April 24, 1956 A. C. DAMAN 2,743,060

BALL MILL WITH RISERS ON LINERS TO THROW BALLS AND OVERSIZE MATERIAL TOWARDS FEED END OF MILL AND TO PROGRESS SMALLER BALLS AND FINE MATERIAL TOWARDS DISCHARGE END OF MILL

Filed Nov. 12, 1954 2 Sheets-Sheet 1

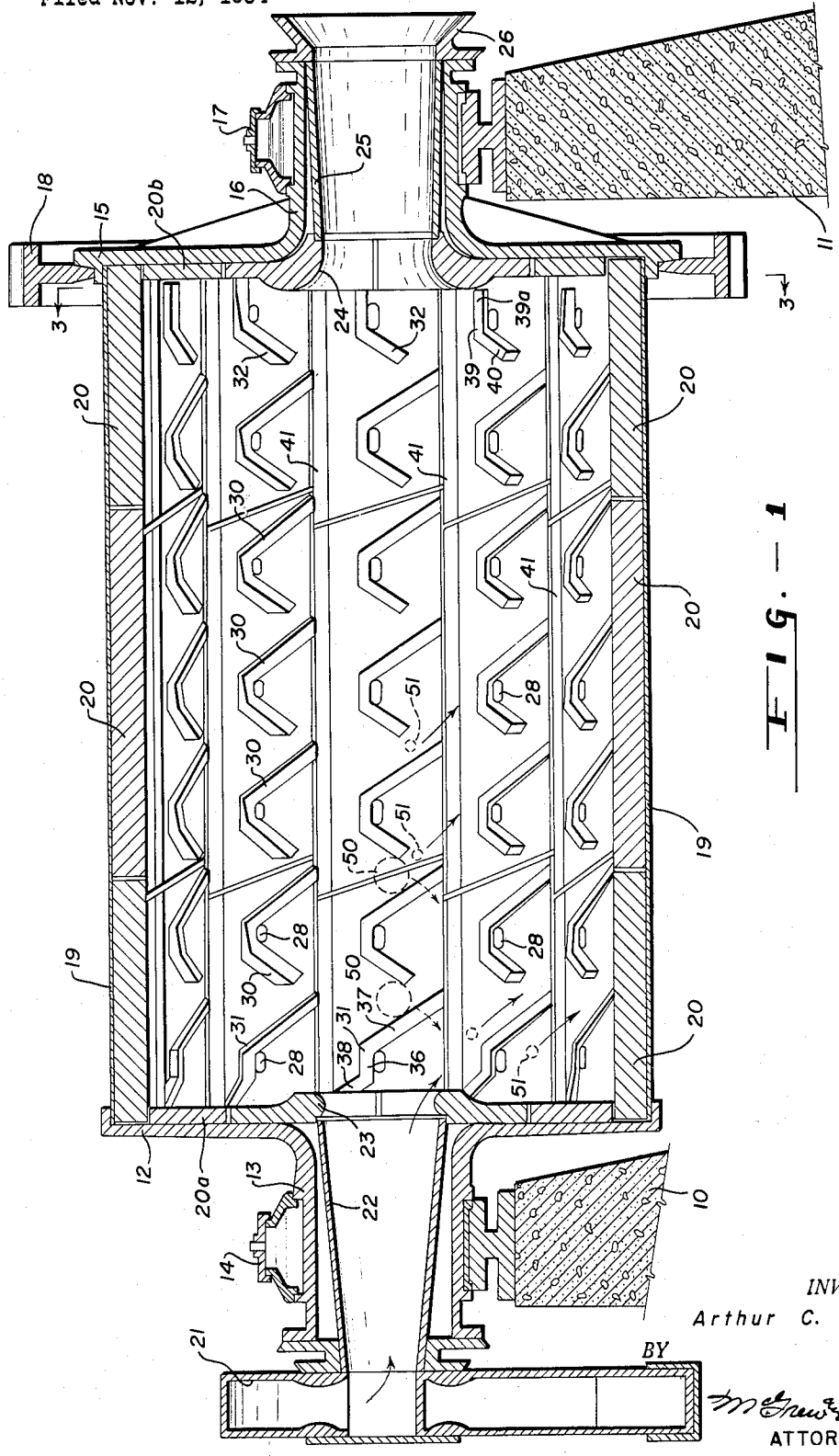


FIG. — 1

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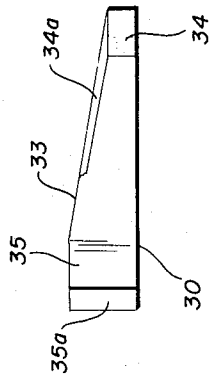


FIG. — 4

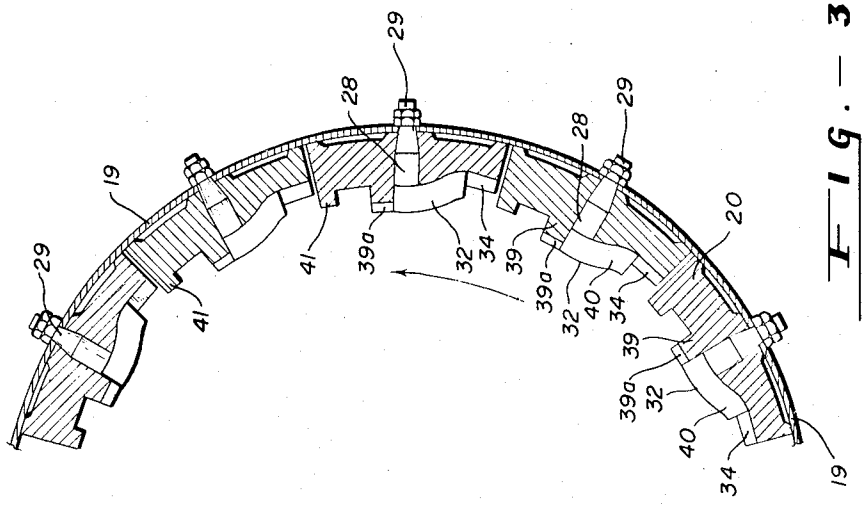


FIG. — 3

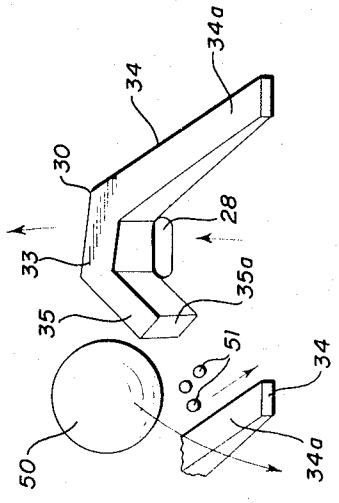


FIG. — 2

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BALL MILL WITH RISERS ON LINERS TO THROW BALLS AND OVERSIZE MATERIAL TOWARDS FEED END OF MILL AND TO PROGRESS SMALLER BALLS AND FINE MATERIAL TOWARDS DISCHARGE END OF MILL

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8 Claims. (Cl. 241—183)

This invention relates to ball mills, and more particularly to the liner or liners of ball mills which are preferably detachably connected to the inner surface of the shell or drum portion of the mill.

Included among the objects and advantages of the present invention is an improved liner arrangement for ball mills which serves to throw the balls, together with oversize feed material, toward the feed end of the mill while permitting the progressive movement of fine material and smaller balls through a series of restricted passages to the discharge end of the mill. The improved liner arrangement includes a plurality of lifter members which may be varied in their spacing on the liner member to provide a predetermined size opening between the members for the passage of fine material. The lifter members are arranged and proportioned to protect the bolt holes in the liner section. The arrangement and shaping of the liner sections and lifter members causes a crisscross counter flow action of the material and the balls within the mill.

These and other objects and advantages may be more readily ascertained by referring to the following description and appended drawings in which:

Fig. 1 is a vertical longitudinal section, through a ball mill according to the present invention;

Fig. 2 is a fragmentary detail of the lifter members illustrating the crisscross arrangement of the ball and the material;

Fig. 3 is a fragmentary cross sectional view of a portion of the shell and liner arrangement illustrating the lifters and the arrangement thereof in relation to the rotation of the drum; and

Fig. 4 is an elevational view of a lifter according to the arrangement illustrating the height of various portions of the lifter above the liner.

Referring to Fig. 1 of the drawings, **10** and **11** represent, respectively, concrete mill beds or foundations for a ball mill at the feed and discharge end thereof. A ball mill feed head **12** has its hub **13** journalled for rotation in a bearing **14**. The discharge head **15** has its hub **16** journalled for rotation in a bearing **17**. A ring gear **18** is secured to the discharge end **15**, and power is applied thereto for rotating or operating the grinding mill.

A shell **19** is secured to the heads **12** and **15**, forming the drum portion of the ball mill. A sectioned liner **20** is secured to the shell **19** to complete the main portion of the assembly. A feed scoop member **21** feeds a frusto-conical sleeve **22**, located within the hub **13**, and which is in communication wth the interior of the mill. Material to be ground and grinding balls are fed by the scoop member through the sleeve into the mill. The end of the mill, adjacent the head **12**, is provided with an end liner **20***a* having a central opening **23** providing communication from the sleeve **22** to the interior of the mill.

The discharge end of the mill is provided with a liner **20***b*, abutting the discharge head **15**, which is provided with a central opening **24**. A sleeve member **25** is secured within the opening **24**. The central opening **24** communicates with the sleeve **25** through which exhausts material from the ball mill. The sleeve **25** terminates at its outer end in a discharge spout **26**. The various sections of the liner **20** of the mill are secured to the shell **19** by means of a series of spaced bolt holes or openings **28**, which receive and support the bolt nut assemblies, as illustrated in Fig. 3. The bolt nut assemblies **29** secure the liner sections to the shell **19**.

The parts heretofore described are more or less conventional in ball mills, and the assembly of the conventional parts is more or less standard practice.

In accordance with the present invention, the liner sections or plates **20** are provided with a plurality of main lifter or riser members **30** spaced apart, in the central portion of the ball mill. Feed end lifters or risers **31** are provided at the feed end of the ball mill, and discharge end lifters or risers **32** are provided at the discharge end thereof. The lifters **30** are generally of the shape of rectangular hooks. The lifter **30** comprises a central sloping section **33**, which is substantially longitudinally aligned with the drum, a tapered tail or long leg portion **34**, which is extended at an angle to the longitudinally aligned sections **33**, and a head or short leg portion **35** which is, likewise, set at an angle to the longitudinally aligned sections **33**. The short and long legs are angularly extended away from the direction of drum rotation. The tail section **34** is tapered from its large end where it connects the section **33** to a small end **34**, and the upper surface **34***a* is slightly tapered from the outside to the insde thereof. The head **35** has an end **35***a* which is on a bias to the longitudinal section **33**. A riser **30** is positioned so as to be in front of each bolt hole **28**, in relation to the rotation of the ball mill.

The riser **31** is constructed similarly to the riser **30**, and it includes a central sloping portion **36** that extends longitudinally along the shell of the liner, a tapered long leg portion **37** extending from the longitudinal portion at an angle thereto along the shell, and a head portion **38** which extends at an angle from the section **36**, on the opposite side of the tapered section **37**. The long leg **37** is angularly extended from the portion **36** away from the direction of rotation, but the short leg **38** extends angularly into the direction of rotation. The short leg **38** tends to keep grinding balls and material away from the liner **20***a*. The riser **32** comprises a portion **39** that extends longitudinally along the liner of the ball mill, which portion is tapered from the feed end toward the discharge end. A head end **40** is secured to the longitudinal section **39** and it extends at an angle downwardly from the longitudinal section. The upper surface **39***a* of the riser **32** slopes from the feed to the discharge end thereof. This riser **32** tends to throw ground material toward the discharge and the balls toward the feed end.

As illustrated in detail in Fig. 2, the risers provide passages for longitudinal distribution of material and the balls in the ball mill. The short leg **35** which is of greater thickness than the long leg **34** tends to throw balls which are of a larger diameter than the width of the passage between the short leg **35** and the next adjacent long leg **34**, toward the feed end. Material which is smaller than the distance between the short leg and its next adjacent long leg tends to move toward the discharge end. For example, a ball **50** which has a diameter greater than the distance between the long leg **34** and its next adjacent short leg **35**, is thrown back toward the feed end over surface **34***a*, as indicated by the arrow, where the movement of the riser **30** is upward, as indicated by arrows near the riser. Small particles **51** pass through the passage between the short leg **35** and the long leg **34** so that they are actually moved toward the discharge end of the ball mill. Material of small size and small balls, therefore, move from the feed end to the discharge end

of the mill. The risers are spaced apart to provide the restrictive passage therebetween, and the width of the passages may be changed from the feed to the discharge end to perform various types of grinding. The width of the passages may, for example, be progressively narrowed from the feed to the discharge end. The short leg of the risers tends to throw large balls back to the feed end of the mill, while the restrictive passage permits small material to move toward the discharge end of the mill. If it is desired, in the charging of the ball mill, small balls may be introduced at the discharge end and the large balls may be introduced at the feed end, although it is possible and satisfactory to introduce both small and large balls at the feed end of the mill along with material to be ground. In either case, the large balls tend to stay toward the feed end of the mill while the smaller balls work their way to the discharge of the mill. Oversize material tends to travel toward the feed end, similarly to the balls, and the smaller material tends to travel toward the discharge end. Thus, a crisscross, counterflow movement of the finer material and finer balls is achieved in relation to the larger balls and larger material to be ground.

The plates or sections **20** are provided with longitudinal ridges **41** at one end thereof to aid the grinding action of the balls on the material in the mill. The ridges increase the height of the cascade and increases grinding efficiency.

While the risers have been shown of a particular shape, that is, with one short leg and one long leg, it is obvious that by changing the configuration of the risers, various grinding actions may be obtained and various types of grinding may be accomplished. Further, the change of spacing of the risers in the ball mill will provide various grinding actions. The risers **31** tend to keep the balls and large material away from the liner **70***a* on the end of the ball mill, likewise the risers **32** aid in maintaining the balls away from the liner end **20***b* on the discharge end. It is to be understood further that the liner sections or plates **20** together with the reflective flanges **41** secured thereon, the lifter members and the angle parts may be formed from any suitable and desirable material, for example, ferrous metal, steel, rubber, or the like.

While the invention has been illustrated with respect to a specific embodiment, there is no intent to limit the invention to the particular details so illustrated, except insofar as set forth in the following claims.

I claim:

1. A sectional liner for crushing mills utilizing balls or the like as a crushing medium comprising a plurality of liner members mounted on the face of said mill, and being shaped for cooperative positioning within said mill to shield the inner surface of the mill from destructive abrasion, raised flanges at spaced positions on the inner material crushing surfaces of said members, raised portions extending from the terminal ends of said flanges toward but out of contact with adjacent portions, one of said raised portions being at least about as high as said flange and extending outwardly at an angle thereto, the other said raised portion being tapered downwardly and extending outwardly from the opposite end of said flanges, whereby to provide helically aligned passages therebetween, said passages being of sufficient dimension to provide for the free flow of small sized particles toward the discharge end of said mill, while preventing the passage of crushing balls and particles larger than the dimensions of said passage through the same toward the feed end.

2. Structure in accordance with claim 1 wherein the liner members, flanges and raised portions are formed of ferrous metal.

3. Structure in accordance with claim 1 wherein the liner members, flanges and raised portions are formed unitarily of steel.

4. Structure in accordance with claim 1 wherein the liner members, flanges and raised portions are formed selectively of rubber.

5. A sectional liner for rotary crushing mills utilizing balls or the like as a crushing medium comprising a plurality of curved liner members mounted on the inner surface of said mill, said members being shaped for cooperative positioning within said mill to shield the inner surface of the mill from destructive abrasion, raised flanges on the inner material crushing surfaces of said members at spaced positions, raised portions extending from the terminal ends of said flanges toward but out of contact with adjacent portions, said passages being of sufficient dimension to provide for the free flow of small sized particles therethrough toward the discharge end of said mill while preventing the passage of crushing balls and particles larger than the dimensions of said passage and through the same toward the feed end of the mill, said liner members being provided with openings therethrough in positions adjacent said flanges and raised portions on the side of said flanges opposite the direction of rotation of said mill, and fastening means for insertion through said openings for securing said liner members to the inner surface of said mill.

6. A sectional liner for crushing mills utilizing balls or the like as a crushing medium comprising a plurality of curved liner members mounted on the inner surface of said mill, said members being shaped for cooperative positioning within said mill to shield the inner surface of the mill from destructive abrasion, raised substantially V-shaped flanges on the inner material crushing surfaces of said liner members at spaced positions arranged to align adjacent flanges in a plurality of directions, the legs of said flanges extending toward but out of contact with the legs of adjacent flanges to provide helically aligned passages therebetween, said passages being of sufficient dimension to provide for the free flow of small sized particles therethrough toward the discharge end of said mill while preventing the passage of crushing balls and particles larger than said dimensions and throwing the same toward the feed end of the mill, and said flanges being spaced circumferentially apart a distance circumferentially sufficient to allow the crushing balls to come into contact with the inner crushing surface of said liner members to effect particle size reduction of the material charged into the mill.

7. A sectional liner for rotary crushing mills utilizing balls or the like as a crushing medium comprising a plurality of curved liner members mounted in said mill, said members being shaped for cooperative positioning within said mill to shield the inner surface of the mill from destructive abrasion, raised V-shaped flanges on the inner material crushing surfaces of said liner members at spaced positions arranged to align adjacent flanges in two directions, said flanges being tapered from one terminal end to the other end thereof, the terminal ends of said flanges extending toward but out of contact with the adjacent flanges to provide helically arranged passages therebetween, said passages being of sufficient dimension to provide for the free flow of small sized particles therethrough toward the discharge end of said mill while preventing the passage of crushing balls and particles larger than said dimension and throwing the same toward the feed end of said mill, and said flanges being spaced circumferentially apart a distance sufficient to allow the crushing balls to come into contact with the inner crushing surface of said members to cause particle size reduction of the material charged into the mill.

8. A sectional liner for rotary crushing mills utilizing balls or the like as a crushing medium comprising a plurality of curved liner members mounted in said mill and shaped for cooperative positioning within said mill to shield the inner surface of the mill from destructive abrasion, raised V-shaped flanges on the inner material crushing surfaces of said liner members at spaced positions arranged to align adjacent flanges in a plurality of direc-

tions, the terminal ends of said flanges extending toward but out of contact with the adjacent flanges to provide helically arranged passages therebetween, said passages being of sufficient dimension to provide for the free flow of small sized particles therethrough toward the discharge end of said mill while preventing the passage of crushing balls and particles larger than the dimensions of said passages, a projecting rib on the leading edge of said liner members out of contact with said flanges, said flanges and

said projecting ribs being spaced apart each from each a distance sufficient to allow the crushing balls to come into contact with the inner crushing surface of said members to cause further particle size reduction of the materials charged into the mill.

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