June 26, 1951 D. WESTON 2,558,327

GRINDING BALL FOR BALL MILLS

Filed April 2, 1947

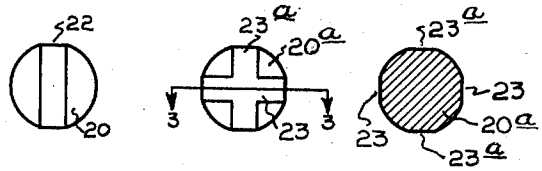


Fig. 1 Fig. 2 Fig. 3

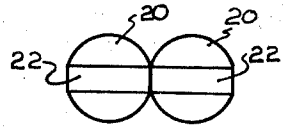


Fig. 4

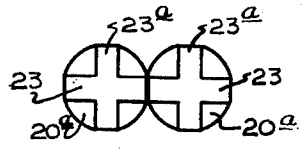


Fig. 5

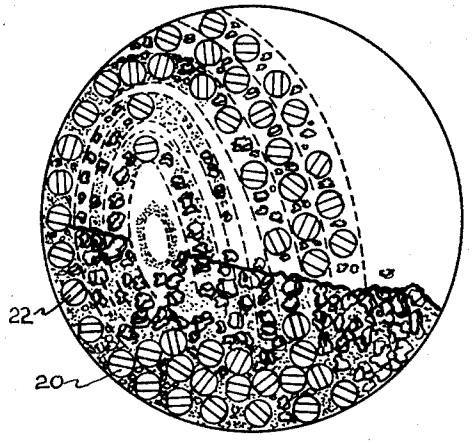


Fig. 6

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Patented June 26, 1951

2,558,327

UNITED STATES PATENT OFFICE

2,558,327

GRINDING BALL FOR BALL MILLS

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Application April 2, 1947, Serial No. 738,785

2 Claims. (Cl. 241—184)

1

The invention relates to a new and useful combined crushing and grinding material, and bodies incorporating the material, for use in crushing and grinding mills of the type, for example, employed in crushing and comminuting ore, rock and like materials.

Rod mills, ball mills and like apparatus for crushing and grinding rock, ore, and like material are well known and are widely used and involve, in general, a rotatable cylindrical body or drum charged with a mixture of feed material to be crushed and comminuted and a ball charge. In such apparatus, balls constituting the ball charge on rotation of the mill, are carried upwardly, by centrifugal force toward the top of the mill and are permitted to fall by gravity, on the mixture of charge and balls in the bottom. Normally, the speed of rotation of the mill is determined to obtain a maximum impact crushing and attrition grinding effect. The ball charge thus serves two important functions, it breaks the particles of the charge by impact in falling, and comminutes the charge by attrition grinding of particles engaged between contacting surfaces of adjacent balls.

Spherical bodies are most advantageous to obtain an efficient crushing or shattering action as they concentrate on a relatively small surface area of the material being crushed. A spherical body, however, has a minimum grinding action in view of the fact that it will only provide for a point contact and consequently steps have been taken in the past to increase the grinding effect of such bodies by generally departing from such a shape and forming bodies with a multiplicity of plane surfaces or enlarged areas, in an endeavour to increase grinding effect. In all such cases, such expedients tend to hinder the free rotatability of the body necessary to achieve efficient grinding.

The present invention avoids the disadvantages of the prior art by providing a combined crushing and grinding body which will provide for optimum crushing effect by employing a spherical body and optimum grinding effect achieved through an enlarged grinding surface on the spherical body of such character that free rotatability of the body is not hindered.

It is therefore a main object of this invention to provide a crushing and grinding body in which the configuration is of an essentially spherical shape with at least one enlarged substantially cylindrical contact surface to provide a body which is freely rotatable in the mill and yet provide relatively large contact surfaces for

2

engagement with the particles of the charge for increasing the rate and efficiency of the grinding operation.

The crushing and grinding medium of the present invention comprises in general: a body essentially spherical in form and in which the surface thereof consists in a combination of at least one substantially cylindrical grinding surface and at least two substantially spherical crushing surfaces separated by said cylindrical grinding surface, the spherical crushing surfaces each forming part of the same sphere and the said cylindrical grinding surface forming a cylindrical band around said body having a diameter slightly less than the diameter of said sphere.

An understanding of the invention may be had from the following description, reference being made to the accompanying drawings in which:

Figure 1 is an elevation of a grinding ball embodying the improvements of the present invention;

Figure 2 is an elevation of a grinding ball embodying a modification of the invention;

Figure 3 is a section taken along the line 3—3 of Figure 2;

Figures 4 and 5 are elevations of pairs of the grinding balls illustrated respectively in Figures 1 and 2; and

Figure 6 is a schematic view of the interior of a ball mill employing a ball charge in which some of the balls incorporate the improvement of the present invention and others are completely spherical to illustrate the extent of the contacting surfaces of adjacent balls.

Like reference characters refer to like parts throughout the specification and drawings.

The numeral **20** indicates a crushing and grinding ball of the type used in mills for grinding or crushing and grinding rock, ore and like material. The ball is of spherical shape and is formed, as illustrated in Figure 1, as a combination of at least one substantially cylindrical grinding surface in the form of the substantially cylindrical band **22** extending circumferentially around the centre thereof and at least two substantially spherical crushing surfaces separated by the cylindrical grinding surface **22**, the spherical crushing surfaces each forming a part of the same sphere, with at least one substantially cylindrical shaped band **22** extending circumferentially around the centre thereof, the cylindrical grinding surface **22** being of a diameter slightly less than the diameter of said sphere and may be formed at the time of moulding the

ball or may be formed by cutting or grinding after moulding.

In the modification of the invention illustrated in Figure 2, the spherical body 23*a* is formed with two circumferential bands 23 and 23*a* which extend circumferentially around the centre of the body and intersect at right angles. The periphery of the body between the outside edges of the bands 23 and 23*a* is also substantially circular in shape.

In each instance, the enlarged contact surface 22 or surfaces 23—23*a* present a contact surface of relatively large area, having regard to the circumferential area of the ball, without decreasing appreciably the free rotatability of the ball. For example, in a ball of about 2½" in diameter, the width of each band forming the enlarged contact surface is about one-half inch.

In the use of balls having the configuration described and illustrated herein, the balls are rolled around the bottom of the mill at different rates of speed and at different angles of direction as the mill is rotated and the substantially spherical shape of the balls does not offer any appreciable resistance to their free rotation. When the circular portions of two balls come in contact there is the usual pin point contact between the adjacent bodies rotating at different rates of speed and a grinding action is effected on the particles of the charge therebetween. However, when two enlarged contact surfaces of adjacent balls rotating at different rates of speed come together, the area of the contact is large as compared with the pin point contact of the spherical portions with longer time of contact to increase greatly the rate and efficiency of the comminuting operation.

In use, the combined crushing and grinding balls of the present invention have many important advantages over the balls hitherto used for the same purpose.

Reduction by impact on the material results from one body falling or being thrown against another with sufficient force so that the less coherent body is shattered, breaks, or weakened to the extent that it breaks or shatters, under succeeding shocks. The design of the impact body is, therefore, an important factor in the efficiency of the crushing or breaking operation in that the greater the concentration of energy delivered to the feed material per unit of surface area, the greater is the shattering, breaking, or weakening effect on the feed material.

Balls of the present invention are designed to provide a substantially spherical shape so that in falling, the force of the fall is concentrated on a relatively small surface area of the material on which it drops or is thrown.

Reduction of the material by attrition results from two or more of the grinding bodies coming together with contacting surfaces and moving at different speeds or in different angles of direction to reduce the feed material caught between the contacting surfaces of the bodies. The area of the contacting surfaces of adjacent balls is an important factor in the efficiency and rate of reduction by attrition. In mills employing the spherical balls of the prior art, the bodies come together with, in effect, a pin point contact, that is, the area of contact, or the friction

area is relatively small and only a small amount of material is engaged between the contacting surfaces. By employing balls having enlarged contact surfaces on the spheres, a much larger area of contact is provided to increase the area of the contacting surfaces, or the friction area, and so increase the amount of material which may be engaged between them, and the length of time surfaces are in engagement one with the other.

The balls of the present invention are ideally adapted for designing to meet the requirements of the feed material with which they are to be used, for example, some types of material, or the same material in its various stages of reduction, will require a greater percentage of impact and others a greater percentage of attrition. In each instance, the balls are designed to have a maximum combined impact and attrition effect, but the enlarged contact surfaces may be modified to increase the impact effect, or exaggerated to increase the attrition effect without materially decreasing its attrition effect in the first instance or the impact effect in the second instance. Also, by retaining the general spherical shape of the balls and using tungsten carbide with its extreme hardness and resistance to wear, the balls retain their original shape over long periods of use with negligible contamination of the final product.

What I claim as new and and desire to protect by Letters Patent of the United States is:

1. A crushing and grinding body for use in ball mills and the like, said body being essentially spherical in form, and the surface thereof consisting of a combination of at least one substantially cylindrical grinding surface, and at least two substantially spherical crushing surfaces separated by said cylindrical grinding surface, said spherical crushing surfaces each forming a part of the same sphere, and said cylindrical grinding surface forming a cylindrical band around said body having a diameter slightly less than the diameter of said sphere.

2. A crushing and grinding body as defined in claim 1 in which there are four crushing surfaces and two grinding surfaces, the latter of substantially cylindrical form, whose theoretical axes intersect at substantally right angles.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,431,475	MacDonald	Oct. 10, 1922
1,746,236	Barton	Feb. 11, 1930
1,823,351	Clements	Sept. 15, 1931
1,864,542	Holzapfel	June 28, 1932
2,253,969	Dawihl	Aug. 26, 1941

FOREIGN PATENTS

Number	Country	Date
246,653	Italy	Mar. 4, 1926
261,664	Great Britain	Nov. 25, 1926
274,786	Great Britain	July 28, 1927
569,122	Great Britain	May 4, 1945