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MILL FOR THE PRODUCTION OF A DIRECTLY FLOATABLE FLUID PULP STARTING FROM COARSE MINERALS

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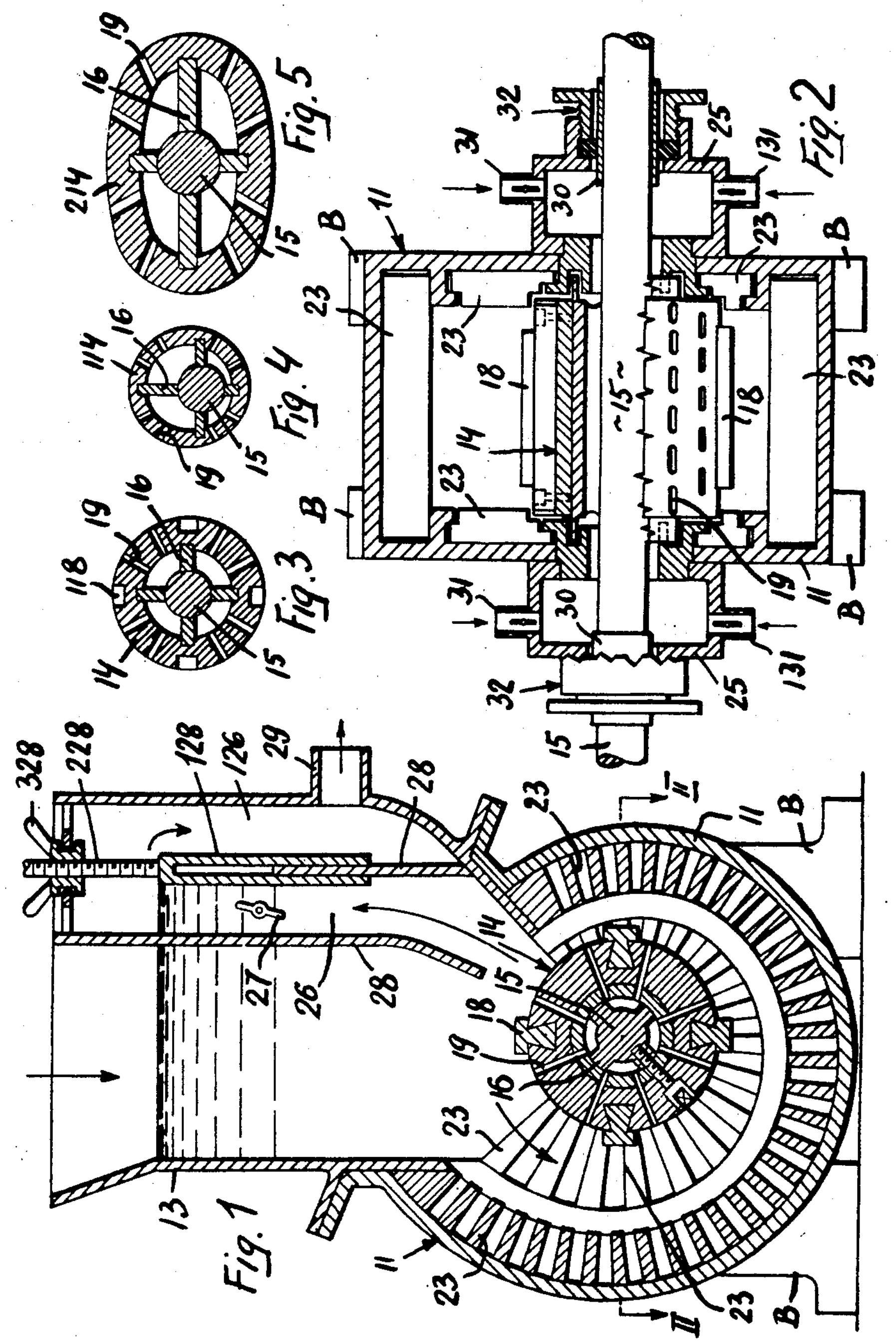

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MILL FOR THE PRODUCTION OF A DIRECTLY FLOATABLE FLUID PULP STARTING FROM COARSE MINERALS

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This application is a continuation in part of abandoned application Serial No. 820,015, filed June 12, 1959.

This invention relates to the comminution in water of solid coarse-sized minerals (this term including sizes up to 6″ or even more) and aims to provide a mill in which the coarse minerals and the water are fed continuously and, at the same time, the minerals which have been comminuted to the desired degree of fineness are continuously discharged, together with the overflow water, in form of a directly floatable fluid pulp or slurry.

The object of the invention is to provide a mill which is very compact and efficient and which permits of accurately regulating by simple means the size of the particles of the comminuted minerals.

According to the invention, these ends are attained by constructing a mill having a drum-like horizontal shell and a hollow rotor provided with radial openings, rotatably mounted therein, said shell being provided with a hopper for the charging of the coarse mineral and with an ascending duct provided with an adjustable overflow and with valve means for regulating its sectional flow area, while the interior of the rotor is connected through rotary joints to a source of water and air under pressure which are discharged through said openings in form of radial jets which, during the revolution of the rotor, cooperate to entrain the bulk of water and minerals therein in form of a revolving liquid belt thrown away from the rotor by centrifugal force and spaced therefrom by a cushion of the air blown together with the water and which separates itself therefrom as soon as it may expand into the shell.

Due to the fact that the liquid belt is not entrained by blades dipping thereinto, the particles of water and solids assume different annular speeds. Thus the said belt of turbulent water, by entraining solids of different sizes and weight and having different velocities, causes said solids to collide and rub against each other and against the walls of the shell and to rebounce against the rotor therein from which they are hurled again into and through the liquid belt, until they are crushed by repeated collisions and rubbing to a sufficient fineness. When this sufficient fineness is attained, the particles of the mineral float into said swirling water until they reach a zone of quiet constituting the inlet end of an overflow duct from where they are discharged together with the water in which they are suspended.

Further characteristic features and advantages of the mill according to the invention will appear from the following specification in which the invention is described with reference to the attached drawings, in which:

FIGURE 1 is a vertical cross section through a mill according to the invention;

FIGURE 2 is a horizontal section taken on line II—II of FIGURE 1, and

FIGURES 3, 4 and 5 are cross sections through three modifications of the mill rotor.

According to one preferred embodiment shown in FIGURES 1 and 2, the improved mill comprises a drum-like shell **11**, supported by a base B, and provided with a hopper **13**, through which the coarse-sized mineral to be ground is fed into the mill.

At one side of said hopper a duct **26–126** is formed,

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having an ascending branch **26** extending slightly above the nearest inner drum wall and provided with a throttle valve **27** or equivalent means and a descending branch **126** connected to the ascending branch at a point below the hopper top and provided by its lower end with an outlet **29**. In practice, the ducts **26** and **126** may be formed by attaching to the hopper wall a vertical partition **28** extending from underneath the inlet end of said duct **26**, preferably above the level of the outlet **29**. Said partition **28** is provided with a vertically movable extension constituted by a pair of parallel partitions **128** attached to a threaded stem **228** which may be axially shifted by means of a wing nut **328** rotatably but not axially shiftable mounted on a fixed part of the said hopper. Thus the ducts **26** and **126** constitute a kind of adjustable overflow duct, the two branches of which are separated by a kind of sluice valve **28–128** the height of which determines the height of the liquid in the hopper **13**.

Through two openings formed in the bottoms on the said drum **11** a shaft **15** is rotatably mounted.

In a central portion of said shaft, a tubular rotor **14** is mounted on a plurality of supporting members **16** fastened radially to the shaft **15**. The rotor proper **14** is a tubular member provided with rows of radial perforations or slits **19** and preferably, but not necessarily, with very short projecting bars **18** extending longitudinally of the rotor, so as to remain well spaced from the drum interior.

The rotor **14** communicates axially with a pair of fluid feed chambers **25** fastened by their inner ends to the heads of the drum, the outer end of said chambers being provided with conventional wear sleeves **30** and stuffing boxes **32** in which the shaft **15** revolves with a fluid-tight fit. The chambers **25** are provided with valved ports or nipples **31** and **131** through which the fluids (water, chemicals, if any, and air) which are necessary for performing the process of the invention are fed. In the example as shown, air may be fed with suitable pressure through the port **131**. The mill shell is usually provided with the conventional liner, which, in the examples as shown is in the form of spaced bars **23**.

The operation of the mill is as follows: The mill is first run by feeding therein, through the rotor **14**, some water which is sprayed through the slits **19** into the drum **11** until its level rises into said drum substantially at its overflow level. Together with the water (which may contain some chemicals, if required) also some air may be fed, in order to create an air-filled space at the central portion of the mill, inside an annular belt of water thrown by centrifugal force away from the rotor **14**. Then the coarse material to be ground finely is fed into the hopper **13** and allowed to fall in the direction of the rotor **14** which throws by centrifugal force both solids and the liquid coming into contact therewith towards and through the annular belt of water, where they encounter other fragments of solid materials and finally the shell walls or liner. At the same time, the jets of water projected with great force through the openings or slits **19** and revolving with the rotor, by acting upon the inner surface of the belt of water, entrain said water and the solids therein into rotation, but at different velocities. Thus a combination of repeated rubbing and impact of the materials between them and against the mill and rotor walls takes place inside the mill, in which the coarse solid material is reduced to the required fineness.

The operation of this mill is a continuous one, that is the solid material to be ground is fed at a rate determined by experiments and at the same time water and some air are fed into the mill across the rotor openings and at the same time the water charged with ground material of the required fineness or "pulp" flows upwardly through the ascending branch of duct **26**, overflows the partition **128** and flows down through the descending duct **126** until it is discharged through the outlet **29**. The pulp may be fed directly to a flotation equipment for separation of its valuable parts from the gangue.

The fineness of the pulp may be exactly regulated by suitably adjusting the rate of feed of the liquid, the height of the overflow **28**, **128** and the free passage area of the ascending branch of duct **26**. In fact, by leaving all other conditions unaltered, it is evident that the fineness of the ground material entrained by the overflow water will be inversely proportional to the velocity of the ascending water flow in the duct **26** and thus by throttling more or less the ascending branch **26** of this duct by means of valve **27**, FIG. 1, the fineness of the discharged fluid pulp may be exactly regulated.

As said in the preamble, experience has shown that, in order that mill may operate as described, the belt of water should not be entrained into rotation by long blade-like members projecting out of the rotor surface radially thereinto. On the contrary the projecting parts of the rotor—if any—should be well spaced from the drum interior as to come to be almost always inside of the inner surface of the water belt.

Although in FIGURE 1 the rotor **14** is shown provided with projecting bars **18**, these bars may be completely omitted or replaced by channels **118** (FIGURE 3) grooves, flutings and even a roughened surface.

In FIGURE 4, as variation, there is shown, a cylindrical rotor **14** mounted eccentrically on its shaft **15**.

In FIGURE 5, the rotor **214** is elliptical.

In any case, it is to be understood that the most projecting parts of the rotor must be such that their distance from the nearest part of the drum interior is less than the size of the coarsest material to be fed into the mill.

Furthermore the rotor **14** is usually mounted in the drum eccentrically, as in the case as shown, in which the drum shell **11** is substantially spiral-shaped.

All the above and other possible embodiments of the invention should be such as to promote the formation of a water belt, containing the solids to be comminuted in it and spaced, at least in part, from the rotor, by an air cushion, the whole in order to avoid that the liquid and solid parts forming the belt revolve at substantially the same angular speed or conversely in order to cause the solids in the belt to revolve at different angular speeds, according to their different weights and position in the liquid belt, thus tending to impact or rub against each other and the drum walls, or the lining bars thereof.

I claim:

1. A mill for the continuous production of a directly floatable fluid pulp starting from coarse-sized solid materials, comprising a drum-like shell, a feed hopper for solid materials opening into the extending above said shell, a hollow rotor journaled for rotation within said shell and having a peripheral surface spaced from the shell, radial through-openings in the peripheral surface of said rotor communicating with the hollow interior thereof, means for feeding aqueous fluids into said hollow rotor and through said radial openings into said shell, means for rotating said rotor at high angular speed, and an ascending overflow duct opening into and extending above said shell.

2. A mill according to claim 1, in which the rotor is provided with short parts projecting from its peripheral surface and which are spaced from the shell interior by more than the maximum size of the material to be comminuted.

3. A mill according to claim 1, in which the rotor is provided with longitudinal grooves.

4. A mill according to claim 1, in which the rotor is elliptical in cross section.

5. A mill according to claim 1, comprising means for adjusting the height of the overflow duct.

6. A mill according to claim 1 wherein is additionally provided duct means for collecting and discharging the fluid overflowing from said overflow duct.

7. A mill according to claim 1 in which the rotor is jurnaled for rotation about a horizontal axis eccentrically positioned with respect to said shell, the peripheral surface of said rotor being spaced at all points from the shell by a distance that is greater than the maximum size diameter of the material to be comminuted.

8. A mill according to claim 1 wherein said radial through-openings have small diameters sufficient only to pass aqueous fluids but too small to pass the solid material to be comminuted.

9. A mill for the continuous production of a directly floatable fluid pulp starting from coarse-sized solid materials, comprising a drum-like shell, a feed hopper for solid materials opening into and extending above said shell, a hollow rotor journaled for rotation within said shell and having a peripheral surface spaced from the shell, radial through-openings in the peripheral surface of said rotor communicating with the hollow interior thereof, means for feeding aqueous fluids into said hollow rotor and through said radial openings into said shell, means for rotating said rotor at high angular speed, and an ascending overflow duct opening into said shell, said overflow duct comprising an upright, partition wall within the hopper extending downwardly to a level slightly within the confines of the shell, a second upright wall within the hopper substantially parallel to said first wall and extending upwardly from a level in the lower part of said hopper, a sluice valve-like member coacting with the top part of said second upright wall to extend it upwardly, said sluice member having a top edge which constitutes the top of said overflow duct, and means for shifting said sluice valve member vertically so as to lift and lower its top edge, said hopper having an opening in its side opposite said second partition wall for discharging fluid overflowing from said overflow duct.

10. A mill according to claim 9 in which valve means are provided in the said overflow duct for constricting its free flow area.

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