D. J. NEVILL.
CONSTRUCTION OF TUBE MILLS AND LININGS THEREFOR.
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3 SHEETS—SHEET 2.

Witnesses.

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Aug. 4.
To all whom it may concern:

Be it known that I, DAVID J. NEVILL, a subject of the King of Great Britain, residing at No. 658 Emerson street, in the city of Denver, county of Denver, and State of Colorado, have invented certain new and useful Improvements in the Construction of Tube-Mills and Linings Therefor; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to grinding mills and has special reference to that type which is generally known as a tube mill, in which a mass of balls or pebbles are agitated by the rotation of the shell or tube to produce the grinding of the material fed through the tube.

The aim of the invention is to provide a lining for such a mill having the advantages to be hereinafter enumerated.

The invention further contemplates means for securely fastening the lining in place, said means being effective throughout the entire life of the lining.

The most common type of lining for tube mills consists of cast iron or steel plates having grooves running longitudinally of the shell of the mill. Some of the pebbles generally used to accomplish the grinding are forced or wedged in the grooves by the pounding action of the mass of material, and therefore afford an excellent wear resisting surface. A lining composed mainly of silex pebbles wedged in place, as intimated, has been found in practice to be less expensive and lighter than a lining of cast iron or steel, and its resistance to wear greater than iron or steel. It is therefore advantageous to use a backing of as little iron or steel as possible and a large percentage of silex pebbles.

The present invention provides means whereby the iron or steel backing can be made much lighter than heretofore and at the same time reinforced and strengthened and rendered capable of efficiently standing the wedging action of the pebbles as they are hammered by the tumbling material. Broadly, this means consists of circumferential reinforcing ribs running transversely of the teeth which form the longitudinal grooves heretofore referred to. This reinforcement is shown in Fig. 2 of the drawings. Further use of such reinforcing and strengthening ribs will appear as the specification proceeds. Heretofore the linings of the shells have been held in place by means of bolts or other securing means which, when worn to a certain degree, became ineffective and allowed the lining to loosen and become separated from the shell. In accordance with the present invention, the backing or metal lining is secured in the shell by wedging or keying the segments of the lining in place against the shell so that the wedging means will remain effective until the lining is completely worn out, thereby insuring that the lining will be efficiently held in place as long as the lining lasts.

The invention is illustrated in the accompanying drawings, but various modifications and changes can be made without departing from the spirit or scope of the invention, as defined in the accompanying claims.

In the drawings:—Figure 1 is a longitudinal section of a tube mill provided with a lining constructed according to the invention; Fig. 2 is a transverse section taken on line 2—2 of Fig. 1; Fig. 3 is a modification showing the circumferential rib located at a different point in the length of the longitudinal teeth; Fig. 4 is a broken detail view showing the manner of wedging the lining segments in place; Fig. 5 is an end view of the construction shown in Fig. 4; Fig. 6 is a sectional view taken on the line 6—6 of Fig. 4; Fig. 7 illustrates in detail a top and side view of the wedge employed; Fig. 8 is a broken view illustrating the manner of placing the lining sections in the shell; Fig. 9 is an enlarged transverse section of the mill showing the manner of dividing the lining sections into segments; Fig. 10 is a longitudinal section of a mill provided with a lining in which the transverse or circumferential ribs are used to convey the larger particles and pebbles toward the feed end of the mill; Fig. 11 is a modification showing a
different method of producing the conveying action depicted in Fig. 8; Fig. 12 is a perspective end view of the construction shown in Fig. 11.

Referring to the drawings in which similar reference characters designate corresponding parts throughout the several views, the numeral 1 denotes the usual shell or casing of the mill suitably carried by the end heads 2 which are provided with trunnions 3 journaled in bearings 4 carried by the journal boxes 5. The standards which support the journal boxes 5 are not shown. The mill is rotated in any suitable manner, such as by means of a gear 6 adapted to mesh with a driving pinion (not shown).

The shell 1 is provided with a cast iron or steel lining 7 which, in the broad aspects of the invention, consists of longitudinal teeth 8 forming therebetween a plurality of grooves or recesses 9 into which the grinding pebbles or balls are wedged by the tumbling material to form a wear resisting surface of the grinding material itself. To reinforce the longitudinal teeth 8, a plurality of circumferential ribs 10 running transversely of the teeth 8 are provided. In the preferred construction, the lining is made up of a plurality of sections, each section having the longitudinal teeth 8 and a transverse rib 10 preferably formed integrally with the teeth 8 as best shown in Fig. 8. If desired, the transverse ribs 10 may be formed intermediate the extremities of the longitudinal teeth 8, as shown in Fig. 3, instead of at the ends thereof, as described. In Figs. 3, 4 and 8 the longitudinal teeth 8 are shown tapering. In such a construction, the teeth 8 form pockets of varying width and therefore pebbles of varying sizes may be lodged between them. The result is that such a lining will be filled with pebbles much sooner than one in which the teeth are made parallel. In the latter case, the pebbles which are too large to be accommodated between the teeth have to be tumbled around in the mill until they are sufficiently worn to fit the pockets.

The lining sections are secured in the casing or shell 1 as follows:—The sections are preferably made segmental, as shown in 9, preferably three segments being used which are expanded circumferentially and forced against the shell 1. This is accomplished by shaping the adjacent extremities of the segments to form key ways 11 and providing a key 12 shown in detail in Fig. 7, which is adapted to be forced into the key-way 11 and thereby expand the lining circumferentially. Each section of the lining may be divided into the desired number of segments and each section clamped in place by forcing the keys between the adjacent extremities of the segments, as clearly shown in Figs. 8 and 9. The keys or wedges 12 are adapted to lie flat against the shell 1 and are preferably positively held against lateral movements by extra thicknesses of metal forming flanges 13 directed over the face of the keys or wedges. These flanges are preferably cast integral with the lining sections, as clearly shown in Figs. 4 and 6.

When the foregoing construction is used, the lining is assembled as follows: Commencing at each end of the shell and working toward the center, the extreme end rings or sections are first positioned with the ribs adjacent the end heads 2 and the unconnected ends of the teeth facing the center of the mill, as shown in Fig. 1. The following sections are successively positioned with the rib of each section adjacent the unconnected ends of the teeth of the preceding section. Each section, of course, is expanded into final position by the wedging means described before the following section is positioned. When the ring sections meet at a central part of the mill, it is obvious that the two sections last positioned will meet, as shown in Fig. 8, with the unconnected ends of the teeth 8 facing each other. This closing joint may be keyed as follows: Due to the limited space between the adjacent key ways, relatively short keys 14 and 15 are successively driven in place. To prevent the keys 14 and 15 from backing out and to fill the space left between the adjacent edges of the keys 15, suitable filling blocks 16 may be filed down to size and forced into place between the teeth.

Tube mills are used for two classes of work; first for fine grinding where all of the material is to be ground to a slime; second, for grinding where a granular product without excessive amounts of fine material is required for use on concentrating tables and the like. In the case of coarse or granular grinding, the cylindrical tube mill has not been successful, due to the fact that a mixed feed of fine and coarse material in its journey from the feed end of the mill to the discharge end receives the same treatment, and consequently, while the coarser material is being reduced to the proper size, the finer is being ground too fine. To obviate this difficulty and produce a uniform product, the transverse ribs are employed to retard the movement of the coarser material toward the discharge, thereby subjecting the coarser particles to more grinding action than the finer particles. This is accomplished as shown in Fig. 10, the transverse ribs 10" being obliquely set so that the juxtaposition of the sections of the lining will cause the ribs to form a helical conveying groove, as shown.
in Fig. 10. The ribs 10' are made to project slightly above the level of the teeth edges, the amount of such projection preferably gradually increasing as the ribs approach the feed end of the mill (Fig. 10). Due to the centrifugal force caused by the rotating shell, the coarser material and larger pebbles will travel in closer proximity to the lining than the finer material. The coarser material and the larger pebbles will, therefore, be conveyed by the helical groove toward the feed end of the mill where the larger grinding particles will act on the larger particles to be ground. This movement of the coarser material causes a counter-movement of the finer material at the surface toward the discharge end. The result is a segregation of the coarser material at the feed end where it is acted on by the coarser pebbles, the material becoming finer and the pebbles smaller as they approach the discharge end, as represented in the drawing. The finer material being in contact with the finer grinding pebbles or balls and being discharged sooner than the coarser material, will obviously be subjected to less grinding action.

Figs. 11 and 12 show a modification of the construction in Fig. 10 to produce the same result. In accordance with this phase of the invention, conveyor blades inclined with respect to the axis of the mill may be employed which project beyond the surface of the lining. In the form shown in Figs. 11 and 12, the transverse ribs lie in planes perpendicular to the axis of the mill, as in the case of the lining shown in Fig. 1, but the teeth are all inclined to the axis of the mill. The longitudinal teeth 8' are inclined, but adapted to retain some of the grinding material wedged and forced therebetween, as previously described. Certain of these teeth, such as 8", are made to project beyond the level of the teeth 8' and when the sections are positioned in the shell, the extremities of the projecting teeth 8'' of adjacent sections are preferably made to register to form a continuous conveyor, as shown in Fig. 11, although this is not essential. The projecting teeth 8'' serve as the inclined conveyor blades referred to, which, during the rotation of the shell, act to lift the material and at the same time, deflect it toward the feed end of the mill. Such a construction has the advantage, among others, of keeping the body of material well agitated and promoting internal movements in the material whereby the grinding is assisted.

From the foregoing, it will be seen that the transverse ribs reinforce the lining, permit it to be of light construction but well adapted for holding the silex pebbles which are forced and wedged between the teeth, the transverse ribs acting to bind the teeth together, and reinforce them against the wedging action of the pebbles. The reinforcing ribs also serve as means for preventing breakage of the lining when positioning the same.

It will be obvious from the description of the wedging or keying means that the same will remain effective until the lining is completely worn out. The extra thickness of metal 13 over the wedge gives the lining at this point a greater life than elsewhere, thus tending to maintain the efficiency of the joint until the rest of the plate is worn out.

What I claim is:

1. In a grinding mill, a shell or casing, a lining therefor comprising a plurality of juxtapositioned sections, each section comprising a plurality of segments provided with longitudinal teeth and a transverse reinforcing rib, and means to expand said segments circumferentially in said shell or casing, said means comprising wedge shaped keys adapted to be inserted in position laterally of the sections and having their outer faces substantially flush with the outer surface of the lining sections.

2. In a tube mill, a lining comprising a plurality of circumferential segments the adjacent edges of which form key ways, and wedge shaped keys adapted to be inserted in said key ways, said segments being provided with flanges directed over the wedge shaped keys, substantially as described.

3. In a tube mill, a lining comprising a plurality of circumferential segments the adjacent edges of which form key ways, and wedge shaped keys adapted to be inserted in said key ways the outer and inner surfaces of said keys being substantially flush with the outer and inner surfaces respectively of the segments, and said segments having flanges directed over the inner faces of said keys.

4. In a tube mill, a lining provided with longitudinal teeth and means projecting beyond the level of the inner edges of said teeth to convey the coarser material toward the feed end of the mill.

5. In a tube mill, a lining provided with longitudinal teeth and members projecting beyond the level of the inner edges of the teeth and inclined to the longitudinal axis of the mill to convey the coarser particles of the contents of the mill toward the feed end thereof.

6. In a tube mill, a lining composed of a plurality of sections arranged in a helical series, each of which has a plurality of longitudinal teeth and a transverse reinforcing rib.

7. In a tube mill having a rotary grinding drum, a lining for the drum provided with
inwardly projecting ribs, certain of said ribs extending farther inwardly toward the center of the mill than others to convey the coarser particles of the contents of the mill toward the feed end thereof.

8. A lining section for the drum of a grinding mill, comprising a backing having a transverse rib and longitudinal teeth, some of said teeth extending above said rib and said rib and teeth forming pockets open on the side of the section opposite said rib.

In testimony whereof I affix my signature, in presence of two witnesses.

DAVID JACK NEVILL.

Witnesses:
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