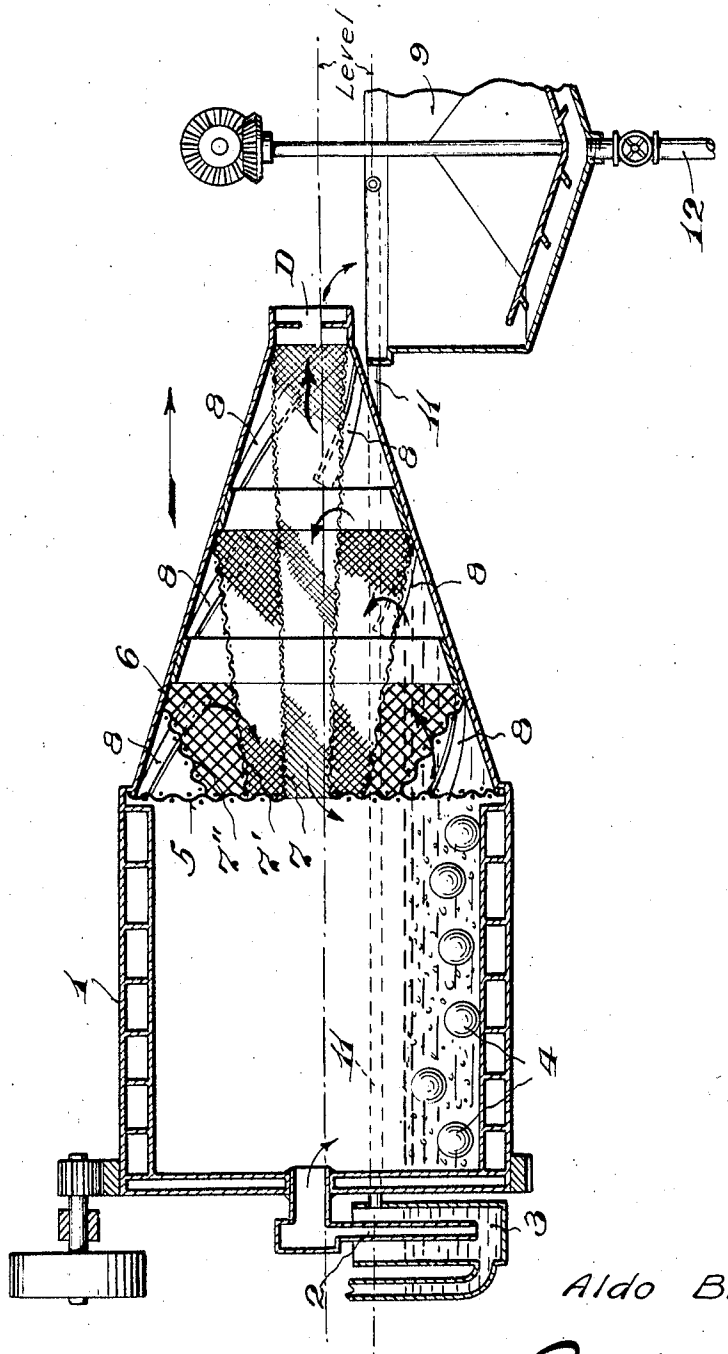
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WET GRIND BALL MILL

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WET GRIND BALL MILL

Aldo Bibolini, Turin, Italy; vested in the Alien Property Custodian

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This invention relates to a new and improved grinding apparatus in which hydromechanical means are provided for forming a homogeneous pulp of predetermined density.

It is an object of the invention to provide means for reducing mineral ores or other solid materials to more or less finely granulated particles which are held in suspension in a liquid which may be added to such material during the feeding thereof.

It is a further object of the invention to provide means for progressively grinding the material under treatment and to remove such material from the grinding mill as soon as such material attains a certain predetermined maximum granular size.

In mills as at present constructed there is produced a considerable percentage of over-ground material which is often reduced almost to a colloidal state and is therefore practically useless in subsequent industrial operations. It is an object of the invention to eliminate this defect in present types of mills.

A principal object of the invention, therefore, is to provide means which will supply granules of material which are all below a certain predetermined size and which will also contain only a small percentage of over-ground material so as to secure a pulp of substantially homogeneous quality and of substantially uniform dispersion which will be better suitable for subsequent treatments such as in flotation processes, pulverized fuel furnaces, and chemical processes in general.

It is a further object of the invention to provide an adjustable closed circuit for the hydraulic means used in the grinding process and this together with the screening apparatus provided renders possible the elimination of the classifying and the thickening or decanting mechanisms which are indispensible in the usual grinding mechanisms.

Furthermore, the invention due to the above mentioned eliminations and by virtue of means providing for the immediate and repeated return to the grinding zone of the granules which are to be retreated and the prevention of over-grinding permits a saving in the power required and in the amount of circulating water or the fluid used.

With the above and other objects in view which will become apparent from the detailed description below, the invention is shown in the drawing which is a diagrammatic longitudinal section of a combined grinding mill of the ball type embodying the novel screening apparatus.

In the drawing, similar reference characters are used throughout the various views to indicate like parts.

The body of the grinding mill is indicated at 1 and is shown as being cylindrical, but of course, such body or casing may have a wall or walls of any desired configuration. The casing 1 rotates about an axis which may be inclined on bearings of any desired type which are not shown. The driving means for the casing 1 may also be of any desired type. Located within the casing 1 are the grinding elements 4 which are shown as balls but, of course, these grinding elements may also be of any type such as pebbles, rods or similar elements.

One end of the casing 1 is connected to a pulp feeder which comprises the rotating scoop 2 shown diagrammatically which removes the material from a tank 3. The tank 3 is also provided with a pipe whereby any deficiencies in the quantity of pulp may be supplied so as to insure the finished product being of the required density.

The material to be ground and the liquid which is to serve as a vehicle for the material are fed into the tank 3 either separately or together. The liquid used may be water or any fluid according to the particular nature of the operation which is to be performed.

The pulp upon entering at one end of the casing 1 is ground by the action of the grinding elements 4 while it travels towards the other end of said casing. At this latter end there is provided a screen 5 which may extend entirely across this end of the casing or may be provided annularly.

Secured to the end of the casing 1 opposite that at which the pulp enters is a classifying conical casing 6. The casing 6 is fitted on its interior surface with helical vanes 8 which enclose a series of axially extending perforated conical drums or trommels 7, 7' and 7''. Some of these drums are of perforated sheet metal or wire gauze while others are constructed entirely or partially of solid plating.

The perforations provided in these screening trommels decrease in diameter progressively from the outer trommel to the central trommel 7 in which latter the perforations have a diamater which corresponds to the desired fineness of the grinding. The grains, therefore, which have been reduced to the predetermined size will pass immediately through all the screening trommels and issue from the outlet D while those which have not yet been sufficiently reduced in size will be progressively stopped by the screens and led back

into the casing 1 by the action of either the helical projections fixed upon the solid walls of the drums or by the action of the circulating water. These grains, therefore, which are to be reground are returned to the casing 1 either directly through the perforations provided in the grid or screen 5 or through an opening in the screen 5 which corresponds with the inner end of the inner drum. The system of helical vanes provided upon the inner surfaces of the casing 6 determines the circulation of the pulp which begins with the entry of the pulp into the casing 1 and continues until the material having the predetermined fineness leaves the device by the outlet D. The circulation of the pulp will depend upon the hydraulic resistance acting upon it and upon the conveying effect of the helical vanes. Therefore, the circulation flow will branch off to return partially, in a stream along the axial zone of the machine or in the outflow zone formed by the screen 5.

The system of vanes is so chosen that such vanes have the hydrodynamic property of tending to expel from the casing 1 a larger volume of fluid than is fed into the casing 1 from the tank 3, so that such system of vanes is capable of keeping in circulation a fluid mass of predetermined volume in the apparatus and maintains a continuous circulation thereof at a speed which is adjustable and depends on the adjustability of the hydraulic resistances present in the closed circuit. These resistances are in the form of jets or calibrated diaphragms which are arranged within the exit D and which are shown diagrammatically. They serve to restrict in adjustable manner the section of the outflow and thereby act in a predetermined manner so as to control the volume of the returned flow.

Therefore by inserting adequate jets or calibrated diaphragms in the exit port D it is easy to produce a pulp having a density which corresponds to the best and most economical treatment in successive processes regardless of the constitution of the pulp originally fed into the casing 1.

It is also possible, if desired, to interpose a receiver between the grinding apparatus and subsequent operating machinery wherein a suitable decanting means may be used. In such case advantage is taken of the head which is set up between the feed level and the raising of the pulp by means of the helical vanes and also any elevating vanes used in the exit D. The outflowing pulp flows into the decanter 9 and settles therein while the overflow liquid may return by gravity through the pipe 11 to the tank 3 whereby the desired level in the grinder and the density of the pulp is preserved.

From the decanter 9 the pulp issues through a tube 12 and at this point there may be added to such pulp by means of a by-pass or other device a quantity of water which will insure the desired density, while the actual grinding is effected within the mill with only that quantity of water which is essential for the operation and which will remain practically constant throughout the grinding process.

It is evident that the above process and apparatus as applied to ball grinding mills or similar devices operates in an entirely different and distinct manner from usual devices at present in use since the circulating fluid operating in the machine carries away continuously the ground particles not only from the free surface of the fluid but also from the interior of the mass which is under treatment. Furthermore, the hydrodynamical energy and helical vanes acting on the mass insure rapid and frequent repassage of the particles being treated through the mill and the screens arranged inside the apparatus classify the output of particles as soon as ground.

It is also to be noted that the folowing advantages are obtained by the above described hydrodynamic and mechanical details of the apparatus:

1. The forced circulation which is hydrodynamically regulated by means of the calibrated hydraulic resistances inserted in the circuit carries off the ground pulp which issues through a screening zone or grid interposed between the mill and the classifier. Such carrying off or transport is effected from all portions of the fluid mass and not only from its free surface through the use of suitable helical vanes which are fitted to the inner surface of the classifiers.

2. There is a continuous volumetric classification of the ground material combined with the grinding within the mill. The classification is effected by a succession of screening surfaces formed by the screen drums or trommels which act in a centripetal direction and are located in the classifier which is attached to the casing of the grinding mill and separated from the grinding mill by a screening zone or grid so that it may be easily fitted to any existing mills of the ball type.

3. The advantage of the return into the mill either through the tank 3 or in any other way of the material screened by the screens provided and consequently the automatic regrinding thereof with consequent recirculation inside the machine. This is accomplished with the aid of the spiral drum which is interposed between the screening surfaces and the fluid mass which the prearranged hydrodynamic equilibrium maintains in the mill so as to cause the unscreened material to return internally or externally. The internal return is accomplished in the following ways: (*a*) through the grid; (*b*) through the central zone and (*c*) by way of the mill feed where an axial conveyor pipe may be installed connecting the feed tank with the discharge of the material passing through the restricted opening D. The external return may be accomplished in the following ways: (*d*) through the feed tank when the above mentioned conveyor pipe is prolonged so as to extend beyond the feeder scoop.

4. The control of the return velocity in which use is made of the adjustability of the circulation by the hydraulic resistances interposed such as the calibrated diaphragms or jets mentioned at the discharge port D for the finished product. This adjustability may be varied in accordance with the physical properties of the material being ground and the liberation of the constituents of the ore or other material being treated.

5. The advantage of a direct securing of the ground product so that in the case of pulp the desired degree of concentration is obtained by making use of the adjustability of the feed and the above mentioned hydraulic resistances regardless of the original concentration of the pulp fed to the machine. It is therefore possible to obtain, even without the aid of additional thickeners or decanters, the most suitable product for the best and most economical treatment out of the pulp itself in successive operative processes such as rotation, chemical treatments, etc.

6. The arrangement in a closed circuit, ac-

tuated by gravity where it is desired to avoid the use of auxiliary hydraulic operating machinery, of a hydrodynamical device comprising the following: a grinding apparatus provided with forced circulation means, a volumetric classifier and a decanting apparatus from which all or part of the water coming from the circulating pulp flows back to the grinding apparatus. The circulation may be regulated as to velocity so as to avoid over-grinding of the material under treatment and maintain the fluid mass unaltered in motion, thereby saving both fluid and power.

From the above features of the invention it will be noted that overgrinding is substantially prevented and that furthermore any intervention of separate classifiers and concentrators is eliminated, thereby giving the mill an exceedingly high efficiency with respect to the energy utilized in operating the same.

A large saving is also possible in the amount of fluid necessary to form the pulp of predetermined density due to the adjustment which can be effected within extremely wide limits either by acting on the hydraulic resistances in the circuit or by acting on the outflow ports of the decanter.

I claim:

1. In combination with a horizontally disposed cylindrical wet grinding mill, an open ended conical shell extending from the outlet end of the mill and tapering outwardly toward the axis of the mill, an outwardly flaring conical sieve mounted within the shell and helical conveyer blades on the inner surface of the shell for advancing the material outwardly against the sieve.

2. In combination with a horizontally disposed cylindrical wet grinding mill, an open ended conical shell extending from the outlet end of the mill and tapering outwardly toward the axis of the mill, a plurality of coaxial conical sieves mounted within the shell and progressively increasing in outward flare in the order of their distance from the axis of the mill and helical conveyer blades on the inner surface of the shell opposite each sieve for advancing the material outwardly against the sieves.

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