Sept. 29, 1942. H. L. MEAD ET AL 2,297,009

DISINTEGRATING APPARATUS

Filed Dec. 17, 1940 2 Sheets-Sheet 1

Fig. 1.

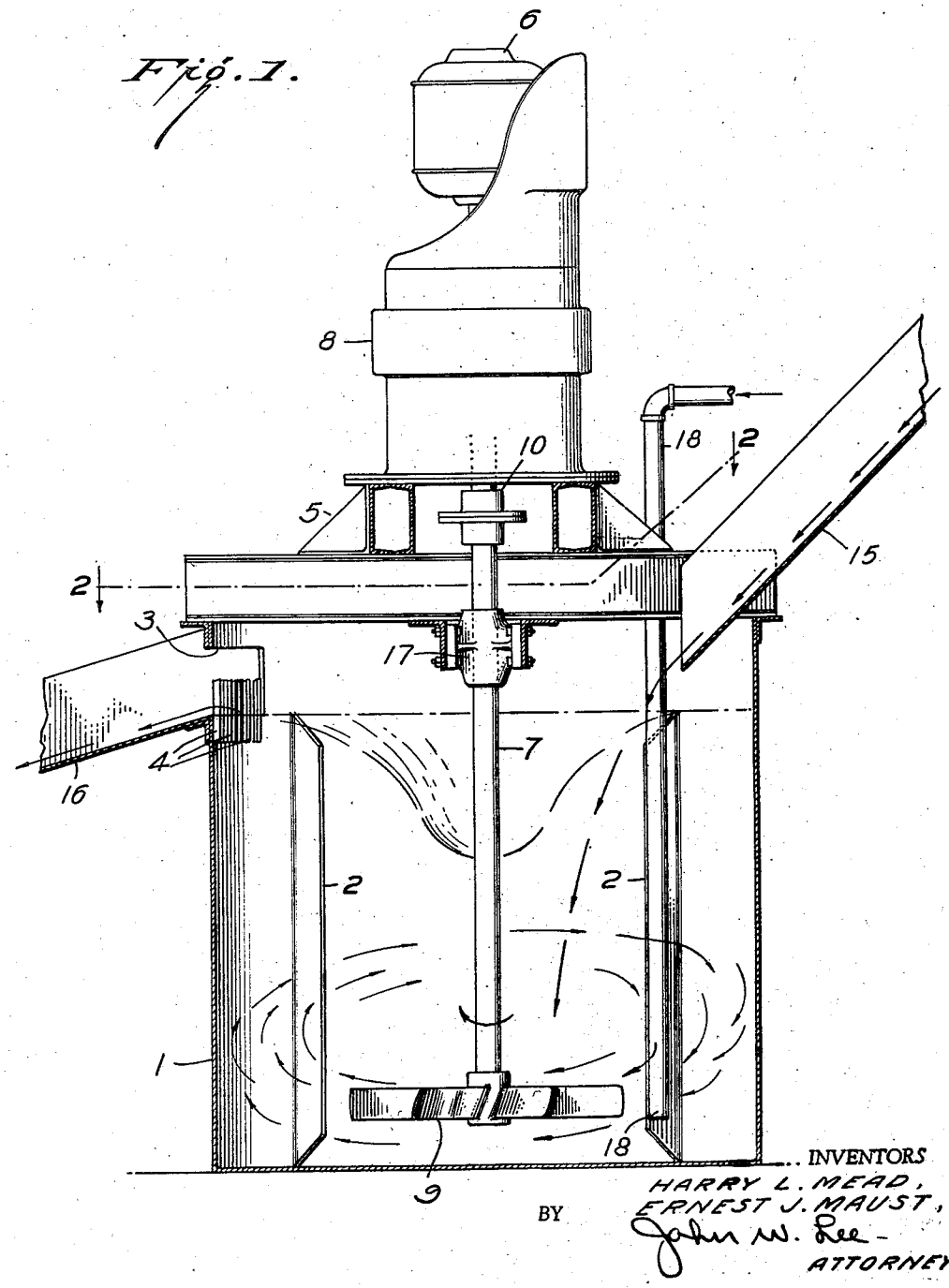

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Fig. 2.

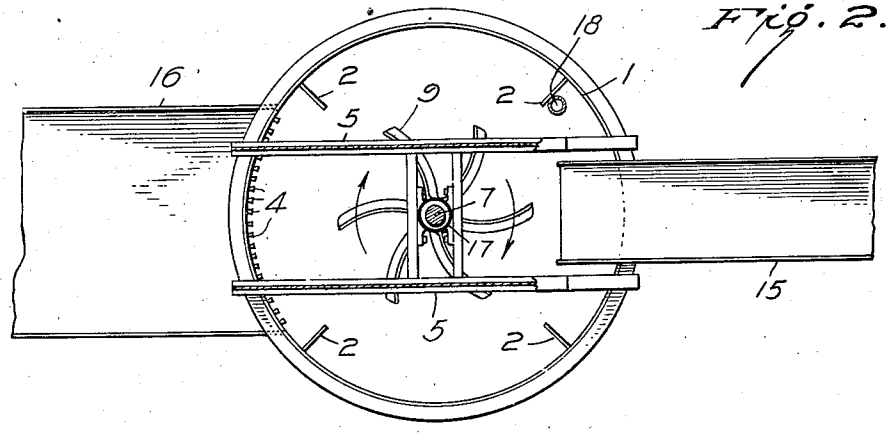


Fig. 3.

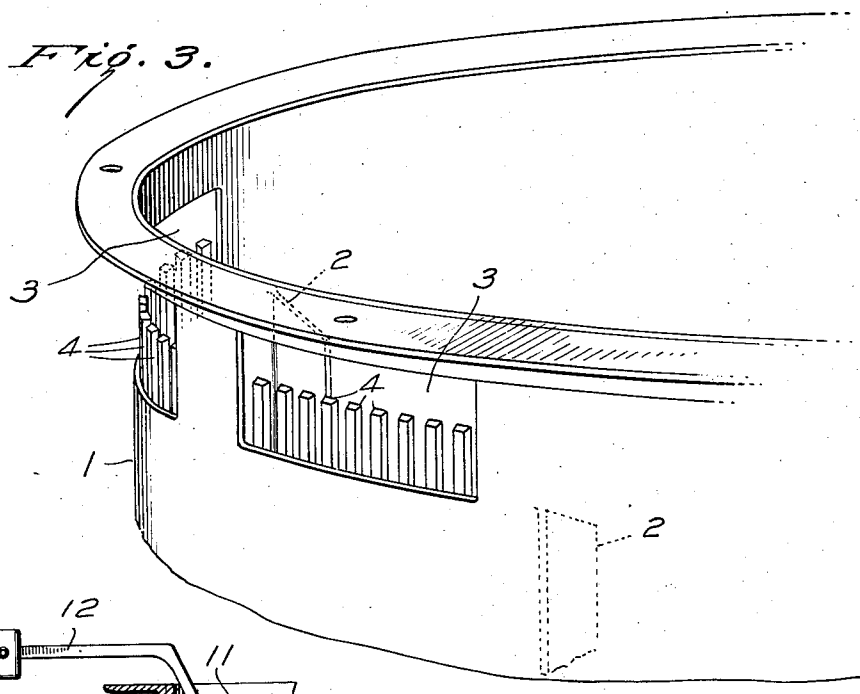


Fig. 5.

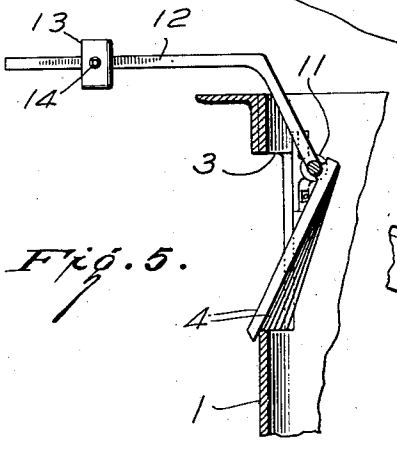
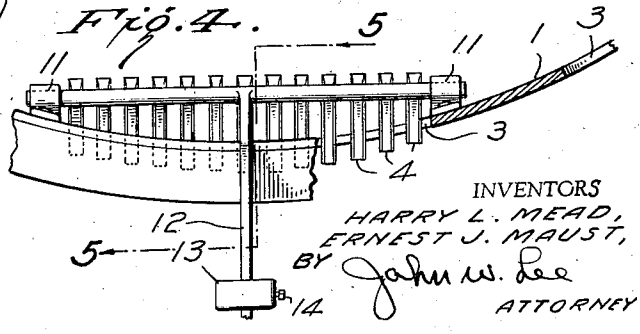


Fig. 4.



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DISINTEGRATING APPARATUS

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Application December 17, 1940, Serial No. 370,436

4 Claims. (Cl. 83—11)

This invention relates to an improved apparatus for the disintegrating of materials and more particularly the invention relates to the treatment and disintegration of phosphate matrix, utilizing coarse pebbles as disintegrating medium.

In the mining of phosphate rock and particularly from heavy clay deposits, the phosphate material frequently is found intermingled with relatively large chunks of the clayey parts of the deposit forming the phosphate matrix. In the past considerable difficulty has been encountered in the washing and screening of pebble phosphate rock because of the presence of considerable quantities of these clay agglomerates or the so-called "mud balls." In most phosphate washing and screening processes in the past these large clayey chunks or mud balls were discarded to waste because the difficulty experienced in attempts to process this type of material either resulted in the clogging up of the log washers or produced an inferior grade of concentrate. In mining Florida pebble phosphate one of the usual procedures comprises subjecting the ore deposits to the action of a stream of hydraulic water to produce a slurry which is then pumped to a trommel separator or screen which permits the smaller or under-size material of from about 1 to 1½ inches in size to pass through. The larger particles or oversize of from 1½ inches up to about 6 to 8 inches in diameter are discarded. The under-size material is passed to a washer usually of the log type and again screened, this time producing a coarse fraction of pebble phosphate of a marketable grade and a fine fraction which may be processed by froth flotation or similar means to produce a marketable grade of phosphate. The over-size of large mud balls from the separator have in many instances in the past been discarded as waste material without further processing. These mud balls, however, contain considerable quantities of valuable phosphate materials and it is therefore economically desirable to recover these values. In order to recover the values from these mud balls it is necessary that they be disintegrated or reduced in size so that they can be processed by the log.

In accordance with the present invention we have provided an apparatus which will efficiently disintegrate or reduce the size of the so-called phosphate mud balls to such an extent that the phosphate values can economically be recovered therefrom. Our improved apparatus utilizes a process never heretofore employed which essentially comprises a method of maintaining an aqueous suspension of the mud balls and rock materials in a violent state of agitation while continuously removing the particles of a pre-determined size from the zone of agitation and continuously introducing rock and mud balls, together with water to the agitation chamber. The agitation chamber is provided with a novel overflow or discharge opening which will permit water, together with disintegrated or smaller phosphate material, to pass through while causing the larger rock particles and clay balls to drop back into the agitation zone where they are subjected to further disintegration. The coarse rock particles coming in contact with the mud balls serve to effect a disintegration thereof to make a clap slip from which the phosphate pebbles and sands can be recovered.

It is an advantage of the present invention that an improved apparatus is provided which will take any size of mud ball or rock that can be economically pumped, and reduce it to clay slip and rock of a predetermined size.

It is also an advantage of this invention that the improved apparatus will disintegrate phosphate mud balls larger than log washing equipment will handle, which results not only in an increase in the mining rate but also permits the recovery of rock from coarse mud balls formerly thrown away.

An additional advantage of this invention is that a disintegrator is provided which will hold an aqueous slurry of rock associated with mud balls within a tank in such a manner that swirling coarse pebbles have a disintegrating action on the mud balls, which apparatus is substantially free from parts that are subject to excessive wear.

A further advantage of the present invention is that an apparatus is provided into which an aqueous slurry of large phosphate mud balls may be continuously introduced and from which is continuously discharged clay slip and rock of a pre-determined size. It is also an advantage of the invention that an improved process of treating phosphate rock is provided which increases the average grade of washed phosphate rock from about ½ to 1% BPL.

The many objects and advantages of the present invention will be apparent during the course of the following description.

In the drawings wherein for purposes of illustration we have shown embodiments of the improved disintegration apparatus:

Fig. 1 is a central vertical section of the apparatus showing one embodiment of the present invention;

Fig. 2 is a horizontal sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged fragmentary section of a portion of the tank of Fig. 1 showing the discharge opening;

Fig. 4 is a top plan view partly broken away of a portion of the tank illustrating another embodiment of the discharge opening; and

Fig. 5 is a vertical section taken along the line 5—5 of Fig 4.

Referring to the drawings, the numeral 1 designates a vertically disposed, preferably cylindrical, tank open at the top and provided with a plurality of vertical baffles 2. The tank has a discharge opening 3, said discharge opening having grids or fingers 4 extending across the discharge area. These grids or fingers are shown in Figs. 1, 2, and 3 as rods spaced apart and extending from the bottom of the discharge opening upwardly about half the distance of the discharge opening. These retaining grids could, if desired, be extended to cover the full discharge area. We prefer, however, to have them extend only about half way from the bottom of the opening, and preferably the grids are tilted inwardly into the tank. The area between the half grids may be of any pre-determined size, say from about ½ inch to 1 inch. Thus large volumes of mud and water will readily flow through them leaving the coarse fractions to drop back into the tank. The inclined grids cause the large particles to readily fall back into the tank, and there is little tendency to clog the opening. Further, since the solution in the tank is in a very violent state of swirling, the flow tends to keep the grids clean and this, together with the sloping grids, minimizes the clogging tendency. The discharge opening 3 may be protected, if desired, by grids 4 as illustrated in Figs. 4 and 5 in which the grids are shown as a gate adapted to be raised but normally remaining in a closed position and extending vertically but at a slightly inclined angle inwardly and upwardly from the bottom of the discharge opening. The grids form a unitary member and is movably mounted on the tank 1 by means of the bearings 11. The grid has an arm 12, said arm having a counterbalance or weight 13 mounted thereon which serves to normally hold the grid in a position covering the entire discharge area. When a force is brought to bear against the grids or gate from inside the tank which is greater than that exerted by the counter-balance 13, the gate will be raised and the lower portion of the discharge area will serve as an unobstructed over-flow lip. The weight 13 is preferably mounted on the arm 12 in such a manner that it may be moved to vary the amount of force which is necessary to raise the grid and may be secured in any pre-determined position by means of the set screw 14. The grids are shown extending vertically across the discharge opening, and they may if desired, however, be extended horizontally across the opening so long as they are suitably spaced to permit the disintegrated material to pass through. The tank 1 has disposed thereon a frame 5 which serves as a support for the motor 6. The drive shaft 7 extends downwardly through the speed reducer 8 through the coupling 10 vertically into the center of the tank ending at a point near the bottom of the tank and having mounted thereon an impeller 9. The impeller 9 is preferably the type illustrated in Fig. 2 having a plurality of slightly curved arms to form a spiral shaped impeller which when rapidly rotated produces a violent swirling motion in the tank sufficient to keep the coarse rock particles and the mud balls in suspension. Bearing 17 may be suitably secured to the underside of the frame 5 for the purpose of steadying the drive shaft 7 during the disintegrating operation. A water line or pipe 18 is shown in Figs. 1 and 2 leading down into the tank 1 to a point near the bottom thereof and preferably lying close to the side of the tank and behind one of the baffles 2 so that the baffle will protect it from the swirling rock, preventing excessive wear. This water line is used to introduce water into the tank where it acts to dilute the clay slurry or pulp presenting a free-flowing aqueous suspension of mud, mud balls, and rock.

In operation a slurry comprising the over-size from a preliminary phosphate washing separator, containing phosphate mud balls, is fed into the tank 1 by means of the feed chute 15. The motor drives the impeller 9 at approximately 180 R. P. M. which is usually sufficient to keep the coarse rock and mud balls in suspension. The continual swirling and collision of the rock particles and the clay balls, together with the aid of the baffles 2 disintegrates the larger particles, and as soon as the particles are reduced sufficiently in size they are carried out the discharge opening 3 through the spaces between the grids 4. When a mud ball or particle larger than the space between the grids 4 comes in contact with the grid, it will pause momentarily and then drop back into the tank where it is subjected to further disintegration. When the tank becomes temporarily over-loaded due to the presence of an unusually large proportion of large particles, causing a congestion at the discharge opening, the congestion is relieved by the large particles passing over the half grids or by opening the counter-balanced grids illustrated in Figs. 4 and 5. In normal operation the disintegration can be carried out continuously, and there is very little danger of clogging or over-loading the apparatus when the space between the grids is from ½ to 1 inch in size.

In actual operation we have found that a 6' x 6' steel tank on which is mounted a 60 H. P. gear reducer motor and which turns a 24-inch to 38-inch impeller at approximately 180 R. P. M. will handle the entire over-size from a phosphate separator which has 1½ inch perforations. The entire over-size from the separator is fed into the tank, together with approximately 500 gallons of water per minute. The mud balls are readily disintegrated and they pass out through the 1 inch or ½ inch spaced grill near the top of the tank. The material so treated may be passed directly into the logs for the final washing.

From the foregoing description it is apparent that an apparatus is provided by which retaining grids may be used to hold rock of a pre-determined size in a tank while utilizing this rock as a milling or disintegrating medium on phosphate matrix, mud balls, and the like. It is further apparent that many variations and types of grids may be used for obtaining this result. For example as pointed out heretofore, the fingers of the grids may extend say about half way from the bottom of the discharge opening, acting normally to allow the suspended mud and sand to float through while at the same time preventing large mud balls or rock to pass through, and when a very heavy load occurs or material is temporarily coming into the tank at a rate faster than it is being disintegrated, the material will

float over the grid thus relieving the temporary congestion. The grids may also be inwardly inclined, which also reduces the tendency to clog and/or they may protect the total discharge area being held in place by a counterweight and so positioned that, when blinded, the head against the gate will force it open to relieve the temporary load.

The disintegrating operation in the present invention is especially applicable to the treatment of phosphate matrix, mud balls, and so forth, at various stages in the handling of the material wherever mud balls are present and whenever an effective and rapid disintegration of the matrix is desired. The invention, however, is not limited strictly to phosphate rock but is applicable to ore materials generally wherein they are associated with softer materials in relatively large chunks or balls.

The disintegrating operation of the present invention should be distinguished from grinding operations since the action accompanied by this process is the break-up and reduction in size of phosphate mud balls agglomerates without very materially pulverizing the phosphate pebbles. In general, the present invention makes possible the disintegration of softer materials such as clay mud balls, and so forth, which may be accompanied by subjecting an aqueous slurry of the material to a violent agitation such that the coarse rock is held in suspension and serves to disintegrate the softer material.

What we claim is:

1. In an apparatus for the disintegration of mixtures of clay balls and rock, a vertically disposed cylindrical tank for holding water and having rotatably mounted therein only near the bottom a bladed impeller type agitator, vertical baffles disposed about the inner wall of the tank, said impeller being spaced apart from the vertical baffles but cooperating therewith to effect disintegration, a discharge area opening in one side and confined to an area near the top of the tank, said discharge opening being at a sufficient distance above the impeller to provide for a circulation zone between the impeller and the opening and having spaced retaining means disposed therein capable of retaining in the tank clay balls and rock of a pre-determined size, said spaced retaining means comprising a plurality of spaced fingers extending only substantially vertically and protecting the lower half only of the discharge area, means for continuously feeding an aqueous slurry of clay balls and rock into the tank at a substantial peripheral distance from the discharge opening, means for imparting high speed rotary motion to the impeller sufficient to keep the clay balls and rock in suspension and causing the clay and rock particles smaller than the spaced opening of the retaining means together with water to be discharged from the tank.

2. In an apparatus for the disintegration of mixtures of clay balls and rock, a vertically disposed cylindrical tank for holding water and having rotatably mounted therein only near the bottom a bladed impeller type agitator, vertical baffles disposed about the inner wall of the tank, said impeller being spaced apart from the vertical baffles but cooperating therewith to effect disintegration, a discharge opening in the side and confined to an area near the top of the tank said discharge opening having spaced retaining means disposed therein capable of retaining in the tank clay balls and rock of a pre-determined size, said spaced retaining means being comprised of a plurality of spaced fingers inclined slightly inwardly from bottom to top protecting the lower half of the discharge area, means for continuously feeding an aqueous slurry of clay balls and rock into the tank, means for imparting high speed rotary motion to the impeller sufficient to keep the clay balls and rock in suspension and causing the clay and rock particles smaller than the spaced opening of the retaining means together with water to be discharged from the tank.

3. In an apparatus for the disintegration of mixtures of clay balls and rock, a vertically disposed cylindrical tank for holding water and having rotatably mounted therein only near the bottom a bladed impeller type agitator, vertical baffles disposed about the inner wall of the tank, said impeller being spaced apart from the vertical baffles but cooperating therewith to effect disintegration, a discharge area opening in one side and confined to an area near the top of the tank, said discharge opening being at a sufficient distance above the impeller to provide for a circulation zone between the impeller and the opening and having spaced retaining means disposed therein capable of retaining in the tank clay balls and rock of a pre-determined size, said spaced retaining means comprising a grid having spaced fingers extending only substantially vertically which protects the entire discharge area, means for continuously feeding an aqueous slurry of clay balls and rock into the tank at a substantial peripheral distance from the discharge opening, means for imparting high speed rotary motion to the impeller sufficient to keep the clay balls and rock in suspension and causing the clay and rock particles smaller than the spaced opening of the retaining means together with water to be discharged from the tank.

4. In an apparatus for the disintegration of mixtures of clay balls and rock, a vertically disposed cylindrical tank for holding water and having rotatably mounted therein near the bottom an impeller type agitator, vertical baffles disposed about the inner wall of the tank, said impeller being spaced apart from the vertical baffles, a discharge opening in the side and confined to an area near the top of the tank said discharge opening having spaced retaining means disposed therein capable of retaining in the tank clay balls and rock of a pre-determined size, said spaced retaining means comprising a grid having spaced fingers inclined inwardly from bottom to top, said grid being movably mounted on the tank and having means to normally hold in a position protecting the entire discharge area but, when subjected to a pre-determined force, operating as a gate and leaving the lower portion of the discharge area unprotected, returning to normal position when the force is removed, means for continuously feeding an aqueous slurry of clay balls and rock into the tank, means for imparting rotary motion to the impeller sufficient to keep the clay balls and rock in suspension and causing the clay and rock particles smaller than the spaced opening of the retaining means together with water to be discharged from the tank.

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