Sept. 11, 1928. 1,684,366

S. H. DOLBEAR

METHOD OF TREATING ASBESTOS ORES

Filed June 3, 1924 2 Sheets-Sheet 1

Fig. 1

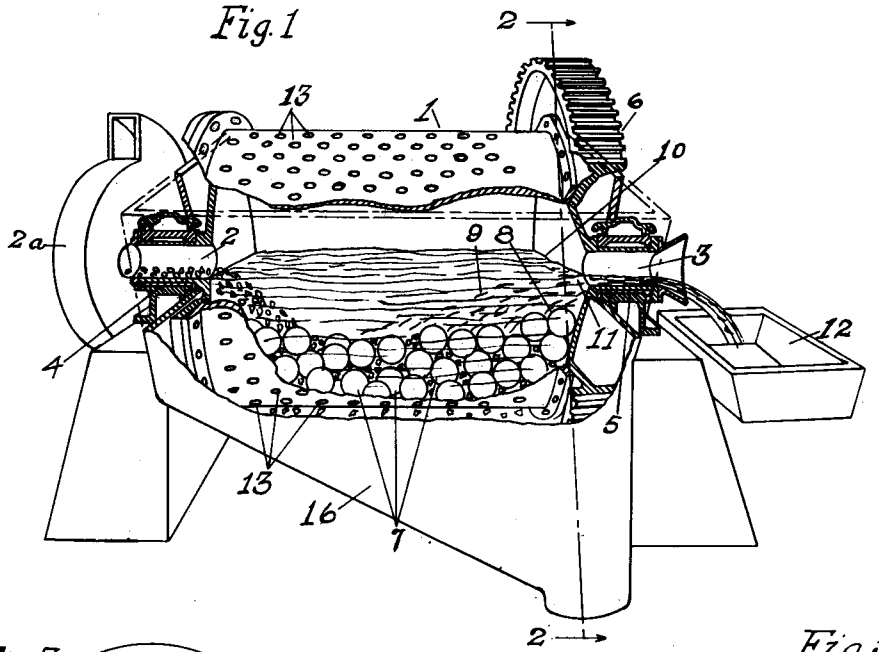


Fig. 3

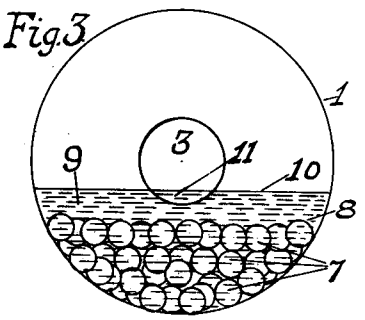


Fig. 4

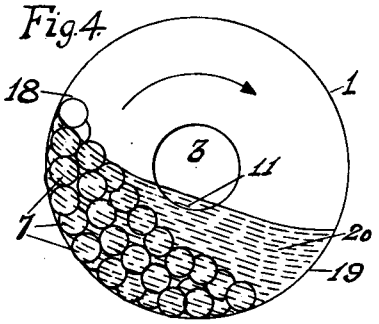
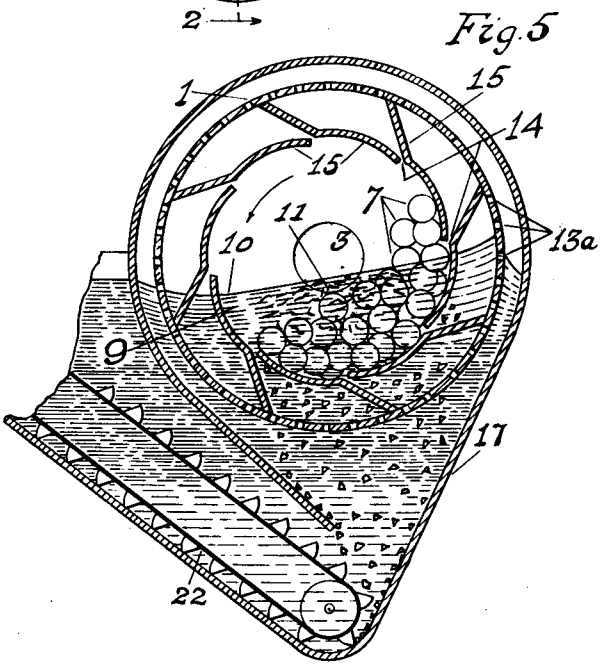


Fig. 5



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Fig. 2

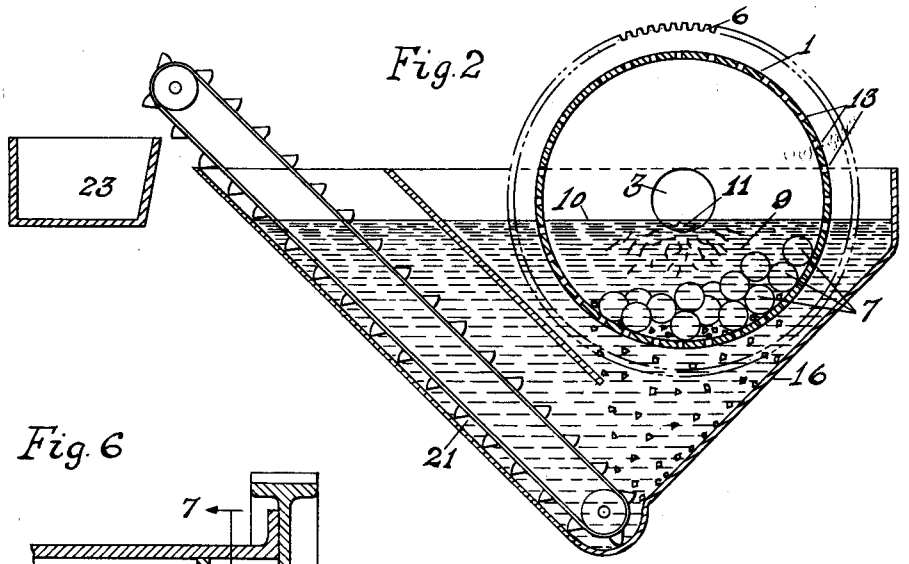


Fig. 6

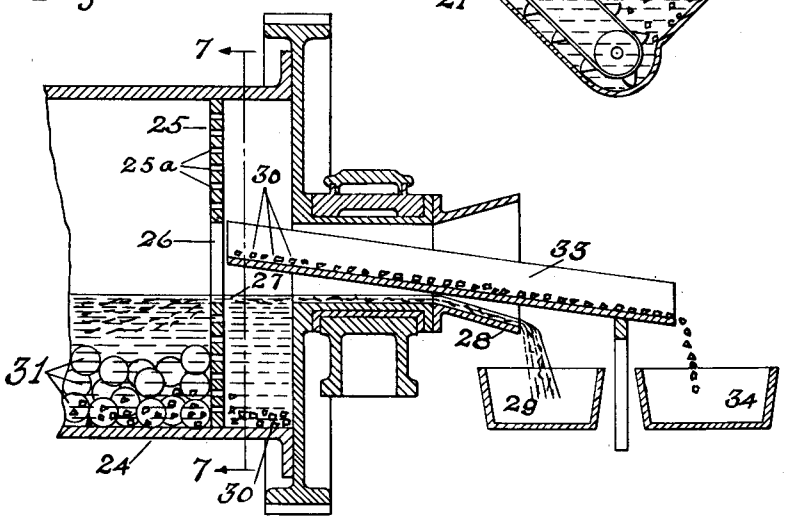
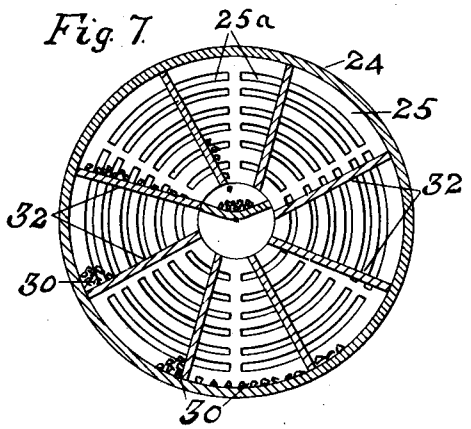


Fig. 7



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Patented Sept. 11, 1928. 1,684,366

UNITED STATES PATENT OFFICE.

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METHOD OF TREATING ASBESTOS ORES.

Application filed June 3, 1924, Serial No. 717,556, and in Canada November 11, 1922.

This invention primarily relates to methods of treating asbestos ores; it involves a procedure by which the ore is suitably reduced (as by grinding) and concentrated; and it contemplates the successive reduction of the ore and the separation of its fibrous component (uncrushed) from its rocky component.

The primary object of the invention is to provide a simple and effective method of treating ore by which its fibrous portions are separated from its rocky portions without destructive breakage of or damage to the fibers.

The present-day practice in most, if not all, asbestos plants is to crush the ore, while in a dry condition, in mills of the so-called "cyclone" and other high velocity types. Therein, a very considerable breakage of fibers results, with consequent loss because the commercial value of asbestos, (as quite generally recognized in the art) is largely dependent upon the length of the recovered fibers, the longer fibers being much more valuable than the shorter.

I have discovered, and the present invention is based upon the discovery, that by suitably treating asbestos ore while submerged in water so as to effect the detachment of asbestos from the associated rocky matter, at the same time avoiding as far as possible the complete separation of the asbestos into its smaller subdivisions or integral fibers, the destructive action on the fibers may be avoided. In other words, if the asbestos is detached from the associated rocky matter under water, and is partly opened or fluffed, at the same time being given freedom of movement, that the asbestos will move out of contact with the detaching means and may be maintained out of contact therewith until recovered. Freedom of movement of the asbestos away from the detaching instrumentalities is essential to the practice of this invention, as is also the maintenance of the fiber out of contact with such instrumentalities until recovered. The fiber may be so maintained by agitating the water in which it is submerged.

Any appropriate type of apparatus may be utilized for practising my improved method; but such types as ball-mills, rod-mills, pebble-mills, and other similar types employing a shell or casing and freely movable rolling or grinding elements working therein and capable of being operated with such elements submerged in a fluid, such as water, are well adapted for the purpose and, more especially, the ball-mill.

I am aware that it has heretofore been proposed to treat asbestos ore by pulverizing it in a stamp-mill operating in a body of water, the fibers of the mass—or some of them—floating out of the zone of action of the stamp. In the very nature of this type of apparatus there would be of necessity breakage of the fibers by the impact of the heavy stamp, the weight of which ordinarily runs from 750 to 2250 pounds.

Furthermore, stamp mills, are particularly unsuited to my use as they confine the asbestos in contact with the bed block or mortar, preventing its freedom of movement, and causing the associated rock to cut the fiber. The stamping action also pulverizes the ore. A desideratum in my invention is to avoid pulverizing the ore, in so far as possible, the ore being treated only sufficiently to detach the fiber from the rock, and to loosen the fiber mass to an extent necessary to give it buoyancy in water. When the rock is pulverized in the presence of fiber, unnecessary crushing is done, and the pulverized material tends to discolor the fiber. Furthermore, pulverent rock is carried with the fiber, thereby increasing the equipment required for and the cost of subsequent treatment for separation of the two.

My invention is differentiated from stamp mill action in that, in the mill which I employ—such as the aforementioned ball-mill—the fiber is detached and partly opened by the relatively gentle impact of the balls. Where the stamp type of mill is used, if the stamp, at its lowest point of drop, were submerged in water, the fiber freed by the blow thereof would remain under the stamp and be beaten into short lengths, not only by the impact and pressure of the stamp itself but also by reason of its being subjected to the cutting action of associated pieces of rock. These are serious objections, resulting in short length fiber, and which objections, are overcome in a mill such as I contemplate utilizing in the practice of my method.

In carrying out the procedure contemplated by my invention, it is important—in fact, quite essential—that the mill be so operated as to house a pool of liquid, such as water, and in which pool the detached asbestos (resulting from the action of the detaching elements on the asbestos mass) may readily pass

out of contact with such elements. Preferably, in order to achieve the desired results, a portion of the grinding or detaching elements usually employed in these mills is omitted—that is, a fewer number of them than usual are used—so that, when the mill is at rest, the water-level therein will be above the plane of the bed of balls. Such a pool, or free-water zone, may also be provided by rotating the mill at a speed sufficient to cause the mass of the ball-load at one side to be lifted up on one side of the shell and above the water-level and its opposite side to be considerably submerged below the water-level on the opposite side of the shell.

In the accompanying drawings, I have shown the proposed preferred type of apparatus for practising my invention; but in thus illustrating it as a part of the disclosure thereof, I wish particularly to say that I am not to be understood as limiting the invention thereto nor in that connection.

In these drawings:

Figure 1 is a view in perspective of a ball mill adapted for practising my method, a portion of the shell being broken away to show its internal construction and its contents;

Fig. 2 is a view in vertical transverse section thereof, on the line 2—2, Fig. 1;

Fig. 3 is a diagrammatic view in elevation of the shell of the mill of Figs. 1 and 2, showing the normal position of rolling elements therein when at rest;

Fig. 4 is a similar view but showing the rolling elements in the position they occupy when the mill is rotated at sufficient speed to cause them to be shifted from their normal position when at rest;

Fig. 5 is a view in vertical transverse section, and more or less diagrammatic, of a modified type of mill;

Fig. 6 is a fragmentary view in vertical longitudinal section, and more or less diagrammatic, of still another type of mill; and

Fig. 7 is a view in vertical transverse section, on the line 7—7, Fig. 6.

Referring to these drawings, and to Figs. 1, 3 and 4 thereof, the reference-character 1 designates a shell or casing forming a component of the mill and having an intake or port 2 at one end—in the form of a rotating feed-scoop 2^a—and a discharge or port 3 at the opposite end. The shell is supported at 4 and 5 for rotation on a horizontal axis, and its driven by a gear 6 which is connected to a suitable prime-mover (not shown).

Within the shell are freely movable grinding or detaching elements, shown in this instance as balls 7, these being in number sufficient only to reach to a level 8 under normal conditions. The balls may be of any required type and dimensions for the purposes to be accomplished.

A fluid 9—in this instance indicated as water—is contained within the shell and in quantity normally sufficient to reach to a level indicated at 10, and forming a fiber-floating pool 11, this being considerably higher than the level 8 of, but above, the bed of rolling balls, and somewhat above the plane of the bottom of the discharge opening 3. The water is introduced into the shell at the scoop-end, and a certain predetermined quantity thereof (with its liberated fibrous mass) discharges through the opening 3 into a suitable receptacle, such as a fiber-launder 12.

Preferably and as shown, the rocky mass—gangue—when reduced sufficiently will pass through perforations 13 (in the form of structure shown in Fig. 1); and which perforations open into a rock-gangue-launder 16 by which the shell is maintained submerged in the separating liquid. Thus, a peripheral discharge of the gangue is effected while the bouyant asbestos is discharged axially off the shell, as at 3. In consequence, I provide for the discharge of the buoyant mass at a level different and removed from the plane of discharge of the heavier gangue. This effects a separation of the masses. In some instances, it may be desirable to locate the perforations 13 adjacent the discharge end, only, of the mill so as to increase the length of time that the material remains in the mill and subject to the action of the rolling elements. It is to be understood that the number of these perforations, their distance from the feed end, etc., may be varied to meet the particular conditions prevailing.

In the structure shown in Fig. 5, the gangue passes through slots 14 formed between equidistantly spaced wearing-plates 15, and which slots communicate with perforations 13^a which open into a housing 17 in which the shell 1 is mounted and which housing contains a body of liquid in which the shell is submerged.

Hence, where, as here, there is a peripheral discharge of a portion of the contents of the shell, the latter is submerged (partly or completely) in the separating fluid, so that the field of action of the rolling elements is under water. It will be understood that the perforations 13 (Fig. 1) and the slots 14 (Fig. 5) are of such size as to permit passage therethrough of certain amounts of the ground rock, while the oversized pieces are re-deposited in the field of action of the balls in the course of rotation of the shell, and eventually reduced to perforation-passing dimensions.

Preferably and as shown, the gangue is removed from the bottom of the tank 16 (Fig. 2) and the housing 17 (Fig. 5) by an elevator 21 (Fig. 2) and 22 (Fig. 5) which operates (in each case) to raise the gangue into a gangue-launder 23 (Fig. 2).

Operation.—In practising my novel meth-

od, the asbestos ore is introduced into the mill in the usual manner through the scoop 2ª, or by any other convenient means. The ore becomes mixed with the balls, 7, the rocky part of the mass working downward through the ball-load. As rapidly as the rocky portions of the ore are broken away from the asbestos, the latter becomes partly fluffed or fiberized, whereupon it absorbs water and becomes buoyant, working its way rapidly upward between the balls until it passes into the pool 11 or zone of free water. This pool is kept in a state of agitation by the movement of the balls, such agitation being sufficient to maintain the fiber in suspension and prevent it from sinking into the grinding-zone measured by the field of action of the balls 7. Further to facilitate the discharge of the fiber, it may be desirable to provide irregularities or offsets in the liners to cause the balls to cascade, thereby producing an intermittent surge in the mill to cause the fiber to overflow through the discharge by impulse. If the type of ball mill employed be that here shown and having both axial and peripheral discharging means 3 and 13, respectively, (Fig. 1), a concentration is effected and the separation completed by allowing the fiber to flow from the mill through the central discharge opening 3, while the heavier, nonbuoyant rocky matter (which has passed downwardly through the ball-load) may be discharged at the periphery through the perforations 13, say, or at some other point below the central or axial discharge means 3. In the event that but one axial discharge means—such as 3—is employed, the rocky portion, of the ore is ground to a mesh less than that of the fiber, and the two masses—fiber and rock—are then separated by screening. If sufficient separation is not effected in the mill, this can be secured by passing the material through any appropriate type concentrator, such as that exemplified in United States Patent No. 1,624,134, dated June 28, 1927, of S. H. Dolbear and B. L. Eastman.

In Fig. 4, the apparatus shown is, in general, similar to that illustrated in Figs. 1 to 3; but the normal ball-load—indicated as embracing the balls 7—is maintained at a somewhat different position of action; that is to say, the shell 1 is rotated at a sufficient rate of speed in the direction indicated by the arrow to cause the balls to be lifted on the emerging side 18 of the apparatus and lowered at the submerging side 19. In this way, a pool 20, or free-water zone, is provided.

The position or angle of the surface of the ball-load relative to horizontal may be controlled by varying either the speed of rotation of the shell (as in Fig. 4) or the diameter of the shell, or, (to a lesser extent) by changing the size of the balls 7. In a ball-mill of a given diameter and size of balls, the speed necessary to maintain a pool of sufficient depth for the practice of this invention may be readily predetermined by preliminary test.

In Figs. 6 and 7, a somewhat different form of structure is disclosed. In this instance, the shell 24 of the mill is provided with a grate or slotted element 25 provided with a central or axial opening 26 through which the liquid-buoyed fiber 27 passes to the discharge 28, by which it is delivered into the fiber-launder 29. The gangue 30, reduced by the rolling elements 31, works itself through the slots 25ª in the grate and, as the shell rotates, gangue-lifting plates 32 raise the gangue and then drop the ground mass onto a chute 33 (supported independently of the shell, as at 33ª) by which it is discharged into a gangue-launder 34.

The operation of so-called rod and pebble mills, so as to practice this invention, is similar to that of the ball-mill; wherefore it is not deemed necessary to illustrate these and, besides, the structural details of these mills are well known to those skilled in the art of hydraulic ore treatment.

In utilizing ball or rod mills such as are available on the market, a pool of water is maintained as described and the mill operated to effect a detachment of fibers in the manner and under the conditions herein described. If fibers and gangue matter are discharged together, a separation of the two may be accomplished by utilizing the concentrator of Byron L. Eastman and myself heretofore mentioned herein or by any other suitable means.

Any appropriate predetermined speed of rotation of the mill may be effected so long as the aforementioned water pool within the shell is maintained. In some instances, it may be desirable to rotate the mill at relatively high or abnormal speed; but this may be predetermined in accordance with the requirements. It is important that the pulp shall be relatively thin in contrast to the relatively dense pulp which is usually employed. In this connection, I may state that the results already described may also be accomplished by rotating the mill at usual speed and with the usual ball-load, and effecting the flow of a large volume of water through the mill with sufficient rapidity to carry off unbroken fiber and discharge it from the mill. A thin pulp is desirable, not only because it is then in a condition favorable to agitation but also because thick pulp has a tendency to coat the fiber with fine, crushed rock, which discolors the fiber. The pulp dilution in ordinary ball mill operations varies from 40% to 50% of the weight of the pulp. In milling asbestos ore, however, as contemplated by my invention, a very much larger dilution is preferable, due to the fact that a thick pulp, if produced, discolors the fibers.

It is also found desirable in most cases to discharge relatively coarse hard rock before it is comminuted because only the softer portions of the ore contain fiber and, hence, these are readily comminuted while the harder portions (not containing much if any fiber) should be gotten rid of as soon as possible. In other words, when a given weight of ore—say, 100 pounds—is placed in a ball mill and ground in water until the fiber ceases to be liberated therefrom, the rocky matter remaining in the mill may constitute as much as 50% of the total ore fed into the mill, and the size of the rocky particles would range up to an inch or more in diameter.

The product resulting from the practice of the hereindescribed method has the following distinctive and distinguishing characteristics, to-wit: It is of natural length; it is stalky in character; it is composed of a multiplicity of "pencils"; the fiber mass may be somewhat flattened; it is non-pulverent; it is reduced or subdivided along its natural lines of cleavage only; and it has a natural density which will have been changed sufficiently to render the fiber buoyant in water without dividing the mass into its integral fibers.

Where, in the specification, I use the term "reducing," or equivalent terms, it is to be understood that these denote the character of milling accomplished, for instance, by the ball milling operation employed by me in which the chief function of the mill is to detach fiber from associated rock and avoiding as far as possible the usual ball milling function of pulverizing the ore, and in contradistinction to a mill crushing action such as is effected by a stamp mill operation. In other words, as already pointed out, the reduction of the ore in the manner I contemplate results in the separation of the fibers from the gangue in a relatively unbroken state and of normal length, rather than broken and of short length. Moreover, the term "grinding," as herein used, contemplates the reduction of the asbestos ore in such a way that the fibers are liberated from the associated harder portions of the rock, and the separation, during the early stages of the operation of the harder, fiber-free particles so that they are rendered inactive to crush or injure the fibers.

Where I have herein and in the appended claims employed the expression "parting," it is intended in its broadest meaning, that is to say, in the sense of "separation," "division," or "dissociation." When thus used, the term may include what in crystallography is technically known as "parting" and also what is technically known as "cleavage." The expression "parting," therefore, is intended to include, broadly, a separation substantially along the longitudinal lines of least cohesion of the fiber.

The inventive-concept involved in the subject-matter of the present case contemplates the treatment of asbestos, as by ball-milling, whereby ore is reduced in a body of liquid until the fiber is detached from the associated rocky matter and divided along the lines of its natural parting only, and the claims herein are directed thereto. In my companion application, Serial No. 717,385, filed June 2, 1924, there is disclosed and claimed, broadly and more generically, treatment of asbestos which involves also the reduction of the ore in any appropriate manner (and including ball-milling, if need be) in a body of liquid to produce asbestos in pencil-like form and, then, subsequent treatment to effect a relatively complete concentration of the fiber and other treatment to produce and recover a valuable asbestos product.

Having now described and ascertained the nature of my said invention, and the manner in which the same is to be performed, I declare that what I claim is:

1. The method of concentrating asbestos ore which consists in subjecting the ore to under-water treatment, loosening the asbestos and at the same time preserving its natural length, causing the loosened asbestos to pass into a body of water adjacent the comminuting-zone, and maintaining the loosened asbestos in a state of suspension in said body of water until overflowed.

2. The method of concentrating asbestos ore which consists in subdividing the ore while submerged in water for detaching and dividing the asbestos only along its natural lines of parting and, at the same time, modifying its natural density only sufficiently to render the resultant fiber buoyant, causing the asbestos to become buoyant and to rise into a body of water above the sub-dividing zone, agitating said body of water to keep the buoyant asbestos above the grinding-zone, and overflowing the water.

3. The method of treating asbestos ore which consists in treating the ore to the action of a rotating fiber-detaching means operating in a pool of water, maintaining the pool in a state of agitation, detaching the asbestos, causing the resultant fiberized mass to pass into the pool, and removing the mass from such pool.

4. The method of treating asbestos ore which consists in subjecting the same to the action of freely-movable rolling elements operating in a mill in which a pool of water is maintained over the rolling elements, and separating the rocky matter from the fibrous portion of the ore.

5. The method of treating asbestos ore which consists in subjecting the ore to action in a ball mill containing a body of water normally above and free from the grinding-zone, causing the asbestos to pass into said body of water, and separating the asbestos from the associated rocky matter.

6. The method of separating asbestos fibre from rock and associated impurities which comprises submerging the mineral in water, subjecting the submerged mineral to a crushing operation to break up the friable elements and separate the asbestos fibres substantially unimpaired as to length, maintaining a circulation of the water and mineral through the crushing means, floating off certain constituents of the mineral, and separating certain of the heavier constituents from the first-mentioned constituents by sedimentation.

7. The method of treating asbestos-ore which includes ball-milling the ore in the presence of an excess of liquid sufficient to effect a division of the fiber along its natural, lengthwise lines of parting only, and to maintain detached fiber in suspension away from the ball-zone.

8. The method of treating asbestos-ore in a ball-mill which includes reducing the mass in a pool of water in the mill in which there is a ball charge sufficient to effect division of the fiber along its natural, lengthwise lines of parting only, and supplying the mill with an excess of water.

9. The method of treating asbestos-ore which includes reducing the mass in a ball-mill within which is maintained a substantial pool of water until a division of fiber along its natural, lengthwise lines of parting only is attained.

Signed at New York, N. Y., this 24th day of May, 1924.

SAMUEL H. DOLBEAR.

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