March 19, 1940. C. J. ABRAMS 2,193,956

LINER FOR BALL MILLS

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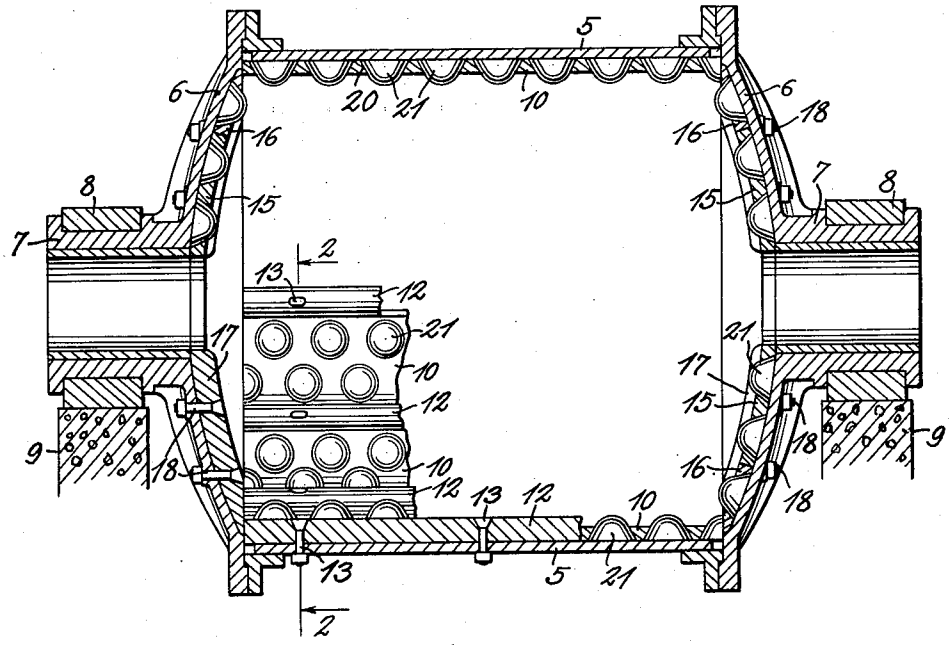


Fig. 1.

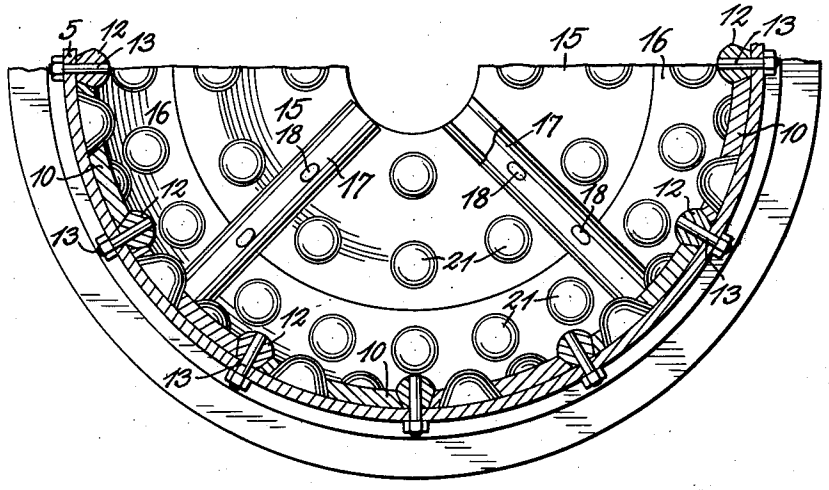


Fig. 2.

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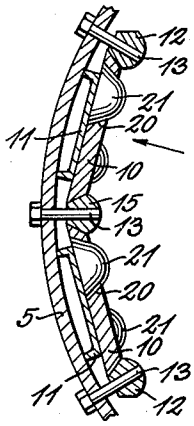


Fig.3.

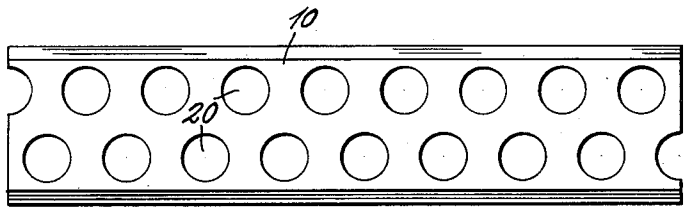


Fig.4.

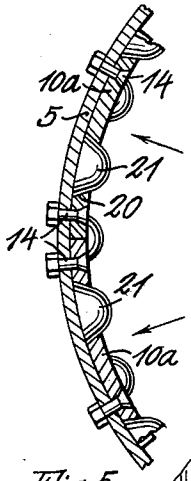


Fig.5.

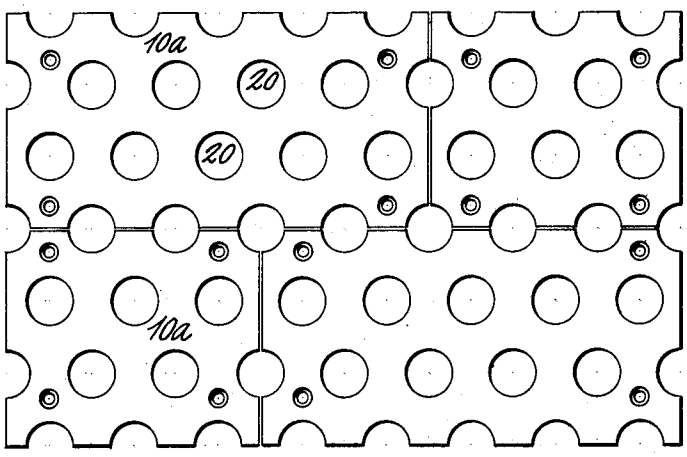


Fig.6.

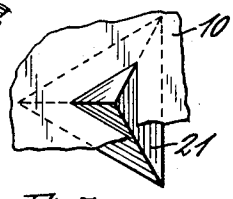


Fig.7.

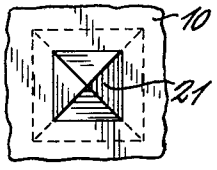


Fig.9.

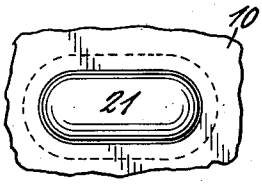


Fig.11.

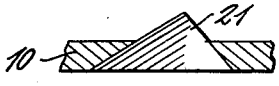


Fig.8.

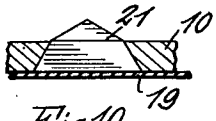


Fig.10.

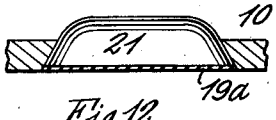


Fig.12.



Fig.13.

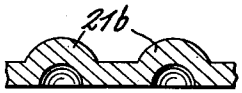


Fig.14.

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UNITED STATES PATENT OFFICE

2,193,956

LINER FOR BALL MILLS

Charles J. Abrams, Denver, Colo.

Application October 10, 1938, Serial No. 234,977

2 Claims. (Cl. 83—9)

This invention relates to improvements in liners for grinding machinery.

It is commonly necessary to grind materials of different kinds, such as coal or rock, and more particularly metalliferous ores, and for this purpose various kinds of machines have been invented and used, among which are machines generally referred to as "ball mills", "rod mills", and "rock crushers." Such machines, briefly described, for example a ball mill, consist of a metal cylindrical drum mounted for rotation on axial tubular trunnions. The rock or ore to be ground is fed into the rotating cylinder through one trunnion and is discharged through the other trunnion, or through peripheral grates. The grinding takes place within the rotating cylinder and is effected by means of a charge of metal balls, metal rods or pebbles, which are known as the grinding media. When the drum is rotated the grinding media are carried up along the leading side of the drum and then cascade downwardly. This cascading of the attrition members, when they are mixed with ore or rock, serves to grind finer the ore or rock either in a wet or dry condition. It is evident that the inner surface of the rotating drum or cylinder is subject to great wear and it is therefore customary to provide the drums with removable liners, which are usually made from thick slabs of cast iron or steel to which has been added some alloying material, such as manganese.

Such liners, even if made quite massive and thick are soon worn to such an extent that they must be replaced by new ones and they are therefore attached to the drum in such a way that they can be removed and replaced in a convenient manner. Cast iron balls are extensively used as a grinding medium in mills but steel balls, steel rods, and pebbles are also used. Forged steel balls have been found superior in wear resisting qualities, but while extensively used as grinding media are more expensive than the others. It may be possible to forge grinding machinery liners from steel and use such liners in lieu of the cast liners now commonly employed but such liners would be unduly expensive. It is also quite apparent that the attrition surfaces of liners would be more efficient if they were knobby instead of smooth, as such surface resists sliding and carry the grinding media and the material being ground higher than smooth liners and the grinding media therefore operate with greater effect. If the attrition surfaces of ordinary liners are made uneven the projections will wear off in a short time and the attrition surfaces of the liners have therefore, as a rule, been made quite smooth or merely wavy or ridged to retard slipping.

It is an object of this invention to produce a liner having a knobby attrition surface in which the elevated portions are harder than the lower areas or are formed from a material having greater wear resisting properties, as for example, steel castings, forgings, rubber or metal covered with rubber.

Another object is to increase friction between the liners and the grinding media thereby reducing wear on the liners and increasing the grinding efficiency.

A further object is to produce a lining of such construction that it has removable portions that project above the attrition surface in the form of knobs which may be made of harder or more abrasive resisting material than the other portions so as to lessen the cost of repairs and maintenance.

A still further object is to produce a lining that will be lighter than the types now in use, so that the volume of the mill will have a greater capacity and permit a greater weight of grinding media to be used.

Another object is to make the lining with a knobby attrition surface so as to cause a greater agitation of the grinding media whereby grinding efficiency is increased.

A further object is to increase the scrap value of the liners due to the fact that the removable knobs can be used as grinding media after they have been worn to such an extent that they must be removed from the lining.

The above and other objects that may appear as the description proceeds are attained by means of a construction and an arrangement of parts that will now be described in detail, and reference for this purpose will now be had to the accompanying drawings in which the invention has been illustrated in its preferred form, and in which

Figure 1 is a longitudinal diametrical section through a ball mill showing the improved lining, portions of the lining being omitted to simplify the drawings;

Figure 2 is a section taken on line 2—2, Fig. 1;

Figure 3 is a fragmentary section showing flat liner slabs supported on shallow channels;

Figure 4 is an elevation of a liner slab, looking in the direction of the arrow in Fig. 3;

Figure 5 is a section similar to that shown in Fig. 3 and shows transversely concavo-convex

liner slabs resting against the inner surface of the drum;

Figure 6 is an elevation of the concave surfaces of the slabs, looking in the direction of the arrows in Fig. 5; and

Figures 7 to 14, inclusive, illustrate specifically different forms of the invention.

In the drawings numeral 5 designates the cylindrical shell of the mill drum and numerals 6 the ends. Each end has a tubular trunnion 7 which rotates in a bearing 8 that is supported on a pillow block 9. In the drawings no attempt has been made to show means for feeding material to the mill or for discharging the ground material because such means are old and well known and the present invention relates solely to the lining.

In this description it will be assumed that the mill is provided with the usual charge of balls or other grinding media which have not been shown because they would complicate the drawings.

The inner surfaces of all grinding mills are provided with removable liners that can be replaced when worn. Such liners may be flat slabs of cast iron or steel, like those designated by numeral 10 in Fig. 3, and may be spaced from the inner surface of the shell 5 by means of shallow channels 11. The several slabs are held in position by means of wedge-shaped bars 12 that are attached to the shell by bolts 13.

In Figs. 5 and 6 a construction has been shown in which the channels have been dispensed with and the liner slabs 10*a* made of concavo-convex transverse sections so that they will fit against the inner surface of the shell and in this case the liners have been shown as attached to the shell by bolts 14.

The ends of the mill are also provided with removable liner sections 15 and 16, forming pairs that are substantially sector shaped, as shown in Fig. 2. The blocks of adjacent pairs are preferably secured in place by wedge bars 17 and bolts 18, or by bolts as in Fig. 5.

Where the liners are positioned as in Fig. 5 a spacer like that indicated by numeral 19 in Fig. 10, formed from some yieldable material such as rubberized belting or the like may be positioned between the liners and the shell.

As stated above, it is the principal object of this invention to produce liners having greater wearing properties, which are more efficient and which can be more cheaply replaced than the ordinary liners and this object is attained by forming the liner slabs with a plurality of openings 20, preferably circular in shape, and with outwardly flaring sides. Positioned in the openings are knobs or attrition members 21 that are shaped to fit the openings so as to be firmly secured in place when the liner slabs are attached to the shells. The openings have been shown as arranged in parallel lines and staggered but the exact arrangement is not of great importance.

The plugs or attrition members 21 shown in Figs. 1, 2, 3 and 5 have frusto-conical sides and substantially spherical heads but may be of other shapes as shown in Figs. 7 to 12. As above stated, the liner slabs are preferably made from cast steel or cast iron, suitably alloyed, and may have their attrition surfaces covered with rubber or some rubber-like composition. The attrition members 21 may be made of a variety of specifically different materials, such as hard cast iron, cast steel, rubber, either synthetic or natural, and of metal covered with rubber, but are more generally steel forgings. Since members 21 are not as liable to break as the balls, which serve as grinding media, they may be made of very hard cast iron, with chilled surfaces.

In the drawings the removable attrition members 21 have been shown as secured in place by the outwardly flared walls of openings 20 but may be secured to the liners in any other suitable way as by bolts or rivets, or by welding. The means illustrated, however, is believed to be preferable. The shapes of the replaceable members may be varied, as above stated, so long as they perform the intended function.

Owing to the succession of impacts received by members 21 they may be spaced from the shell by individual rubberized fabric spacers 19*a*, as shown in Fig. 12, where such spacers do not extend between the liner and the shell as in Fig. 10.

In Figs. 13 and 14 fragmentary sections of liners have been shown which are formed with integral knobs 21*b*. Such liners may be cast and the surfaces of the knobs chilled so as to make them harder and more wear resisting than the other portions of the liner.

The slabs that hold the attrition members can be used over and over again due to the fact that they are protected to a great extent from wear by the presence of the knobs which retard slipping and wear.

Owing to the smaller weight of the individual members, the labor and cost of repair is reduced as is also the danger of accidents.

The increased friction between the liners and the grinding media causes the latter to be lifted higher, thereby increasing the distance that the media cascade and this steepens the cascade angle thereby increasing the grinding efficiency.

The slabs can be made much lighter where renewable knobs are used as the reduced slipping also reduces the wear and this reduces the power required to operate machine.

Let us now assume that a mill is provided with a lining whose inner surface is knobbed and that it has the ordinary charge of grinding media mixed with rock or other material to be crushed or ground and that the mill is being rotated by suitable power means. It is evident that the rock and the grinding media will be carried upwardly on the advancing surface and when the material reaches a certain inclination it will begin to cascade inwardly and will crush the solid particles of the rock. If the inner surface of the lining were smooth the material, or a large proportion of it, would slide downwardly and the crushing action would be comparatively small while the wear on the liners would be very great. In order to avoid such sliding the inner surface of the lining has sometimes been provided with ridges or longitudinally extending elevations or the wedge bars 12 have been projected beyond the inner surface of the lining so as to assist in lifting the load and prevent sliding. In the present invention the staggered arrangement of the knobs causes greater agitation of the grinding media thereby imparting to the media different movements than they will have in mills having only longitudinally extending lifter ribs. Where rubber or rubber surfaced knobs are used friction between such knobs and the material is greater than with metal knobs, which further reduces sliding and wear.

After the knobs have worn to such an extent that they operate inefficiently, the liners are removed and new knobs or attrition members inserted in the openings in the slabs. The worn knobs can then be used as grinding media.

Owing to the presence of the knobs and the resultant increased friction, the sliding of the material under treatment is greatly retarded and as a result the surface of the liner wears very slowly compared to that of the ordinary liners and the knobs and the liner slabs will therefore last a very long time which reduces the cost of mill upkeep. Although the feature of removing the knobs is an important consideration in connection with the cost of maintenance, the advantages of improved operation are present as well in an integral construction like that shown in Figs. 13 and 14.

From the above description, taken with the drawing, it will be apparent that several advantages are obtained from the construction that forms the subject of this invention and that mills having such liners can be maintained in optimum operative condition at a smaller cost than mills having the ordinary kind of liners.

It is evident that the liner slabs can be of any other shape than that shown and may extend helically or circumferentially and may be held in place by means other than that shown.

In the above description the invention has been described with reference to ball and rod mills, but attrition surfaces provided with removable knobs are of advantage in crushers and grinders of other types and protection is therefore desired for all such uses whether they have been particularly pointed out or not.

Having described the invention, what I claim as new is:

1. A grinding machine liner comprising a slab of extended area and curved to fit the interior of a cylindrical drum, said liner slab having spaced openings extending entirely through the same, the walls of the openings being flared from the concave to the convex side of the slab, and removable attrition members positioned in the openings, the surface of the attrition members being shaped to fit the openings, the attrition members being thicker than the slab with portions projecting above the concave surface of the latter, the attrition members being held in place by the concave surface of the drum when the slab is attached to the inner surface thereof.

2. A grinding mill comprising in combination a cylindrical drum, a lining comprising a plurality of slabs of extended area, curved to fit the inner surface of the drum, each liner slab having spaced openings extending entirely through the same, the walls of the openings being flared from the concave to the convex side of the slab, removable attrition members positioned in the openings, the surface of the attrition members being shaped to fit the openings, the attrition members when positioned in the openings projecting above the concave surfaces of the slabs, and means for securing the slabs to the inside of the drum whereby the attrition members will be held in place by the inner surface thereof.

CHARLES J. ABRAMS.