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BALL MILL LINER

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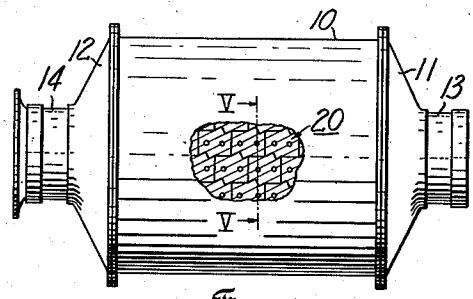


Fig. 1

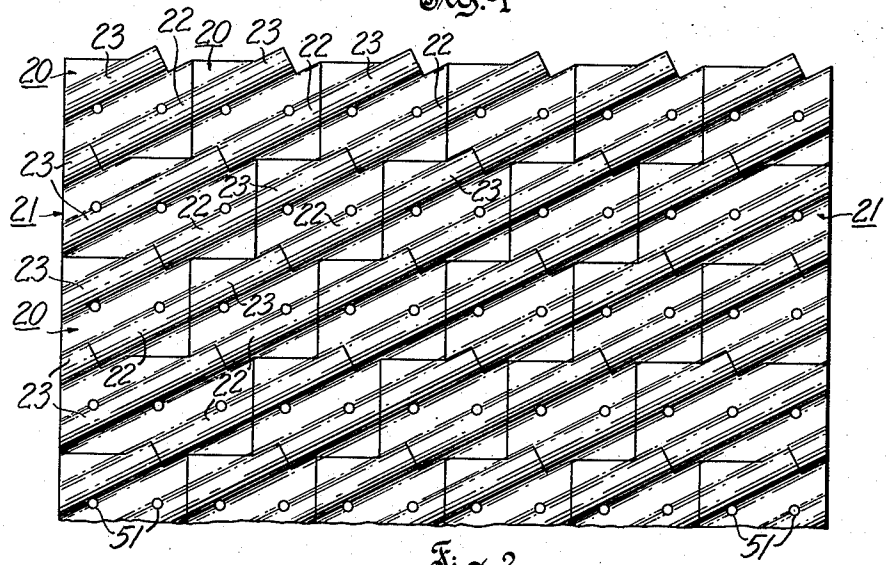


Fig. 2

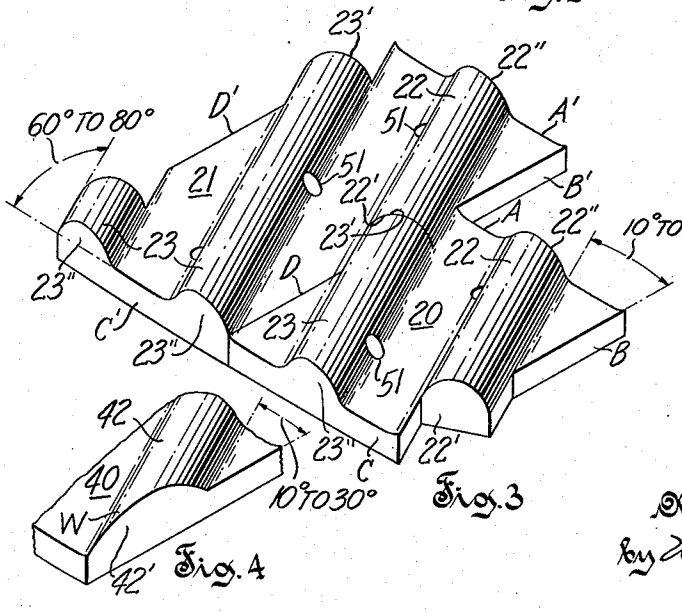


Fig. 3

Fig. 4

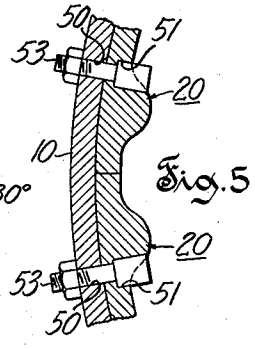


Fig. 5

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BALL MILL LINER

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6 Claims. (Cl. 241—183)

This invention relates to liners for ball mills and more particularly concerns an improvement in a ball mill liner of the type having formed on the internal working surface thereof a series of spirally extending ribs or lifters.

A ball mill is a grinding machine used for both wet and dry grinding operations and comprises a rotatable container partly filled with hard balls or the like, referred to as tumbling grinding bodies, which are free to move as the container revolves. In the majority of ball mills the rotatable container has a cylindrical shape and is mounted with its axis horizontal.

The grinding action in a mill of this type results from the crushing and abrading of the material being ground, such as an ore, between tumbling grinding bodies and between the liner of the container and the tumbling bodies. The tumbling bodies may be in the form of steel balls, pebbles or the like. The grinding action is such that when the container of the ball mill revolves, the centrifugal force on the charge, which includes the tumbling grinding bodies and the material to be ground, and the frictional force between the charge and the liner, causes the charge to be elevated. The force of gravity overcomes the centrifugal and frictional forces acting on the most elevated portion of the charge and such portion of the charge cascades downwardly causing particles of the material being treated to be effectively ground by repeated impact and attrition action of the grinding bodies.

Ball mill liners may be provided with a series of spirally extending ribs or lifters on the internal working surface thereof for retarding or accelerating the flow of material through the mill, the retardation or accelaration being dependent upon whether the ribs trail on the feed end or the discharge end of the mill. Liners of commercial ball mills are usually formed with generally rectangularly shaped plates and, when a mill is equipped with a series of spirally extending ribs, each rib is formed with aligned rib segments which are either formed integrally with or bolted to respective plates.

In prior art spiral type liners the rib segments which comprise the spirally extending ribs are inclined relative to longitudinally extending edges of the plates. With this construction an end portion of each rib segment is wedge shaped at the point where the rib segment intersects a longitudinal edge of the plate and the wedge shaped portion is susceptible of having a piece thereof chipped off upon being subjected to wear such that a pocket or cavity of irregular shape is formed in the rib. An irregular shaped pocket or cavity formed in a rib, when a piece of the rib has been chipped off, constitutes a weak spot which is subjected to a concentrated crushing, abrading and scouring action during normal operation of the mill which causes the cavity to become gouged out and enlarged until a portion of the rib is entirely eaten away.

As portions of the ribs become chipped and cavities are formed therein, in the manner described above, the ribs of course do not function efficiently to perform their intended functions and the lining or parts thereof must be replaced sooner than if there was only normal wear on the ribs. When there are no pockets or cavities in the ribs, the crushing, abrading and scouring action of the mill is not concentrated at certain points on the ribs and the wear on the ribs is generally uniform at all points thereof such that replacement of the liner is necessary only when the ribs are worn to the extent that the crests thereof become too low to be effective.

It is accordingly the main object of the present invention to provide a ball mill liner having a series of spirally extending ribs on the internal working surface thereof, of the type referred to above, in which aligned rib segments on adjacent plates of the liner are formed so that the adjoining end portions of the rib segments are not susceptible to being chipped off upon being subjected to the crushing and abrading action with the mill.

Other objects and advantages will become apparent from the following detailed description and the accompanying drawing, in which:

Fig. 1 is a side elevation of a ball mill equipped with a liner constructed in accordance with the present invention, a portion of the shell being broken away to reveal a fragmentary view of a part of the liner;

Fig. 2 is a projected plan view of a portion of the liner;

Fig. 3 is a perspective view of two individual plates with which the liner is formed;

Fig. 4 is a fragmentary perspective view of a prior art liner plate having a rib segment thereon; and

Fig. 5 is an enlarged, fragmentary, transverse sectional view through the mill shown in Fig. 1, taken along the line V—V, which shows how a liner plate is attached to the shell of the mill.

Referring to the drawing, the ball mill shown in Fig. 1 may be of a standard or other suitable design having a shell **10**, shown with a cylindrical shape but which may have a conical shape, end walls **11** and **12**, and trunnions **13** and **14** through which a material such as iron ore is respectively fed and discharged. The mill may be suitably mounted, although this is not shown, for power driven rotation about its longitudinal axis.

A portion of the shell **10** is shown broken away to reveal a fragmentary view of the liner which has a series of spirally extending ribs or lifters formed on the working surface of the liner. In the fragmentary view the ribs are inclined upwardly towards the right and if the mill is rotated in a clockwise direction, when viewed from the left end thereof, the ribs function to accelerate the flow of material through the mill from right to left.

Referring to the projected plan view of the portion of the liner shown in Fig. 2, the liner shown is formed with a plurality of generally rectangularly shaped plates **20** and **21**, the end plates **21** being one and one half times the length of plates **20** because the plates in adjacent rows are arranged in staggered formation. The staggered formation, while it is of importance in a commercial mill to prevent circumferential channeling from occurring between the plates, it is not important to the present invention and, if the staggered formation is not utilized, all the plates may be the same size. It is also not important that plates **20** and **21** necessarily be rectangular in shape in that the advantages of the invention may be realized with plates of other shapes and sizes as will be apparent to those skilled in the art.

As indicated in Figs. 2 and 3, plates **20** and **21** are each provided with rib segments **22** and **23**. In the embodiment of the invention illustrated, each rib segment **22** extends diagonally between adjacent edges A and B of plate **20**, or between adjacent edges A′ and B′ of plate **21**. Each rib segment **23** extends diagonally between adjacent edges C and D of plate **20** or between adjacent edges C′ and D′ of plate **21**. The angle of inclination of rib segments **22** relative to one of the

adjacent edges, edge B on plate 20 or edge B' on plate 21, ranges from 10° to 30°; the angle of inclination of rib segments 23 relative to one of the adjacent edges, edge D on plate 20 or edge D' on plate 21, ranges from 10° to 30°. Although in the embodiment illustrated the rib segments extend between adjacent edges of the plates, plates of different sizes and shapes may be utilized within the scope of the invention in which the rib segments thereon extend between opposite edges of such plates.

Each rib segment 23 on a plate 21 or 21 is aligned in adjoining relation to a rib segment 22 of an adjacent plate, which may be a plate 20 or 21. In accordance with the present invention a plate has at least one notch or recess in one of its longitudinally extending edges into which the end portion of a rib segment on an adjacent plate protrudes. In this respect an end portion of a rib is serrated, or tooth shaped, relative to the edge of the plate from which it protrudes. Adjoining end surfaces 22' and 23' of rib segments 22 and 23 are formed generally perpendicular to the longitudinal dimension of the rib segments so that pieces will not be chipped out of the adjoining end portions of the rib segments upon being subjected to wear. In the embodiment of the invention illustrated it is not necessary to make the opposite end surfaces 22'' and 23'' perpendicular to the rib segments since the angle these surfaces make with the rib segments ranges from 60° to 80° and such angle is sufficiently blunt so that it is not likely that pieces will be chipped out of the respective adjoining end portions of the rib segments.

In Fig. 4 there is shown a fragmentary view of a prior art type plate 40 shown in a position which corresponds to the position of plate 20 in Fig. 3. Plate 40 has a corresponding rib segment 42 but instead of being notched or recessed to form a surface thereon corresponding to the surface 22' in Fig. 3, the plate 40 has an end surface 42' on the rib segment 42 which forms an angle between 10° and 30° with rib segment 42. It is seen that the wedge shaped portion W of rib segment 42 has a very thin section and would be easily chipped off when subjected to the severe crushing and abrading action which occurs within the mill during normal operation. A pocket or cavity would then be formed in rib segment 42 and the abrading and scouring action within the mill would soon cause the cavity to be gouged out and enlarged until a portion of rib segment 42 would be entirely eaten away.

Fig. 5 is an enlarged, fragmentary, transverse sectional view through the mill shown in Fig. 1 which shows how a liner plate 20 or 21 is attached to the shell 10 of the mill. Bolt holes 50 are provided in shell 10 and bolt holes 51 provided in plates 20 and 21, through which bolts 53 are inserted, are aligned therewith.

A preferred embodiment of the invention is illustrated and described herein and modifications may be made without departing from the spirit of the invention. The appended claims should therefore not be limited to the precise details of the construction set forth.

It is claimed and desired to secure by Letters Patent:

1. A grinding mill liner formed with a plurality of plates and having an internal working surface which cooperates with a ball charge to effect grinding of a material and having formed on said working surface a series of spirally extending ribs, comprising, a first plate having a rib segment thereon which is inclined to intersect at an angle of not more than 30 degrees with one edge of said plate, and an adjacent plate disposed with an edge thereof adjoining said edge of said first plate having a rib segment thereon aligned in adjoining relation to the rib segment on said first plate, the adjoining end portions of said rib segments being serrated relative to the adjoining edges of said plates, and the adjoining end surfaces of said rib segments being formed generally perpendicular to the longitudinal dimension of said rib segments so that the adjoining end portions of said rib segments will not be chipped off upon being subjected to wear.

2. A grinding mill liner formed with a plurality of plates and having an internal working surface which cooperates with a ball charge to effect grinding of a material and having formed on said working surface a series of spirally extending ribs, comprising a first plate having a rib segment thereon which intersects and forms an angle ranging from 10° to 30° with one edge of said plate, and an adjacent plate disposed with an edge thereof adjoining said edge of said first plate having a rib segment thereon aligned in adjoining relation to the rib segment on said first plate, the adjoining end portions of said rib segments being serrated relative to the adjoining edges of said plates, and the adjoining end surfaces of said rib segments being formed generally perpendicular to the longitudinal dimension of said rib segments so that the adjoining end portions of said rib segments will not be chipped off upon being subjected to wear.

3. A grinding mill liner formed with a plurality of plates and having an internal working surface which cooperates with a ball charge to effect grinding of a material and having formed on said working surface a series of spirally extending ribs, comprising, a plate having a rib segment thereon which intersects and forms an angle ranging from 10° to 30° with one edge of said plate, and an adjacent plate disposed with an edge thereof adjoining the said edge of said first plate having a rib segment thereon aligned in adjoining relation to the rib segment on said first plate, each of said plates being formed with a recess in an adjoining edge into which the end portion of the rib segment on the other plate protrudes and the adjoining end surfaces of said rib segments being formed generally perpendicular to the longitudinal dimension of said rib segments so that the adjoining end portions of said rib segments will not be chipped off upon being subjected to wear.

4. A grinding mill liner for a mill having a container rotatable about a central axis to effectuate grinding action within said container, said liner formed with a plurality of plates having a pair of edges disposed parallel to said central axis and having an internal working surface which cooperates with a ball charge to effect grinding of a material and having formed on said working surface a series of spirally extending ribs, comprising, a first plate having a rib segment thereon which is inclined to intersect at an angle of not more than 30 degrees one of said pair of edges of said plate, and an adjacent plate disposed with an edge thereof adjoining said one edge of said first plate having a rib segment thereon aligned in adjoining relation to the rib segment on said first plate, the adjoining end portions of said rib segments being serrated relative to the adjoining edges of said plates, and the adjoining end surfaces of said rib segments being formed generally perpendicular to the longitudinal dimension of said rib segments so that the adjoining end portions of said rib segments will not be chipped off upon being subjected to wear.

5. A grinding mill liner for a mill having a container rotatable about a central axis to effectuate grinding action within said container, said liner formed with a plurality of plates having a pair of edges disposed parallel to said central axis and having an internal working surface which cooperates with a ball charge to effect grinding of a material and having formed on said working surface a series of spirally extending ribs, comprising a first plate having a rib segment thereon which intersects and forms an angle ranging from 10 to 30 degrees with one of said pair of edges of said plate, and an adjacent plate disposed with an edge thereof adjoining said one edge of said first plate having a rib segment thereon aligned in adjoining relation to the rib segment on said first plate, the adjoining end portions of said rib segments being serrated relative to the adjoining edges of said plates, and the adjoin-

ing end surfaces of said rib segments being formed generally perpendicular to the longitudinal dimension of said rib segments so that the adjoining end portions of said rib segments will not be chipped off upon being subjected to wear.

6. A grinding mill liner for a mill having a container rotatable about a central generally horizontal axis to effectuate grinding action within said container, said liner formed with a plurality of plates having a pair of edges disposed parallel to said central axis and having an internal working surface which cooperates with a ball charge to effect grinding of a material and having formed on said working surface a series of spirally extending ribs, comprising, a plate having a rib segment thereon which intersects and forms an angle ranging from 10 to 30 degrees with at least one of said pair of edges of said plate, and an adjacent plate disposed with an edge thereof adjoining said one edge of said first plate having a rib

segment thereon aligned in adjoining relation to the rib segment on said first plate, each of said plates being formed with a recess in an adjoining edge into which the end portion of the rib segment on the other plate protrudes and the adjoining end surfaces of said rib segments being formed generally perpendicular to the longitudinal dimension of said rib segments so that the adjoining end portions of said rib segments will not be chipped off upon being subjected to wear.

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