

April 25, 1933.

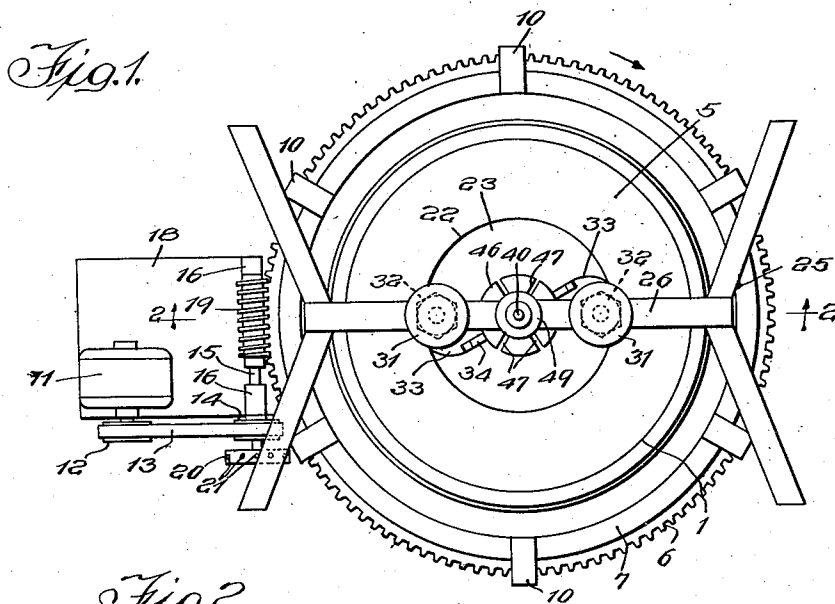
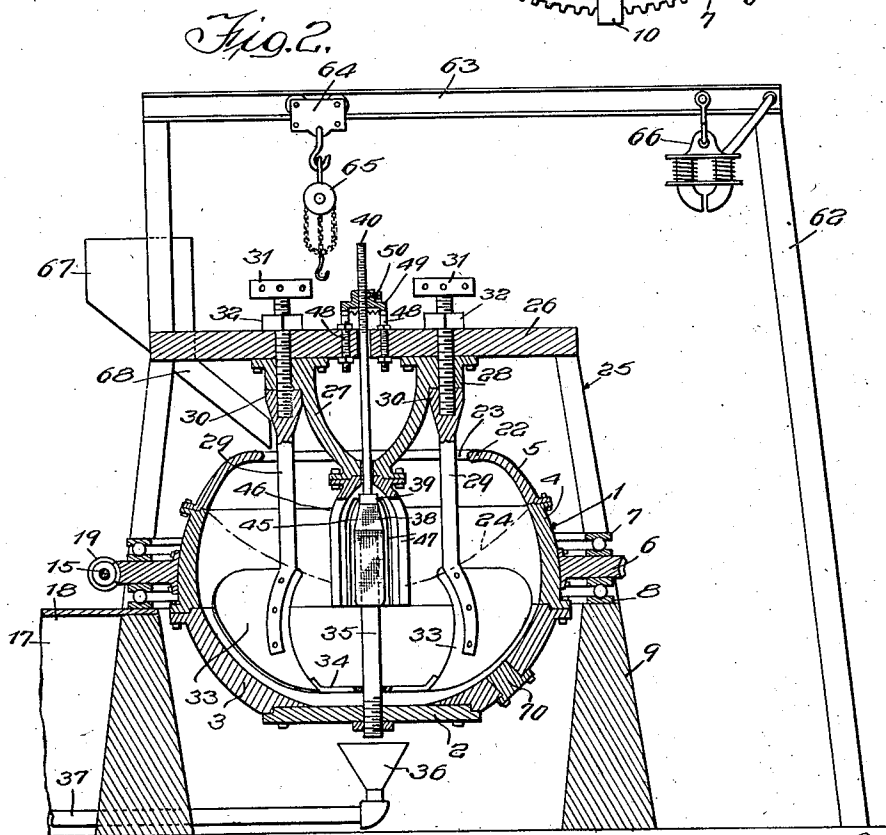
C. E. WUENSCH

1,905,545

GRINDING MILL

Filed March 6, 1931

2 Sheets-Sheet 1



Witness:

William E. Kilroy

Inventor:
Charles Erb Wuensch

134 Brown, Jackson, Baettcher & Simmons

ATTOR.

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2 Sheets-Sheet 2

Fig. 3.

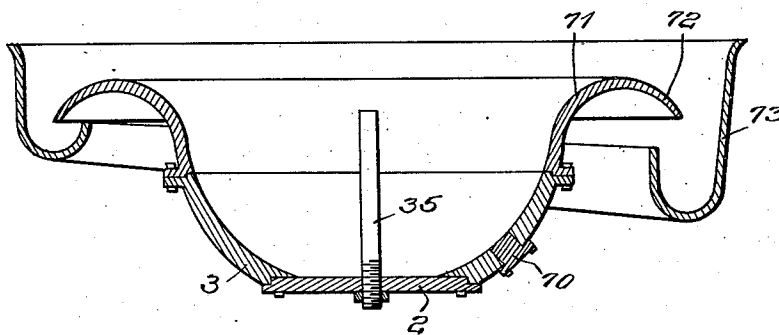


Fig. 4.

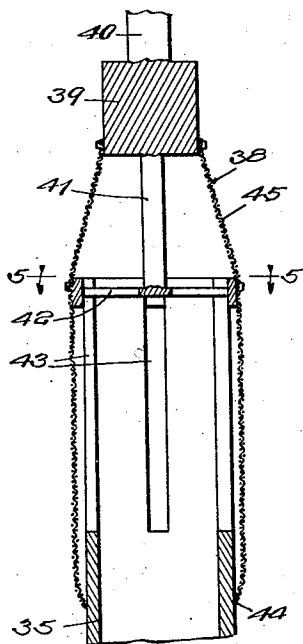


Fig. 6.

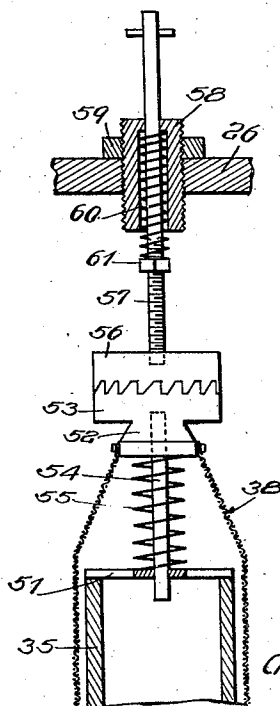
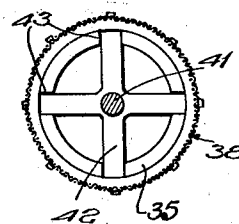


Fig. 5.



Witness

William P. Kilroy

Inventor:
Charles Erb Wuensch

By Brown, Jackson, Rothman & Kimmel, Attorneys

UNITED STATES PATENT OFFICE

CHARLES ERB WUENSCH, OF JOPLIN, MISSOURI, ASSIGNOR TO MINERALS BENEFICIATION INCORPORATED, A CORPORATION OF DELAWARE

GRINDING MILL

Application filed March 6, 1931. Serial No. 520,535.

This invention relates to grinding mills, and more particularly to a grinding mill of the ball type in which balls or equivalent means are employed for effecting the grinding operation.

One of the main objects of my invention is to provide a grinding mill of simple construction and high efficiency. A further object is to provide novel means for removing from the mill, during operation thereof, the fines or slimes during the grinding operation and produced thereby. It is also an object of my invention to assure thorough agitation of the balls and the material being ground without interfering with the grinding operation to a material extent. A further object is to assure proper travel of the grinding balls in a predetermined manner such as to effect maximum efficiency in the grinding operation. Another object is to provide a grinding bowl of novel construction such as to assure this desired travel of the grinding balls. Further objects and advantages of my invention will appear from the detailed description.

In the drawings:

Figure 1 is a plan view of a grinding mill constructed in accordance with my invention;

Figure 2 is a section taken substantially on line 2—2 of Figure 1;

Figure 3 is a central vertical sectional view through a modified form of the mill adapted for use as a disintegrator;

Figure 4 is a vertical sectional view through the take-off pipe and the screen therefor and associated part;

Figure 5 is a section taken substantially on line 5—5 of Figure 4; and

Figure 6 is a vertical sectional view through a modified form of screen and associated parts, parts being shown in elevation.

My mill includes a grinding bowl 1 mounted to rotate on a vertical axis. This bowl is conveniently formed of a bottom plate 2, lower and upper sections 3 and 4, respectively, and a top section 5. The bottom plate and the sections of the bowl are provided with suitable interengaging rabbets and projections forming step joints, and with outwardly projecting flanges which receive bolts

for securing the sections and the bottom plate together. A gear ring 6 extends about section 4 and is bolted or otherwise suitably secured thereto. This gear ring operates between upper and lower ball bearings 7 and 8, respectively, the latter bearings being suitably supported by a base 9 formed of concrete or other suitable material, this base being preferably continuous and of annular shape in plan, though suitably spaced piers may be employed for supporting the lower bearing if desired. The upper bearing is supported by means of brackets 10 suitably anchored to the base 9 and extending upwardly over the gear ring, the upper race of the upper ball bearing 7 being suitably secured to these brackets. The two sets of ball bearings provide antifriction bearings for the bowl and also serve to prevent any tendency of the bowl to tip or rock during rotation thereof.

For rotating the bowl I provide a source of power, such as an electric motor 11 of suitable type. A pulley 12 is keyed upon the shaft of this motor and is connected by a belt 13 to a pulley 14 keyed upon drive shaft 15. This shaft 15 is rotatably mounted in suitable bearing members 16 anchored to extensions 17, in the nature of piers, projecting from the base 9. These extensions may be connected at their outer ends to provide a pier 18 upon which the motor 11 is suitably mounted. Shaft 15 is provided with a worm 19 suitably secured thereon and meshing with the gear ring 6. Preferably, a wheel 20, of considerably greater diameter than the pulley 14, is secured upon one end of shaft 15. This wheel is provided with suitably disposed openings 21 for reception of a bar or similar tool. This provides convenient means whereby a great leverage effect can be obtained for turning the bowl 1 manually, for the purpose of loosening and breaking up materials which have dried within the bowl to such an extent as to become cemented together and to the bowl and associated members, due to the mill being out of operation for an appreciable period of time with the partially ground materials remaining therein. After the bowl has been turned slightly manually, in this manner, so as to loosen or

break up the dried materials, it is then rotated by means of the motor 11 and associated gearing. The bowl 1 is rotated at relatively high speed, which increases the rate and effectiveness of the grinding operation. Any other suitable or preferred means may be employed for rotating the bowl, and any suitable driving connection between the motor 11 and shaft 15 may be employed.

The bowl 1 may be provided with a suitable liner, if desired, though such a liner has been omitted for clearness of illustration. Also, the balls and the material to be ground have been omitted, for the same reason. Referring more particularly to Figure 2, it will be noted that the interior of the bowl is of approximately elliptical shape in transverse vertical section. The inner surface of the surrounding wall of the bowl is of arcuate shape in vertical section, the mid-portion of the arc being at approximately the central horizontal plane of the bowl so that the inner surface thereof curves upwardly and outwardly of the bowl at its lower portion and then upwardly and inwardly of the bowl at its upper portion. The top portion of top section 5 curves inwardly and provides a lip 22 which projects inwardly of the bowl and defines an opening 23 through the top thereof. When the mill is loaded with grinding balls and is standing still, the top line of the charge of balls occupies approximately the position indicated by the dot and dash line 24.

A suitable frame 25 extends about and above the bowl 1, and includes a cross beam 26 which extends across the opening 23 of the bowl. A bracket 27 of approximately semi-ellipsoidal shape is bolted or otherwise suitably secured to the under face of beam 26. This bracket is provided, at the base thereof, with a thick outwardly projecting flange 28. This flange provides a seat for supporting members 29, in the form of heavy rods or shanks, which extend downwardly through opening 23 into the bowl. Each of these members is provided, at its upper end, with an enlargement 30 which is suitably bored and threaded for reception of the lower portion of a capstan screw 31 which passes through, but is free from, beam 26 and flange 28. A nut 32 screws upon screw 31 and bears upon the upper face of beam 26, this nut cooperating with the screw for securing supporting member 29 in adjustment. By loosening the capstan screw 31, the supporting member 29 can be turned about the screw to a desired extent, after which enlargement 30 of this member is forced against the flange 28, by means of the capstan screw and nut 32, so as to effectively lock member 29 in adjustment.

At the lower end of each of the supporting members 9 I provide a deflector 33 suitably secured thereto. This deflector is in-

clined to the vertical and is also inclined transversely of the bowl, the degree of the latter inclination being controlled by the adjustment of the supporting member 29. As will be noted more clearly from Figure 1, the deflectors 33 are oppositely related, the downward inclination thereof being counter to the direction of rotation of the bowl, indicated by the arrow in Figure 1. The deflectors are also spaced away from the inner surface of the lower portion of the bowl, as shown, but act to direct the grinding balls and the intermingled material to be ground upwardly and inwardly of the bowl toward the center thereof. Preferably, the lower ends of the deflectors are connected by a brace member 34 suitably shaped to extend about a take-off pipe 35 extending through the center of bottom plate 2.

The take-off pipe 35 is suitably secured through bottom plate 2 for rotation with the bowl, and extends upwardly within the bowl centrally thereof, this pipe opening into the bowl remote from the bottom of the same. The pipe 35 discharges into a funnel 36 which serves to direct the discharged material into a pipe line or launder 37, by means of which the material is conducted to suitable receptacles for storage or for further treatment, as conditions may require.

Referring more particularly to Figure 4, a screen 38 extends about the upper portion of pipe 35. The upper end of this screen is conveniently secured to an enlargement 39 of a rod 40 slidably mounted through beam 26. A reduced rod 41 depends from enlargement 39 and is provided, at its lower end, with a spider 42 the arms of which are slidably mounted through slots 43 in pipe 35 and extending from the upper end thereof. The screen is suitably secured to this spider, and extends downwardly beyond the same about pipe 35 in spaced relation thereto, the lower end portion of this screen fitting snugly about the pipe below the lower ends of the slots 43, as at 44. Since the enlargement 39 is of less diameter than the pipe 35, the upper portion 45 of the screen is of frusto-conical shape, which is advantageous as facilitating passage of the finely ground materials thereto. A guard 46 is bolted or otherwise suitably secured to bracket 27, and extends downwardly about the screen 38 in spaced relation thereto, this guard being provided with slots 47 therein to facilitate admission to the screen of the finely ground materials which it is desired to discharge through the pipe 35. The slots 47 may be of any desired width, provided they are not sufficiently wide to permit of the grinding balls striking the screen and causing injury thereto. The bracket 27 and the guard 46 are provided with registering openings which accommodate the rod 40, as in Figure 2.

Ratchet pins 48 are suitably secured

through beam 26 at opposite sides of and equi-distant from rod 40. These pins cooperate with a ratchet disk 49 which screws upon the upper portion of rod 40 and is adjustably secured thereon in a suitable manner, as by means of a set screw 50. During rotation of the bowl 1, pipe 35 rotates therewith and the screen 38 and rod 40 rotate with the pipe due to the engagement of the arms of the spider 42 into the slot 43 of the pipe. Since ratchet disk 49 is fixed to rod 40, it rotates with this rod and the teeth of this ratchet disk coact with the contacting surfaces of the ratchet pins 48 for causing vertical reciprocation of the screen at high speed. In this manner the screen is vibrated and possibility of clogging thereof is eliminated. Under ordinary conditions, the mesh of the screen may vary from 40 to 65 mesh, though the mesh of the screen will depend upon the material being ground and may be varied within wide limits.

In Figure 6, I have illustrated a modified form of means for vibrating or reciprocating the screen. A spider 51 is suitably secured to the upper end of pipe 35 for rotation therewith. The upper end of screen 38 is suitably secured to a neck 52 depending from a ratchet head 53. A rod 54, of squared or other suitable non-circular cross section, is secured at its upper end in neck 52, and is slidably mounted through an opening at the center of spider 51 and corresponding to the cross section of the rod. An extension coil spring 55 is disposed about rod 54 and is confined between the spider and neck 52. This spring yieldingly urges ratchet head 53 toward a cooperating ratchet head 56 secured upon the lower end of a rod 57. The upper portion of this rod is of squared or other suitable non-circular cross section and is slidable through a corresponding opening in the upper end of a sleeve 58 which screws through cross beam 26 and is secured in adjustment therein by a jam nut 59. An extension coil spring 60 is mounted about rod 57 and is confined between the upper end of sleeve 58 and a nut 61 which screws upon the lower portion of rod 57. This nut provides convenient means for adjusting the tension of spring 60. When the bowl 1 is rotated in a clockwise direction, as indicated in Figure 1, the ratchet head 53 is similarly rotated and the teeth of this ratchet head cooperate with the teeth of ratchet head 56, and the springs 55 and 60, for imparting vertical reciprocation to the screen 38 for vibrating the latter. As has been above indicated, and as will be apparent to those skilled in the art, various means may be employed for vibrating the screen. I do not, therefore, intend to in any way limit my invention to the particular means disclosed for vibrating the screen, since any suitable or preferred means, other than the means herein disclosed, may be employed for this purpose.

Preferably the inner surface of the bowl is laid out on the spiral of Archimedes, both considered in horizontal section and in vertical section, so that the materials in the bowl tend to travel at a constant speed for every degree of angular rotation thereof. This tendency of travel of the material, including the grinding balls, is modified to some extent by the deflectors 33. While the bowl is preferably laid out on the spiral of Archimedes, this is not essential and the shape of the bowl can be varied within considerable limits provided the bowl and the deflectors and associated parts are so related as to effect the desired results.

I preferably provide a super-frame 62 which supports an I-beam 63 above the cross beam 26. This I-beam provides a track for travel thereon of a trolley 64 from which may be suspended a suitable hoist 65, or an electromagnet 66, optionally. When the magnet is not in use it may be suspended from the beam 63 adjacent one end thereof, as shown, and when the hoist is not in use it may be suspended from the beam in the same manner as the magnet. The magnet, in conjunction with the trolley 64, provides convenient means for removing the balls from the mill, when desired or necessary, and placing them in a suitable hopper 67 supported above and to one side of the bowl. This hopper is provided with an inclined chute 68, which may have any suitable removable closure means associated therewith, the chute being disposed to direct the balls from the hopper 67 into the bowl 1 when the chute is opened. The hoist 65 provides means for handling parts of the bowl and associated structure.

When the bowl 1 has been suitably charged with the grinding balls and the material to be ground, it is rotated at high speed in the manner previously described. In the rotation of the bowl, the grinding balls and the heavier pieces of material to be ground are urged outwardly by centrifugal force into contact with the surrounding wall of the bowl. After the mill has been in operation for a short time, the inner surface thereof is, in effect, covered with a layer of grinding balls over which the remaining balls and material in the bowl 1 move during the grinding operation. Due to the curvature of the inner face of the bowl, combined with the centrifugal action due to rotation thereof, the balls tend to move upwardly along the inner face of the bowl, together with the material to be ground, and along the underface of lip 22. The balls at the underface of this lip are then displaced or pushed inwardly of the bowl by the following balls and material, and are discharged from the lip downwardly and inwardly toward the center of the bowl. In this manner, the material to be ground and the balls tend to travel from the bottom or lower portion of the bowl outwardly and then

upwardly along the inner face of the bowl and then are discharged downwardly toward the center of the bowl, so that such material and the balls tend to travel through an approximately elliptical path. This travel of the balls and the material, however, is modified by the deflectors 33. The balls and the material at the lower portion of the bowl are deflected upwardly and inwardly of the bowl, by the deflectors 33, and are delivered at the central portion of the bowl, from which these balls and the material are moved outwardly by centrifugal force into contact with the layer of balls at the inner face of the bowl. The travel of the material and the balls which travel over the layer of balls at the inner face of the bowl, instead of being approximately elliptical is through a path approximately in the form of the figure 8. This assures thorough commingling of the balls and the material to be ground with the result that high efficiency in the grinding operation is obtained.

As the grinding operation continues, the heavier particles of material and the balls are thrown outwardly by centrifugal force and the lighter particles of material which has been ground, and which may be referred to as the "fines" for purposes of description, is crowded toward the center of the bowl at the upper portion of the mass, where it tends to accumulate. As these fines accumulate, they pass through the slots in guard 46 and through the screen 38, entering the pipe 35 through the upper end thereof and through the slots 43 when such slots are provided. These fines then pass downwardly through pipe 35, by gravity, into the funnel 36 and thence to the launder 37. This mill is adapted either for dry grinding or wet grinding. The material to be ground is fed into the bowl as required, and, when wet grinding, water is also fed into the bowl as required. In the latter case, when wet grinding, the fines which would be produced in dry grinding form, with the water, slimes, which pass through the screen 38 into pipe 35 and thence into the funnel 36 and launder 37. By this construction I provide extremely simple and highly efficient means whereby the fines or slimes are separated from the remainder of the mass of material in the bowl, during the grinding operation, and are taken off by gravity as they accumulate at the central portion of the bowl. This I consider of value as contributing to the efficiency as well as the simplicity of construction and operation of the mill. A further advantage of my construction is that the finest ground material in the mill is crowded or urged toward the central discharge point by the action of the coarser materials, during the grinding operation, the most finely ground material being removed as it accumulates. This prevents excessive grinding, such as is

encountered in ball mills of ordinary type, with the result that the material is ground more uniformly and has a minimum amount of colloidal forms. This is advantageous as greatly facilitating subsequent treatment of the ground material. Since the bowl is open at its top, the grinding operation can be watched at all times and the rate of feed of the material and water, the amount of balls, the speed of rotation of the bowl, and the angle of deflection of the deflectors, can be controlled in such manner as to effect the most efficient result. A further advantage of my construction is that no broken or worn down balls are discharged from the mill, so that the balls are completely consumed in useful grinding work.

Since the deflectors 33 are spaced away from the surrounding wall of the bowl 1, and are free from this wall, they do not seriously interfere with the circulation of the balls and material within the bowl, nor do they interfere with formation of the layer of balls at the inner surface of the bowl previously referred to. These deflectors assure thorough agitation of the balls and the material in the lower portion of the bowl, but are so adjusted as not to present objectionable resistance to circulation of the balls and the material, this adjustment being effected with facility by means of the capstan screws 31 and associated parts in the manner previously described.

It is desirable that suitable means be provided whereby the bowl can conveniently be washed out after completion of the grinding operation. For this purpose, I provide a suitable opening through lower section 3 of the bowl, this opening being normally closed by a removable plug 70, or other suitable means, bolted or otherwise suitably secured to section 3. After completion of the grinding operation, the plug 70 may be removed and the interior of the bowl and the parts therein may be thoroughly washed and flushed out, the water and the material in suspension therein passing through the opening referred to.

The bowl of my mill is also well adapted for use as a disintegrator. For this purpose, the sections 4 and 5 may be replaced by an upper or top section 71 which is curved outwardly and reversely to the lower portion of the bowl so as to provide an outwardly extending and downwardly curved lip 72. An annular sloping launder 73 extends about the bowl and beneath the lip 72 for receiving materials discharged therefrom. When using the mill as a disintegrator, no grinding balls are necessary, the residual nodules in the material itself serving to cause the desired disintegration thereof during the rotation of the bowl. As these nodules accumulate in the mill they move upwardly over the top section 71 of the bowl and then travel over

the lip 72 into the launder 73. The clayey or slimy material produced by disintegration collects at the central portion of the bowl and is taken off through the take-off pipe 35, as before. The deflectors 33 may be used or not, as desirable or as conditions may require. Also, if desired, the screen 38 over the upper portion of pipe 35 may be employed although, under ordinary conditions, this is not necessary. It is apparent, therefore, that the bowl of my invention while ordinarily particularly adapted for use as a grinding mill employing grinding balls, can readily be converted into a bowl suitable for use as a disintegrator in which the grinding balls are not employed.

As above indicated, and as will be apparent to those skilled in the art, changes in construction and arrangement of parts of my invention may be resorted to without departing from the field and scope of the same, and I intend to include all such variations, as fall within the scope of the appended claims, in this application in which the preferred forms only of my invention are disclosed.

What I claim is:

1. In a grinding machine, a bowl mounted for rotation on a vertical axis, the interior of said bowl being of approximately elliptical shape in transverse vertical section, deflecting means within the bowl and disposed to deflect materials in the lower portion of the bowl upwardly and toward the central portion of the bowl during rotation thereof, and a take-off pipe opening into the bowl centrally and remote from the bottom thereof and disposed to take off by gravity fines accumulated at the central portion of the bowl.

2. In a grinding machine, a bowl mounted for rotation on a vertical axis, the interior of said bowl being of approximately elliptical shape in transverse vertical section, deflecting means within the bowl and disposed to deflect materials in the lower portion of the bowl upwardly and toward the central portion of the bowl during rotation thereof, and a take-off pipe extending through the bottom of the bowl centrally thereof and opening into the bowl remote from the bottom of the same for taking off by gravity fines accumulated at the central portion of the bowl.

3. In a grinding machine, a bowl mounted for rotation on a vertical axis, the interior of said bowl being of approximately elliptical shape in transverse vertical section, deflecting means within the bowl and disposed to deflect materials in the lower portion of the bowl upwardly and toward the central portion of the bowl during rotation thereof, a take-off pipe extending through the bottom of the bowl centrally thereof and opening into the bowl remote from the bottom

of the same for taking off by gravity fines accumulated at the central portion of the bowl, a screen extending over the inlet of the pipe, and a guard extending about the screen.

4. In a grinding mill, a bowl mounted for rotation on a vertical axis, the bowl being open at its top and the interior thereof being of approximately elliptical shape in transverse vertical section, supporting members mounted above the bowl and extending downwardly through the open top thereof, deflectors mounted upon said members and inclined transversely of the bowl and to the vertical, said deflectors being oppositely related and disposed to deflect materials within the lower portion of the bowl upwardly and toward the central portion thereof during rotation of said bowl, and a take-off pipe disposed between the deflectors and opening through the bottom of the bowl centrally thereof, said pipe opening into the bowl centrally and remote from the bottom thereof for taking off by gravity fines accumulated at the central portion of the bowl.

5. In a grinding mill, a bowl mounted for rotation on a vertical axis, a take-off pipe opening through the bottom of the bowl centrally thereof and opening into the bowl remote from the bottom of the same for taking off by gravity fines produced in the grinding operation, the lower portion of the surrounding wall of the bowl being curved upwardly and outwardly and the upper portion of said wall being curved outwardly and reversely to said lower portion and forming a downwardly curved lip at the top of the bowl for discharge of materials therefrom, and a launder extending about the bowl beneath said lip for reception of materials discharged therefrom.

6. In a grinding mill, a bowl mounted for rotation on a vertical axis and a take-off pipe opening through the bottom of the bowl centrally thereof and opening into the bowl remote from the bottom of the same for taking off by gravity fines produced in the grinding operation, the lower portion of the surrounding wall of the bowl being curved upwardly and outwardly and the upper portion of said wall being curved outwardly and reversely to said lower portion and forming a downwardly curved lip at the top of the bowl for discharge of materials therefrom.

In witness whereof, I hereunto subscribe my name this 25th day of February, 1931.

CHARLES ERB WUENSCH.