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[33] **Poland**

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 49, 52, 275, 97, 253 (Cursory)

[56] **References Cited**

UNITED STATES PATENTS

994,596	6/1911	Marks	241/275
2,919,864	1/1960	Parmele	241/253
2,981,489	4/1961	Hannum	241/97X
3,015,391	1/1962	Sharples	241/275X
3,189,287	6/1965	Byberg	241/275

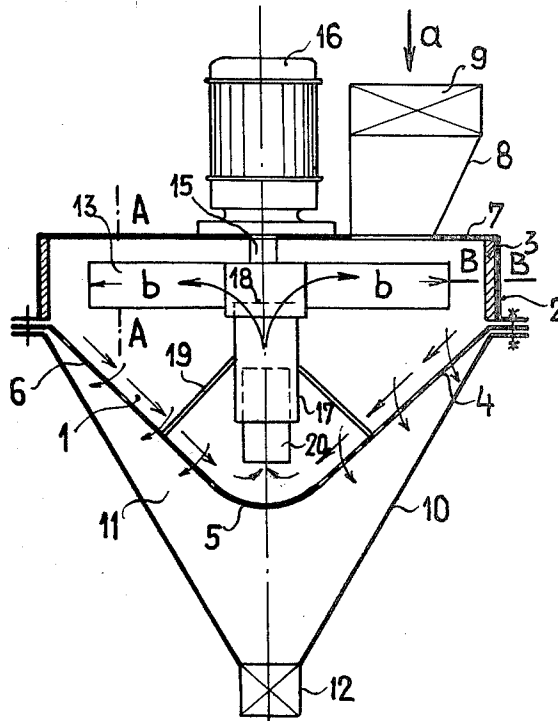
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[54] **MILL FOR GRINDING HARD MATERIALS**
4 Claims, 8 Drawing Figs.

[52] U.S. Cl..... **241/48,**
241/55, 241/275

[51] Int. Cl..... **B02c 19/00**

ABSTRACT: A mill for grinding material in which a rotating element throws the material against a hard lining element, the material being circulated over a separating screen spaced from the lining element and thence back to the rotating element.



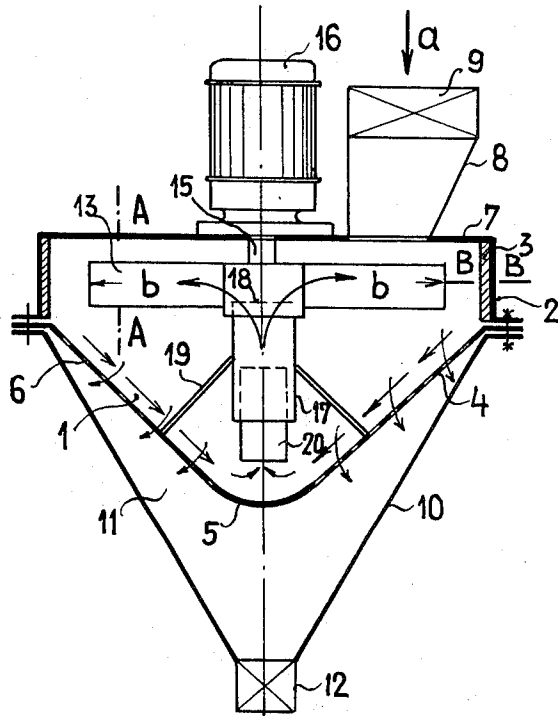


Fig. 1

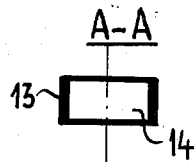


Fig. 2

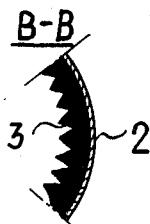


Fig. 3

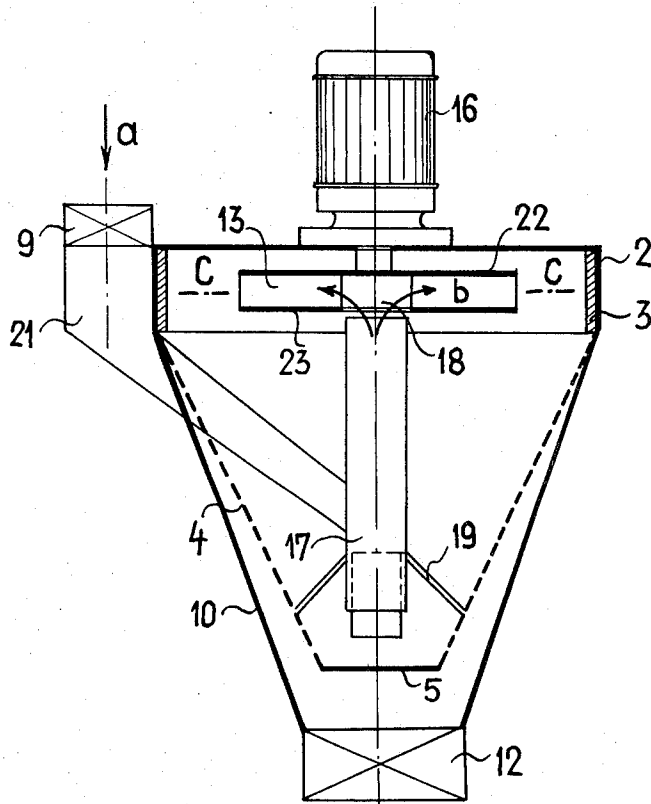


Fig. 4

C-C

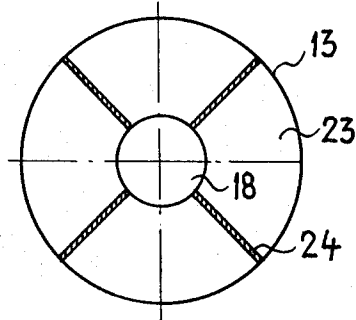


Fig. 5

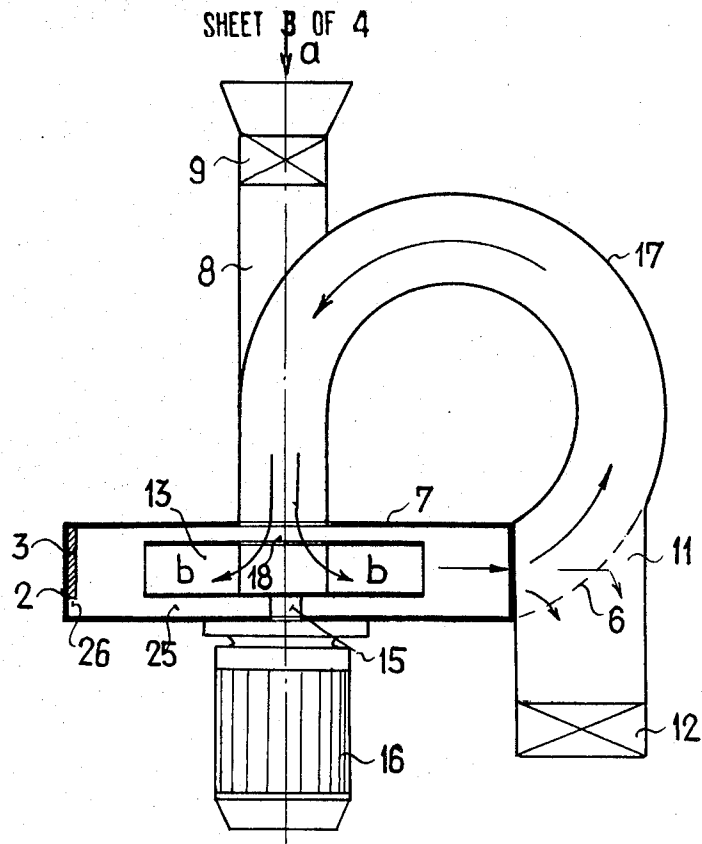


Fig. 6

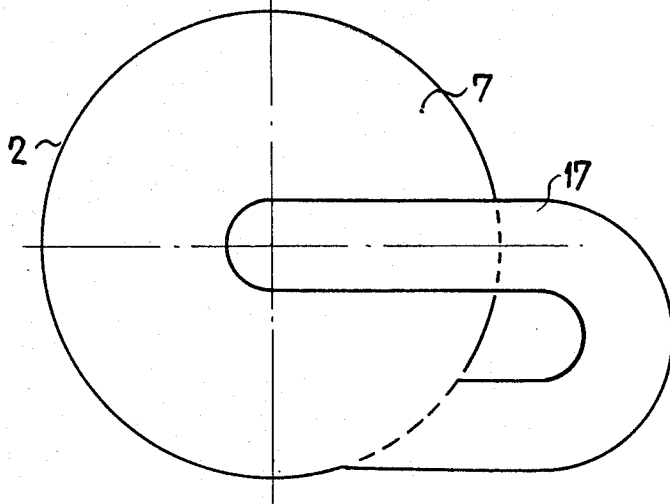


Fig. 7

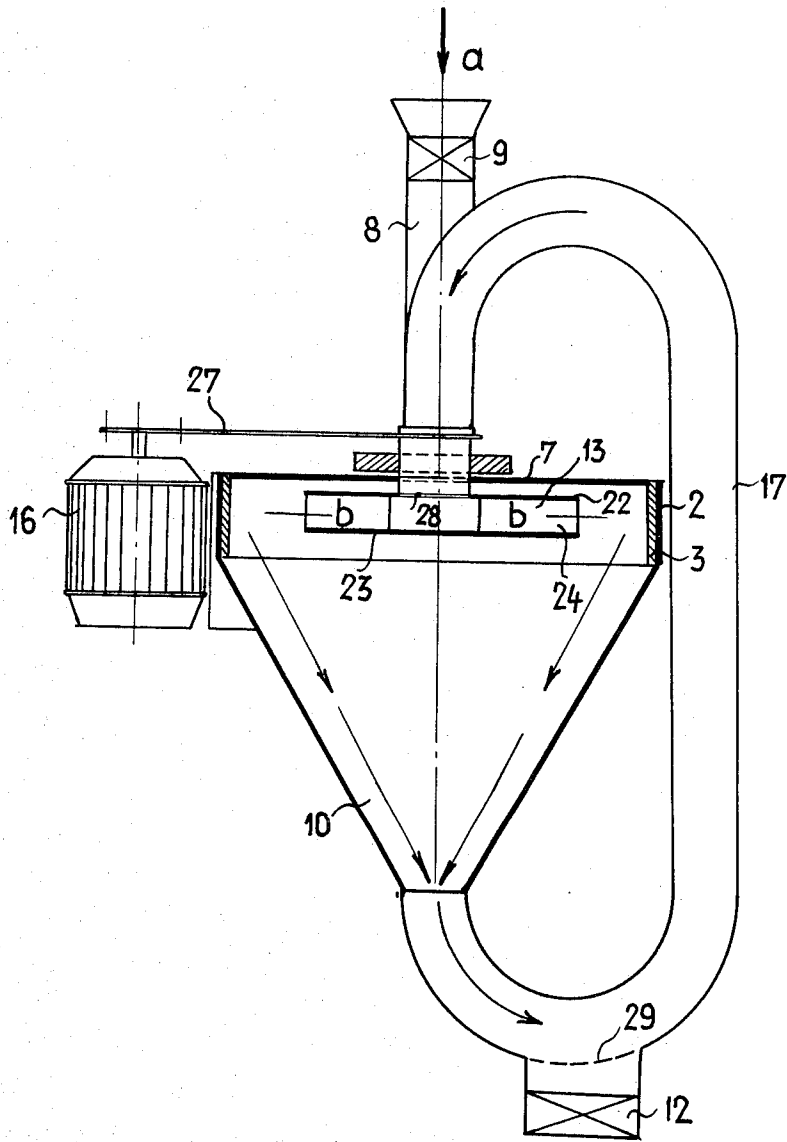


Fig. 8

MILL FOR GRINDING HARD MATERIALS

The problem of grinding very hard materials is difficult and is as yet far from a satisfactory solution. The devices known up to now for this purpose, as for example stroke mills, hammer mills, and beater mills, in which the disintegration is done in a crushing chamber, having elements which are made of armored, screening or grating parts, require large impact forces by vibrating hammers or beaters and have the disadvantage, that the classifying elements of the ground material, such as a grate or a screen, are subjected to these impart forces. Therefore these elements must be made of a thick sheet metal or rods, which construction prevents obtaining fine disintegration. Besides, due to the friction of the materials between the casing and rotating elements which occurs in devices of this type (hammers, beaters) there is caused an increase in the nonproductive power requirement. The other known devices, as for example, stroke mills with vertical impellers in which the material is thrown out with a large force against an armored casing and is crushed there, do not assure simultaneous classification of the material and do not circulate the oversize grains the second time, so that the product is not sufficiently ground.

The jet mills, in which the grinding is done by compressed air directing two streams of material counter currently at high speeds and causing the impact of these streams, are characterized by very high power consumption and they need the application of dust collectors for catching the disintegration product from the stream of air by expensive dust separators, because the air circulation is not closed.

The same deficiencies exist in horizontal mills.

The purpose of this invention is the elimination of these deficiencies in the above-described constructions by avoiding large impact forces on the classifying element (a screen) so that a high grade of disintegration can be obtained, and the application of pneumatic circulation which assures the controlled disintegration of material, without the need of dust separators for catching of product.

The main advantage of the present invention mill with pneumatic circulation is based on the fact that the device performs two operations simultaneously i.e. the disintegration and classification of grain sizes with recirculation of oversize grains for repeated disintegration. The essential fact is that the classifying part of the apparatus is located outside of the region of large impact forces, so it can be made of relatively thin sheet, in which correspondingly small perforations can be made, which enable the production of a finely ground product. The product with grain sizes below 0.3 mm. can be obtained from the feed lumps of e.g. 80—100 mm. during one operation, which is impossible in the case of impact mills of other types, in which the classifying element is a screen, or a grate. The elements in these mills are exposed to the action of large impact forces and therefore they must be made of thick material which excludes having fine perforation.

The second advantage of the present invention mill derives from the fact that after every impact of material, it is classified by elimination of fine grains from the circulation which thereby prevents the further unnecessary disintegration of material already ground and saves a great deal of power input.

Also the angle of impact against the casing is highly advantageous. This angle for a proper shape of the armored lining of casing is 90°. It is the optimal angle, called the head stroke angle, at which the energy losses from nonproductive impacting of the material, not causing its disintegration, are the smallest.

On account of the process described above depending on subsequential disintegration and classification, the present invention mill with pneumatic circulation makes possible so-called petrographic grinding, which is important for the enrichment of ores. The weight of the apparatus in comparison with other devices for similar use is very small.

The mill of the invention is shown by way of example in the drawing where FIG. 1 represents a section of the mill taken along its vertical axis;

FIG. 2 a section along the line A-A on FIG. 1;

FIG. 3 a section along the line B-B on FIG. 1;

FIG. 4 an axial section of another embodiment of the mill;

FIG. 5 a section along the line C-C on FIG. 4;

FIG. 6 an axial section of a further embodiment of the mill;

FIG. 7 a top view of the mill of FIG. 6; and

FIG. 8 an axial section of yet another embodiment of the mill.

The present invention mill comprises the crushing chamber 1 formed by the cylindrical casing 2 having interior thereof an armored toothed lining 3, in the lower part thereof the conical element 4 closed by the imperforate bottom 5, above which is the oblique wall 6 which is in the form of a screen or grate. The upper part of chamber 1 is covered by the lid 7. Inside the chamber 1 rotating element 13 is located having two or more hollow arms of rectangular cross section, with the passage 14 in the middle. The element 13 is fixed to the shaft 15 which is supported in bearings in the lid 7 and is driven by a motor 16. The funnel 4 is within a conical housing 10, providing the chamber 11 inside, which collects the ground material. The material can be discharged at any time through the outlet lock 12.

The vertical duct 17 is held by supports 19 in the crushing chamber 1, with the upper end thereof in the central hole 18 of the rotating elements 13, and with the lower end having a sliding telescopic part 20. The lid 7 is provided with the feed funnel 8 with the lock 9.

The above-described device works in the following way. The feed is introduced to the mill in the direction of the arrow a, through the lock 9 and the feed funnel 8 to the rotating element 13, which throws the thus fed material against the cylindrical casing 2 provided with the toothed lining 3. The thus roughly ground material flows down with a spiral movement onto the screening walls 6 of the conical funnel 4. The ground up feed fraction drops through the screening walls 6 to the collecting chamber 11 from whence it can be taken as processed material, through the lock 12. The remaining imperfectly ground fraction of the feed drops down to the bottom 5 and then it is sucked up by the duct 17, in the direction of the arrows b flowing through the passages 14 of the elements 13 and thrown by centrifugal force against the tooth lining 3 where the feed material is ground further. The described cycle repeats, until by the disintegration of all the grains they fall through the screen 6 to the chamber 11. The inner circulation of the coarse grains of the feed material along the duct 17 and the passages 14 of the arms of element 13 is caused by the rotational movement of the said element 13 which functions as a fan or a pump to suck air in from below, directing it in the inner closed circulation path marked by arrows b on FIG. 1, taking up the grains on the walls 6 or at the bottom 5, of the conical funnel 4. Only the finest grains are not circulated with the air since they drop down through the walls 6 of the screen, to the collecting chamber 11.

As is shown on FIG. 4 and 5, the feed can be charged directly through the feeding funnel 21, to the circulating duct 17 or to the bottom 5, from above through the lock 9, instead of onto the rotating element 13, in order to avoid preliminary crushing. The rotating element 13 consists of two discs 22 and 23 between which the radially extending blades 24 are fastened. The disc 22 is continuous and the lower disc 23 has the hole 18 to which the end of the circulating duct 17 is connected.

FIG. 6 and FIG. 7 show the mill with the same pneumatic grain circulation of the feed, the structure of which is based on the circulating duct 17 connected tangentially to the cylindrical casing 2. In this embodiment the screening wall 6 is placed directly in the circulating duct 17, at the bottom 25 of the casing 2 or in the side parts 26. The motor 16 is located below the casing 2 and the lock 9 and the feeding funnel 8 are above it, delivering the feed onto the rotating element 13. The collect-

ing chamber 11 and the lock 12 are located under the duct 17 or the bottom 25 of the casing 2.

A further embodiment of the invention mill is shown in FIG. 8 wherein the circulating 17 is connected at one end to the conical funnel 10 and at its upper end with the lid 7 of the casing 2, the circulation of the flow of air caused by the rotating element 13 being in the direction of the arrows *b* shown on FIG. 8. The electrical motor 16 is installed at the side of the casing 2 and puts the element 13 in rotating movement, through the gearbox 27. The lower disc 23 of the element 13 is continuous, and the upper disc 22 has a hole in the middle, connecting the circulating duct 17 by the stub pipe 28 with the pressure space between the discs 22 and 23. The feed is charged by the funnel 8 through the upper section of the duct 17 and the stub pipe 28 to the pressing area of the rotating element 13. At its lowest part the circulating duct 17 is provided with a screen or grate 29 for disposing of the ground grains. The described mill works on a similar principal to the mill shown of FIG. 1—3. The feed is introduced by the funnel 8 to the rotating element 13, which by its blades 24 and centrifugal force, throws it onto the toothed lining 3. The grains crushed coarsely drop down and by the pressure of air go through circulating duct 17 and back to the rotating element 13 and the cycle of grinding repeats. During the flow of the feed in the closed circulation path completely ground grain drops through the grate 29 and can be recovered as the processed product through the lock 12.

We claim:

1. A mill for grinding hard material comprising:
a housing, lining means in said housing for disintegrating material thrown thereagainst;

rotating means in said housing having passage means therethrough for discharging material against said lining means;

means for establishing a closed circulation path for material comprising a conical element beneath said lining means having screen means at the upper part thereof and having an imperforate bottom, and duct means for fluid connecting the interior of said housing and said rotating means, said duct means extending from adjacent said imperforate bottom centrally within said housing;

means for introducing material into said housing; and means for collecting material passed through said screen means.

2. The mill of claim 1, said means for introducing material comprising feed means for discharging material into the path of said rotating means, said rotating means comprising hollow arms, whereby material fed into said housing is impelled by said arms against said lining means.

3. The mill of claim 1, said means for introducing material comprising feed means for discharging material beneath said rotating means.

4. The mill of claim 1, said means for collecting material comprising a conical housing beneath said conical element.

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