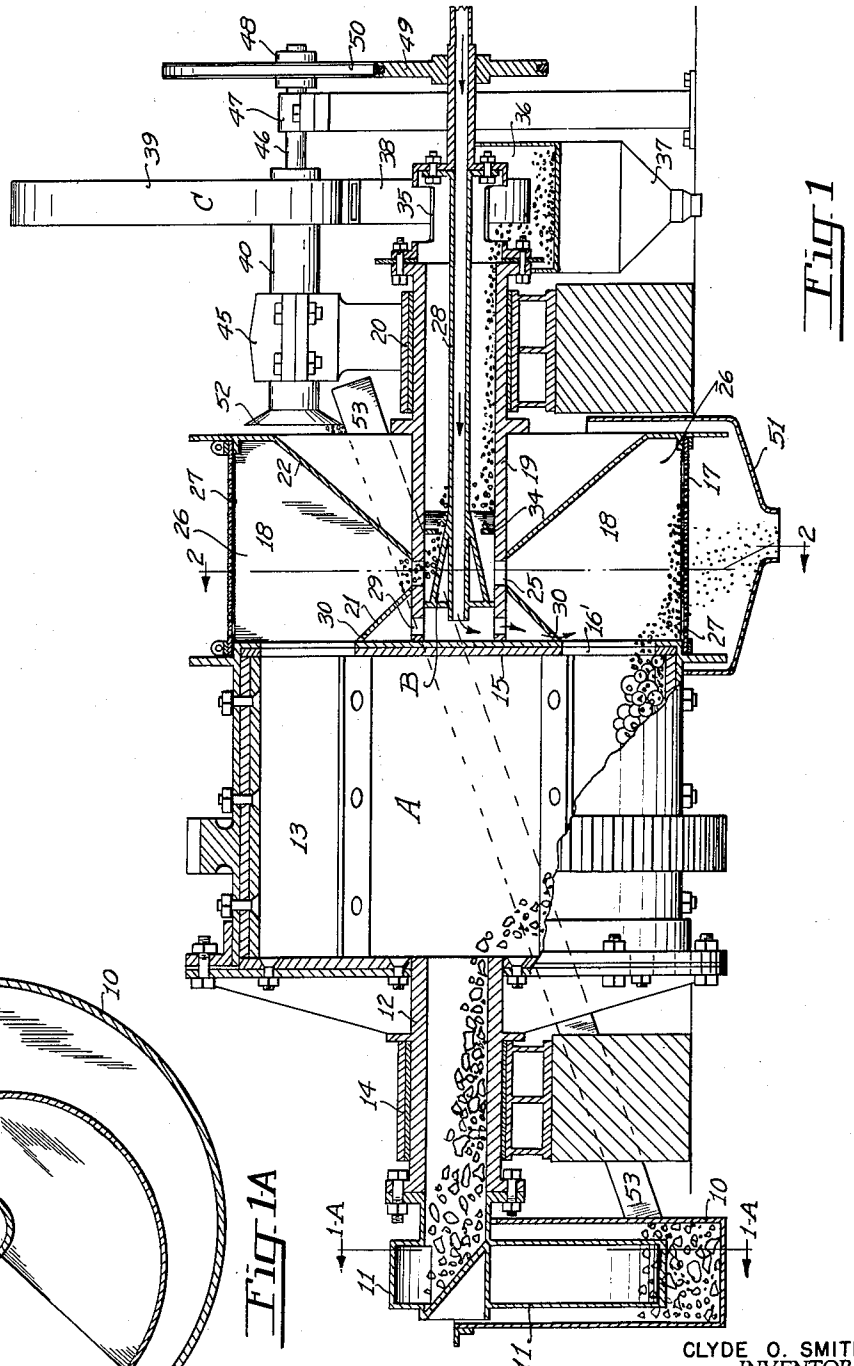

Fig. 1

Fig. 1A

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ORE MILL

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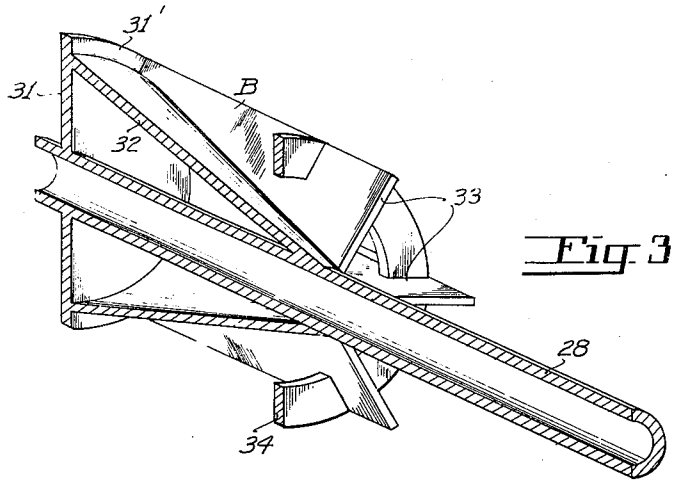

Fig. 3

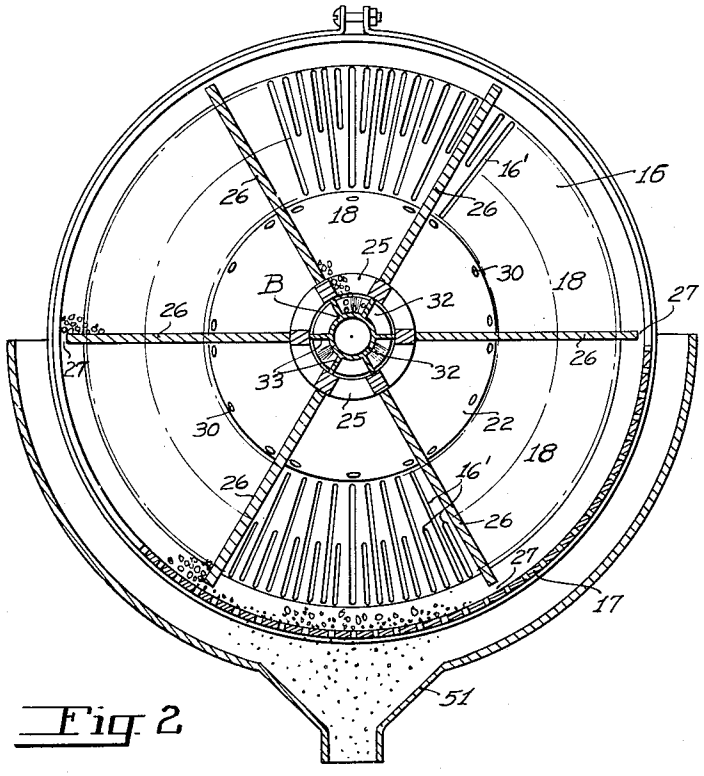

Fig. 2

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Filed Oct. 3, 1941 3 Sheets-Sheet 3

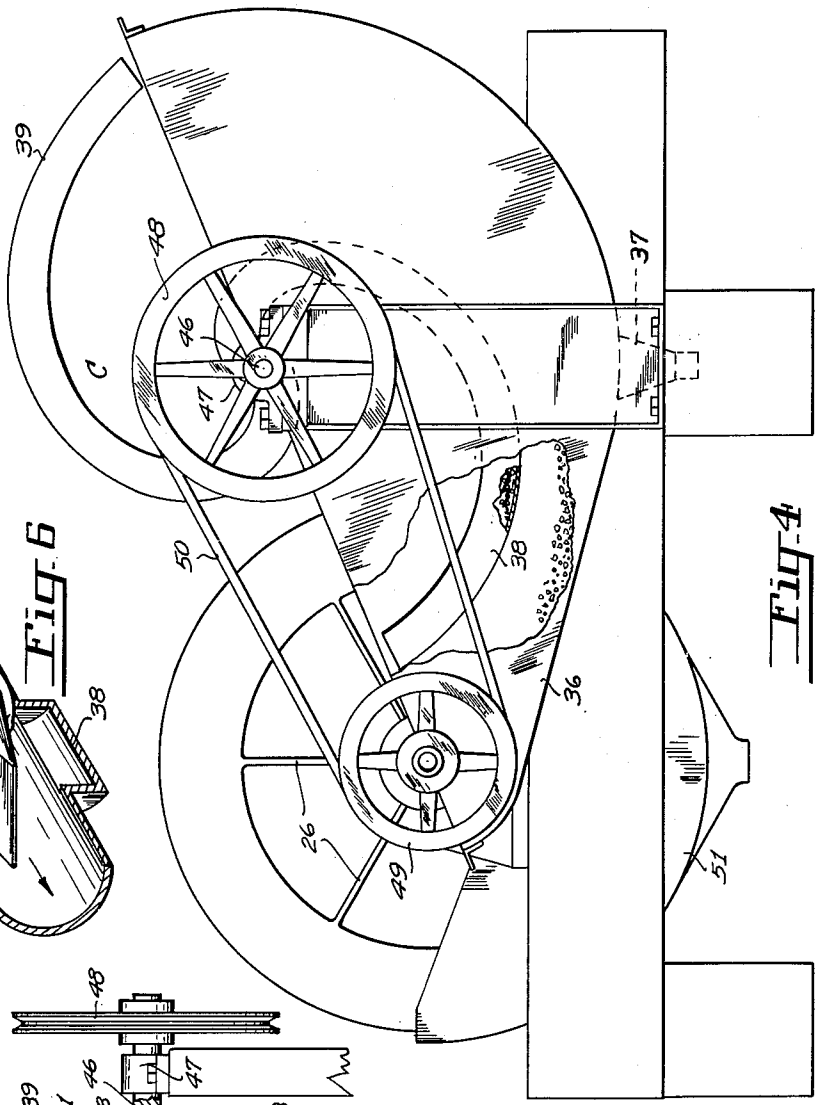

Fig. 4

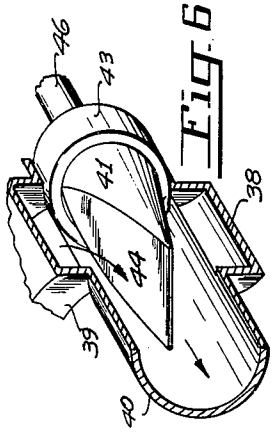

Fig. 6

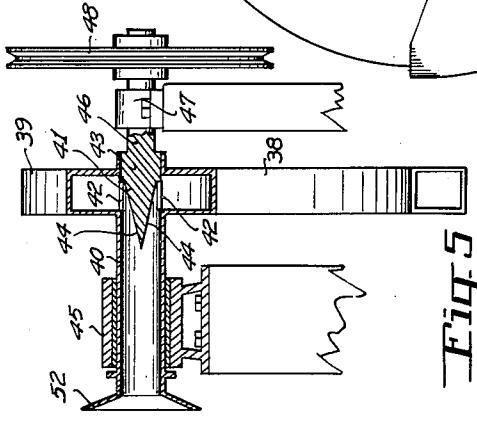

Fig. 5

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UNITED STATES PATENT OFFICE

2,315,281

ORE MILL

Clyde O. Smith, Fort Jones, Calif.

Application October 3, 1941, Serial No. 413,499

7 Claims. (Cl. 83—9)

This invention relates to mills for grinding ore, such as quartz and the like, for the purpose of obtaining metal therefrom. More specifically, this invention relates to mills or classifiers used for obtaining valuable precious metals from the ground ore, and this invention is concerned particularly with that type of mills known as "ball" mills.

In such mills the grinding of the ore or quartz is done by means of steel balls placed with the material to be ground inside a rotating cylinder, the cylinder being supported for rotation on a horizontal axis. The ore and water are fed into the cylinder at one end and small particles of the metal, together with the crushed ore and "mud," pass through a screen or slots at the other end of the cylinder after the grinding. From the finely ground ore or "mud" the particles of metal are then recovered by washing, the metal particles, which are heavier than the finely crushed ore, being held in the bottoms of troughs by means of baffles, etc., or in other suitable settling pans or receptacles, the finely ground ore or "mud" being finally washed away.

It is quite important in this process that particles of the metal which become loosened from the ore during the grinding should not be subjected to any more grinding than necessary, since any further grinding of the metal particles will result in some of the metal being ground to a powder fineness with the result that this is apt to be washed away and lost. For this reason the discharge openings at the end of the revolving cylindrical grinder should be made large enough to permit fairly large particles of loosened metal to pass through, but when this is done some ore will also pass through the openings which will require further grinding before all the metal obtainable from this ore is recovered. These larger particles of ore should therefore be returned to the grinder for further grinding.

The object of this invention is to provide an improved and more efficient means for separating out the dislodged particles of metal from the ore and for further treating those particles of ore which require additional grinding and finally, when necessary, returning such particles of ore to the cylindrical grinder.

A further object of this invention is to provide for a more effective washing of the ore after it first leaves the grinder and before it is returned for further grinding, and also to provide more efficient means for handling the ore which requires regrinding.

The manner in which these objects and other advantages are attained in my improved ore mill will be briefly described in the following specification in which reference is to be had to the accompanying drawings.

In the drawings:

Figure 1 is a longitudinal section or sectional side elevation of an ore mill or "ball" mill embodying my invention;

Figure 1A is a transverse section corresponding to the line 1A—1A of Figure 1;

Figure 2 is a transverse section taken on line 2—2 of Figure 1 looking in the direction of the arrows;

Figure 3 is a sectional perspective view of the feeding cone of the special ore handling means of my invention;

Figure 4 is an end elevation of the entire device;

Figure 5 is a longitudinal section of the return feeder showing the means for returning the ore which is to be ground; and

Figure 6 is a sectional perspective view of part of the return feeder of Figure 5.

In Figure 1, A indicates a rotating cylindrical chamber, of the type common to "ball" mills, into which the ore to be ground is fed at one end. The ore passes into the chamber through the axially aligned tubular channel 12. The ore is delivered into this tubular channel 12 by means of a hollow curved feeding arm 11, which, as the entire device rotates, picks up the ore and water from a trough 10, lifting the mixture which has been picked up until the mixture slides down the arm 11 into the tubular channel 12.

The shape of the feeding arm 11 will be seen in Figure 1A. The feeding arm 11 and tubular channel 12 are integral with, or rigidly attached to, the corresponding end wall of the body 13 of the cylindrical grinding chamber A and thus rotate with the apparatus. This end of the apparatus is journaled within a suitable supporting bearing 14.

The opposite end wall 15 of the cylindrical chamber A carries an annular grating or screened discharge outlet 16, formed preferably of radially arranged slots 16' (Figure 2). As indicated in Figure 1, the particles of ore and metal, when ground sufficiently to pass through these slots, are thus discharged from the grinding chamber A. The apparatus so far described is similar to that commonly found in ore grinders of this type.

Attached to the discharge end of the cylindrical body 13 and thus located on the outside of the end wall 15 of the chamber A are a plurality of radially located compartments 18. The num-

ber of these compartments, as shown in Figure 2, is six in the apparatus illustrated, although this number of course may be varied. A mesh screen 17 forms the outer circumferential wall of these compartments. The compartments are divided from each other by the radial partitions or walls 26 (Figure 2) and the remaining walls of the compartments include two frustro-conical surfaces 21 and 22, located and arranged as shown in Figure 1, together with the annular grating 16.

A second tubular channel or transfer member 19, in axial alignment with the cylinder chamber A and tubular channel 12, is formed integrally with, or rigidly attached to, the end wall 15 of the chamber A and the frustro-conical walls 21 and 22. This tubular member 19 is journaled in a suitable bearing 20, similar to bearing 14, and provides the support for this end of the apparatus.

Openings 25 are provided in the tubular member 19 where the walls of the compartments 18 converge near the axis, one opening 25 being provided for each compartment and this opening thus comprising the final outlet port for the compartment for the ore carried in it which is too large to pass through the circumferential mesh screen 17. Further openings 29 are provided in the tubular member 19 near the end wall 15 of the grinding chamber, for a purpose which will be explained later.

A central pipe or tubular core 28 extends through the tubular member 19. At the right end of the apparatus, as viewed in Figure 1, this pipe or core extends beyond the tubular member 19 and is connected by suitable means (not shown) with a source of water supply. The inner end of the pipe 28, is left open in order to permit water to pass freely through the pipe as indicated by the arrows in Figure 1. The frustro-conical wall 21 is provided with small holes 30 (Figure 1) near its juncture with the wall 15 of the cylindrical chamber A, and the water from pipe 28 passes through the openings 29 at the end of member 19 and through the holes 30, as shown, and mixes with the ore particles as they leave the grinding chamber A and pass on to the mesh screen 17, thus providing desired additional washing of the ground ore. I have found this additional supply of water delivered at this stage to be very important in properly facilitating the washing and screening of the ore and metal particles.

On the pipe core 28, and integral therewith, is a discharge deflecting cone B which is positioned below the openings or ports 25, as shown in Figure 1. The construction of this discharge deflecting cone element will be seen more clearly in Figure 3. This element includes a conical surface 32, a circular end wall 31 which extends slightly beyond the conical surface to form the annular flange 31', and a plurality of radially disposed fins 33. The fins 33 are preferably equal in number to, and in radial alignment with, the partition walls 26 between the compartments 18. The diameter of the end wall 31 corresponds to the internal diameter of the tubular member 19. The fins 33 extend to the wall of the surrounding member 19. A ring 34 crosses the outer ends of the fins transversely near the apex end of the conical wall 32, the outer diameter of this ring corresponding to the interior diameter of the member 19.

As will be apparent from Figure 1, the purpose of the discharge deflecting cone B is to cause the ore particles which pass out from the bottom of each compartment 18 through the discharge outlet 25 to be pushed to the right along the inside of the tubular member 19. The flange 31' of the end wall 31 prevents these particles from escaping to the left when entering the member 19. The ring 34 permits the particles, as they enter the member 19 from a top compartment, to move along to the right under the ring, but this ring prevents the ore particles at the bottom of member 19 from sliding back towards the left (as viewed in Figure 1) and thus escaping through a lower opening 25 into a lower compartment 18.

At the outside end of the tubular member 19 large discharge ports 35 are provided through which all the ore particles which have passed along the tubular member 19 are finally discharged. A trough or box 36 is located beneath these final outlet ports 35. The bottom of this trough or box 36 slopes downwardly, as shown in Fig. 4, so that particles of metal, which might have become dislodged meanwhile from the pieces of ore or rock subjected to this subsequent treatment, will slide downwardly on the bottom until reaching the discharge trap 37 from which such particles, together with some of the "mud," are then directed over settling troughs or similar devices (not shown) in which the metal particles will be allowed to settle and collect in the usual manner while the fine ore or "mud" is finally washed away. For the same purpose a collecting vessel 51 is placed below the circular mesh screen 17 in order to collect the material which passes through screen 17, which collected material at that point is similarly passed over settling troughs or other devices (not shown).

The rest of the ore, discharged from the tubular member 19, must be subjected to further grinding and therefore should be returned to the grinding chamber A. For this purpose I provide means for returning such ore to the grinding chamber and this means will now be explained.

A return feeder, designated as a whole by the reference character C, includes a hollow shaft 40 of fairly substantial diameter mounted for rotation on an axis parallel to, but at a higher level than, the axis of the grinding apparatus. A pair of hollow arms 38 and 39, preferably shaped in the form of an involute curve, as shown in Figure 4, are rigidly mounted on the shaft 40 and discharge into this shaft through suitable oppositely arranged openings 42 (Figure 5). Thus as the shaft 40 and its connected arms rotate, each arm in turn dips into the trough 36, picks up some of the ore from this trough and, as the arm is raised, slides this picked up ore down into the shaft 40.

A deflector 41 (see Figures 5 and 6) is provided at the end of the hollow shaft 40. This deflector 41 has a cylindrical end 43 which forms the closure for that end of the hollow shaft 40. The other end of this deflector is formed into a pair of deflecting surfaces 44 by having two opposite sides cut away obliquely so as to form a V. These deflector surfaces extend between the openings 42 and serve to prevent the ore particles, delivered from one feeding arm, from passing down into the other feeding arm.

The hollow rotating shaft 40 is preferably flared at the left hand end or discharge end 52, as shown in Figures 1 and 5, and discharges into a chute 53 which delivers the ore by gravity to the initial trough 10. When the ore has been

delivered to the trough 10 from the chute 53, it is then in position to renew its journey through the grinding mill.

The hollow shaft 40 is journaled for rotation in a suitable bearing 45. An end shaft 46, preferably formed as an extension of the cylindrical end 43 of the deflector 41, is journaled in a bearing 47. A pulley 48 is mounted on the end of shaft 46 and a belt 50 connects this pulley 48 with a pulley 49 mounted on the pipe or tubular core 28, so that rotation of the grinder produces rotation of the return feeding means C. Rotation of the grinder may be produced by any suitable means (not shown), such means being common with "ball" mills.

Thus in my device special provision is made to prevent unnecessary grinding of the ore or metal particles and thus to minimize the loss of metal particles due to their being reduced to powder form. Unlike some of the "ball" mills now in general use, the ore particles which are too large to pass through the mesh screen 17 are not returned directly to the initial grinding chamber A, but are passed on in the apparatus in the manner explained and the oversize particles or rejects from the screen 17 are then finally returned to the feed box of the mill. Because of the method and means which I employ of returning such screen rejects to the initial feed box of the grinder or mill—that is, the returning of these outside of the mill or grinder itself—it is possible and feasible to install supplementary concentrating devices, such as jigs, traps, amalgamation plates etc., in closed circuit thereby saving considerable of the metal particles before they are ground so fine as to make recovery difficult, if not impossible.

Minor changes would of course be possible in the apparatus which I have shown for carrying out my invention, without departing from the principle of my invention. The particular apparatus described I have found very efficient and satisfactory for attaining the objects which I have in mind. It is not my intention, however, to limit my invention otherwise than is set forth in the claims.

I claim:

1. In an ore mill of the character described, a rotatable grinder, discharge openings at the discharge end of said grinder, compartments on the discharge end of said grinder, said compartments connected with said grinder by said openings, a peripheral screen extending about said compartments, means located below said screen for collecting ore particles passing through said screen, a central member attached in axial alinement with said grinder extending from said end of said grinder and rotated with said grinder, a discharge port in each compartment connecting with the interior of said central member, whereby ore particles which are too large to pass through said peripheral screen will be discharged into said central member, means preventing ore in said central member from discharging back into said grinder from the adjacent end of said central member, a discharge opening at the opposite end of said central member remote from said grinder, means for collecting ore from said discharge opening of said central member and for separating off larger particles of ore for return to said grinder.

2. In an ore mill of the character described, a rotatable grinder, discharge openings at the discharge end of said grinder, radially-arranged compartments on the discharge end of said grinder, said compartments connected with said grinder by said openings, a peripheral screen extending about said compartments, means located below said screen for collecting ore particles passing through said screen, a central transfer member extending from said end of said grinder, a discharge port in each compartment connecting with the interior of said transfer member, whereby ore particles which are too large to pass through said peripheral screen will be discharged into said transfer member, means in said transfer member cooperating with said ports to direct material entering therethrough away from said compartments and from said grinder, a discharge opening at the opposite end of said transfer member remote from said grinder, means for collecting ore from said discharge opening of said transfer member and for separating off larger particles of ore for return to said grinder.

3. In an ore mill of the character described, a rotatable grinder, discharge openings at the discharge end of said grinder, radially-arranged compartments on the discharge end of said grinder, said compartments connected with said grinder by said openings, a peripheral screen extending about said compartments, a tubular member attached to and in axial alinement with said grinder extending from said end of said grinder, a discharge port in each compartment connecting with the interior of said tubular member, whereby ore particles which are too large to pass through said peripheral screen will be discharged into said tubular member, a discharge deflector in said tubular member cooperating with said ports to direct material entering therethrough away from said compartments and from said grinder, a water pipe in said tubular member, said pipe having a discharge end located between said discharge deflector and said grinder, means for delivering water into said compartments from said pipe, a discharge opening at the opposite end of said tubular member remote from said grinder, means for collecting ore from said discharge opening of said tubular member and for separating off larger particles of ore for return to said grinder.

4. In an ore mill of the character described, a rotatable grinder, discharge openings at the discharge end of said grinder, radially-arranged compartments on the discharge end of said grinder, said compartments connected with said grinder by said openings, a frustro-conical wall centrally located on the discharge end of said grinder and extending beyond said grinder with the larger diameter end adjacent the grinder, said frustro-conical wall constituting one of the walls of said compartments, a peripheral screen extending about said compartments, a tubular member attached to and in axial alinement with said grinder extending from said end of said grinder, a discharge port in each compartment connecting with the interior of said tubular member, whereby ore particles which are too large to pass through said peripheral screen will be discharged into said tubular member, a deflecting cone in said member cooperating with said ports to direct material entering therethrough away from said compartments and from said grinder, a water pipe extending longitudinally in said tubular member, said pipe having a discharge end located between said deflecting cone and said grinder, openings in said tubular member and in said frustro-conical wall permitting water from said pipe to pass into said compartments, a discharge opening at the opposite end of said tubu-

lar member remote from said grinder, means for collecting ore from said discharge opening of said tubular member and for separating off larger particles of ore for return to said grinder.

5. In an ore mill of the character described, a rotatable grinder, discharge openings at the discharge end of said grinder, radially-arranged compartments on the discharge end of said grinder, said compartments connected with said grinder by said openings, a frustro-conical wall centrally located on the discharge end of said grinder and extending beyond said grinder with the larger diameter end adjacent the grinder, said frustro-conical wall constituting one of the walls of said compartments, a peripheral screen extending about said compartments, means located below said screen for collecting ore particles passing through said screen, a tubular member attached to and in axial alinement with said grinder extending from said end of said grinder, a discharge port in each compartment connecting with the interior of said tubular member, whereby ore particles which are too large to pass through said peripheral screen will be discharged into said tubular member, a discharge deflector in said tubular member cooperating with said ports to direct material entering therethrough away from said compartments, said discharge deflector including a conical surface, the apex of said conical surface extending away from said compartments and grinder, radial veins on said conical surface, a water pipe extending longitudinally in said tubular member, said pipe having a discharge end located between said deflecting cone and said grinder, openings in said tubular member and in said frustro-conical wall permitting water from said pipe to pass into said compartments, a discharge opening at the opposite end of said tubular member remote from said grinder, means for collecting ore from said discharge opening of said tubular member, said means including a trough, having a sloping bottom and an outlet at the lowest part of the bottom.

6. In an ore mill of the character described including a rotatable grinder and discharge grating at the discharge end of said grinder, radially-arranged compartments on the discharge end of said grinder, said compartments connected with said grinder by said grating, a peripheral screen extending about said compartments, means located below said screen for collecting ore particles passing through said screen, a central tubular member attached to and in axial alinement with said grinder extending from said end of said grinder, a discharge port in each compartment connecting with the interior of said tubular member, whereby ore particles which are too large to pass through said peripheral screen will be discharged into said tubular member, means in said tubular member cooperating with said ports to direct material entering therethrough away from said compartments, said means including a conical surface, the apex of said conical surface extending away from said compartments and grinder, radial veins on said conical surface and a ring member in axial alinement with said conical surface extending across the outer edges of said veins near the apex of said conical surface, a discharge opening at the opposite end of said tubular member remote from said grinder, means for collecting ore from said discharge opening of said member and for separating off larger particles of ore for return to said grinder.

7. In an ore mill of the character described including, a rotatable grinder and discharge grating at the discharge end of said grinder, radially-arranged compartments on the discharge end of said grinder, said compartments connected with said grinder by said grating, a peripheral screen extending about said compartments, means located below said screen for collecting ore particles passing through said screen, a central tubular member attached to and in axial alinement with said grinder extending from said end of said grinder, a discharge port in each compartment connecting with the interior of said tubular member, whereby ore particles which are too large to pass through said peripheral screen will be discharged into said tubular member, means in said tubular member cooperating with said ports to direct material entering therethrough away from said compartments, said means including a conical surface, the apex of said conical surface extending away from said compartments and grinder, radial veins on said conical surface and a ring member in axial alinement with said conical surface extending across the outer edges of said veins near the apex of said conical surface, a water pipe extending longitudinally in said tubular member, said pipe having a discharge end located between said ports and said grinder, holes in said tubular member and in the walls of said compartments for delivering water to said compartments from said pipe, a discharge opening at the opposite end of said tubular member remote from said grinder, means for collecting ore from said discharge opening of said tubular member and for separating off larger particles of ore for return to said grinder.

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