Sept. 5, 1939. G. F. AINSA 2,171,525

ATTRITION MILL

Filed Oct. 4, 1933 2 Sheets-Sheet 1

Fig. 1.

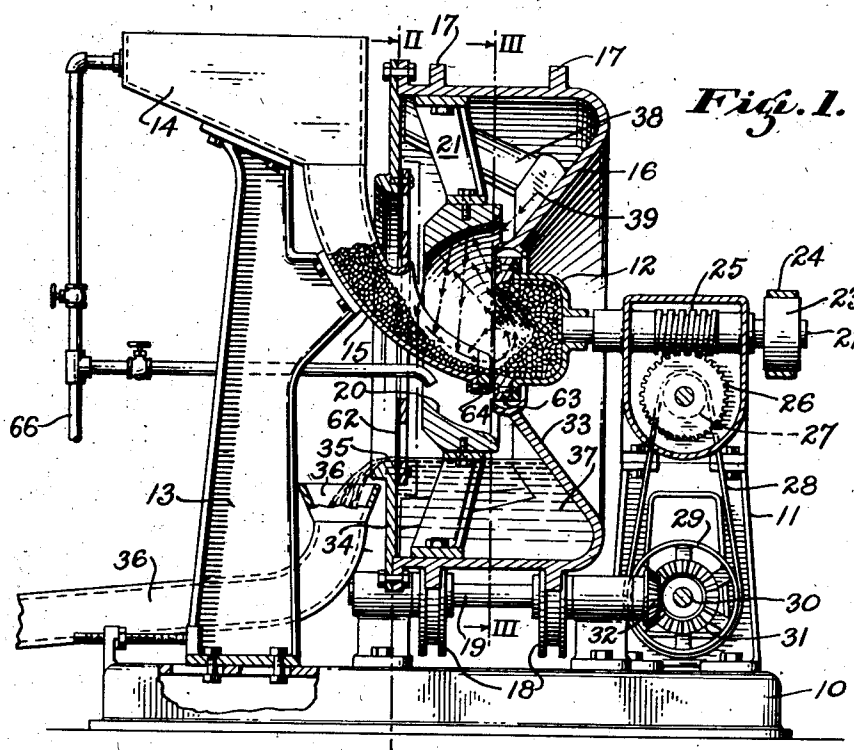

Fig. 2.

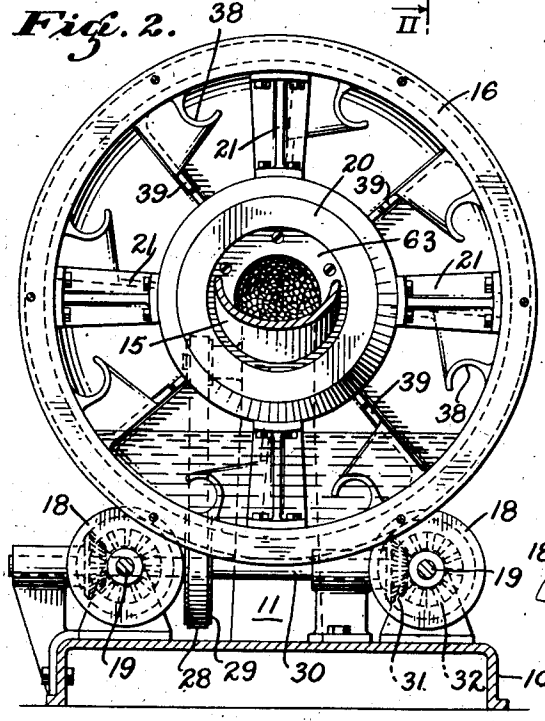

Fig. 3.

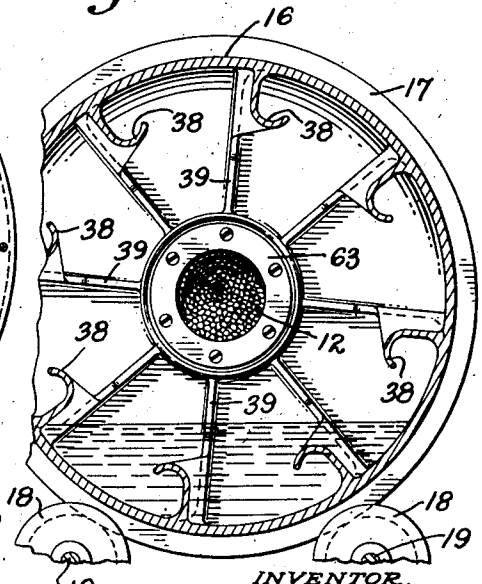

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Fig. 4.

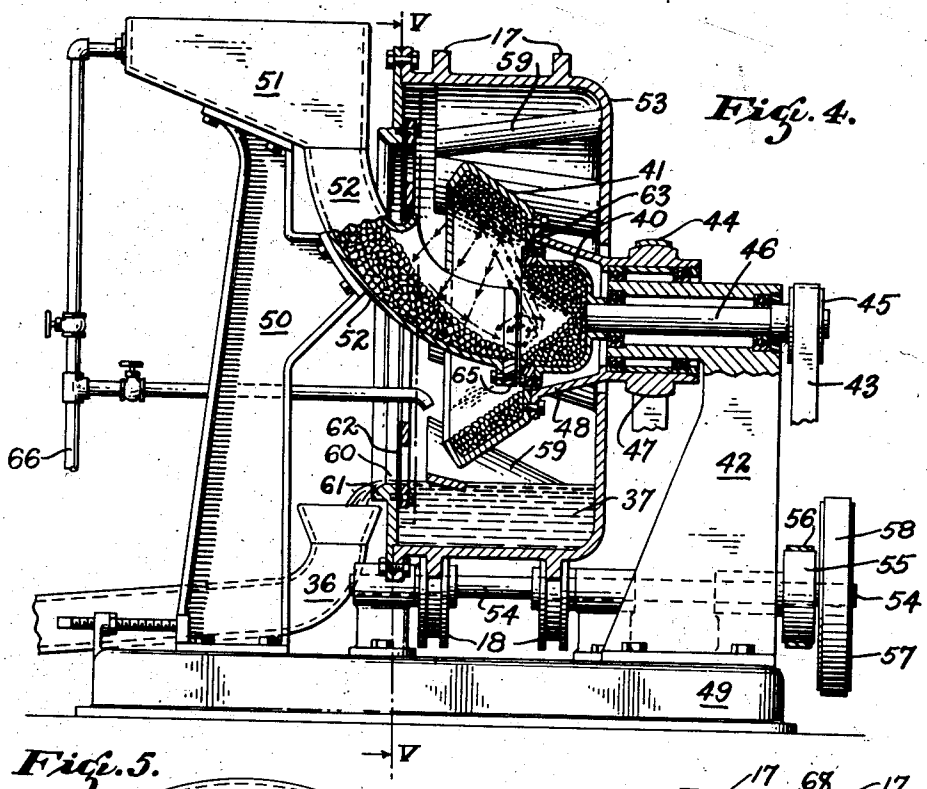


Fig. 5.

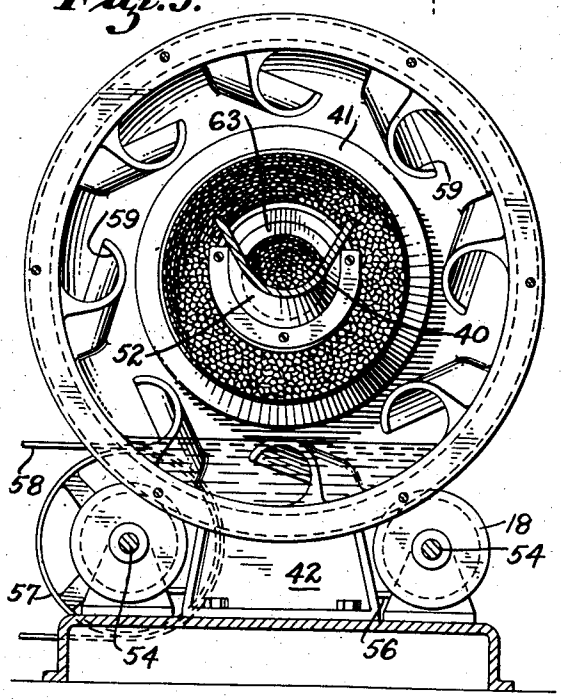
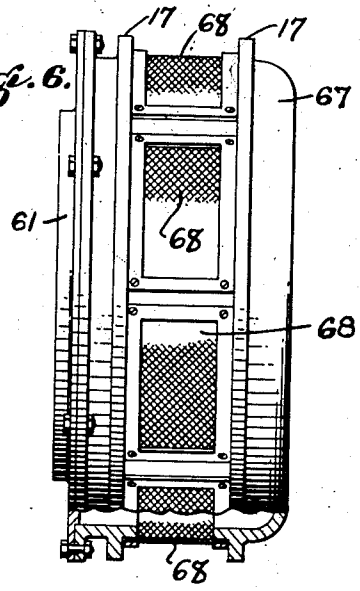


Fig. 6.



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Patented Sept. 5, 1939

2,171,525

UNITED STATES PATENT OFFICE

2,171,525

ATTRITION MILL

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2 Claims. (Cl. 83—46)

The present invention relates generally to an attrition mill of the type in which an agglomerate of loose and lumpy material is reduced or pulverized by a rubbing action between the particles thereof, and more particularly to an improved form of mill wherein, in addition to the rubbing action between the particles, there is provided means for projecting the particles by centrifugal force against a stationary or rotating anvil to thus effect a reduction of the agglomerate by a combined rubbing and impact operation.

An object of the present invention is to provide an attrition mill for reducing and pulverizing an agglomerate which operates on a combined rubbing and impact principle to reduce the agglomerate to powdered form.

Another object of the present invention is to provide an attrition mill wherein the larger particles of the agglomerate will be reduced and disintegrated in a continuous manner by interimpaction created by centrifugal force.

Another object of the present invention is to provide in an attrition mill of the above character means for returning the unreduced particles of the agglomerate to the reducing elements of the mill and separating the finer particles therefrom by a process of flotation.

In the art to which the present invention relates there has been devised a large number of mills for reducing ores and other agglomerate by retaining portions thereof in a receptacle by centrifugal force and causing a mass of agglomerate thus held to rub against a second stationary or relatively movable mass of the agglomerate. For illustrations of apparatus of this character reference may be had to United States Patent Number 429,679, issued June 10, 1890, to H. A. Duc, Jr., United States Patent Number 498,037, issued May 23, 1893, to T. L. Sturtevant, and United States Patent Number 1,877,517, issued September 13, 1932, to J. H. Macartney.

In each of the mills illustrated in the above patents the agglomerate is reduced solely by a rubbing action which takes place between the relatively movable particles of the agglomerate as it travels under the influence of centrifugal force and passes out of the mill between grinding rings disposed about the periphery of the centrifugally operating rotor elements. Mills of this character require the exertion of a high pressure between the particles and consequently consume a large amount of power. Therefore, it is a further object of the present invention to provide an improved attrition mill in which the particles will be thrown by centrifugal force against an impact member and against each other and thus reduced by a combined impact and rubbing action without subjecting the mass to an excessive pressure.

In accordance with one form of the present invention the agglomerate is fed by gravity into a horizontally disposed rotating element and is thrown therefrom by centrifugal force against an impact ring or anvil, from which the heavier particles are directed back into the feed stream of the agglomerate, while the remaining unreduced portion thereof is returned to the hopper feed stream by other means until the agglomerate is reduced to the desired degree of fineness, after which the finely divided agglomerate is conducted away from the mill by flotation or other means.

In another embodiment of the present invention the agglomerate is fed by gravity into one rotating element and thrown therefrom by centrifugal force into a second and oppositely rotating centrifugal rotor which will direct the larger particles back into the feed stream until the agglomerate is reduced to the desired degree of fineness and finally discharged from the mill.

For a better understanding of the invention and the mode of operation reference should be had to the accompanying drawings wherein there is shown, by way of illustration and not of limitation, preferred embodiments thereof.

In the drawings wherein like numerals designate like parts throughout the several views,

Figure 1 is a vertical sectional view of a mill constructed in accordance with one embodiment of the present invention,

Figure 2 is a vertical sectional view taken along line II—II of Figure 1, looking in the direction of the arrows,

Figure 3 is a fragmentary sectional view taken along line III—III of Figure 1, looking in the direction of the arrows,

Figure 4 is a vertical sectional view of a modified mill having two centrifugal agglomerate throwing elements.

Figure 5 is a vertical sectional view taken along line V—V of Figure 4, looking in the direction of the arrows, and

Figure 6 is a side view of a modified drum which may be substituted for the drums illustrated in the other figures of the drawings, should it be desired to construct a mill for the reduction of the agglomerate in dry form.

The embodiments of the present invention illustrated in the drawings are particularly adapted to the reduction of loose and broken lumpy material, such as ores, cement, rock, clay and the

like. As shown in Figures 1, 2 and 3 of the drawings, the mill has a base 10 that may be secured to a suitable foundation and support the several elements of the mill in cooperating relation. Mounted upon the base 10 there is provided a stationary pedestal 11 which supports a horizontally disposed centrifugal rotor 12 and at the other end of the base there is a movable pedestal 13 which supports a hopper 14 having a discharge spout 15, the latter of which is held in spaced relation with the rim of the centrifugal rotor 12. Disposed about the centrifugal rotor 12 and the discharge spout 15 there is a rotatable drum 16 which forms an enclosing housing about the reducing elements of the mill. The rotation of the drum 16 is provided for by externally disposed annular rails 17 carried thereby which engage two pairs of spaced rollers 18 carried by parallel shafts 19. Within the rotatable drum 16 there is a hardened steel anvil or impact ring 20 which is adapted to cooperate with the centrifugal rotor 12. The impact ring 20 is of heavy construction and has a hemispherical interior surface. It is mounted in spaced relation with the walls of the drum 16 by means of stays or struts 21.

The centrifugal rotor 12 is mounted upon a horizontally disposed shaft 22 that carries a pulley 23 which is adapted to be connected with any suitable source of power by means of a driving belt 24. The rotatable drum 16 is also adapted to be driven from the same source of power through a worm 25, a worm gear 26, and a pulley 27 which is connected by a belt 28 with a larger pulley 29. The pulley 29 is carried by a transversely disposed shaft 30 having two beveled gears 31 which mesh with beveled gears 32 secured upon the shafts 19. When the shaft 22 is driven by a suitable source of power the centrifugal rotor 12 will revolve at a high speed and the drum 16 will be rotated in the same or a reverse direction at a considerably slower speed. The centrifugal rotor 12 is preferably disposed with its open end in a plane substantially midway between the ends of the drum 16 and therefore, one end of the drum is provided with a reentrant or inwardly projecting conical end wall 33 which terminates closely adjacent the outer periphery of the rotor. The other end of the drum 16 is provided with a straight end wall 34 having a central opening 35 through which the discharge spout 15 of the hopper 14 may project.

When the above described mill is in operation the particles of the agglomerate will be swirled around into contact with each other and projected against the impact ring 20 until they have been reduced to the desired fineness. During this operation the reduced and some of the unreduced particles of the agglomerate will fall down into the bottom of the rotatable drum 16 where the particles, having the desired degree of fineness, will be decanted or floated out through the opening 35 and into a discharge pipe 36 with the excess water 37 which will be introduced into the mill when it is in operation The heavier and unreduced particles of agglomerate will settle in the water at the bottom of the drum 16 where they will be picked up by spirally disposed scoops or pockets 38, which terminate against radial fins 39, and thus be directed back into the active or reducing zone of the mill.

The agglomerate may be discharged from the hopper 14 and into the mill in either a wet or a dry condition. If the agglomerate is not sufficiently wet to provide for a constant flow of water and finished material from the drum 16 water may be added through the hopper 14, whereas, if it is desired to introduce the agglomerate into the mill in a dry condition the water, necessary to provide for a flow from the mill, as suggested above, may be added to the drum 16 through the opening 35 in the end wall 34. Since the depth of the water in the drum 16 and the rate of flow therefrom will effect the fineness of the material decanted, the diameter of the opening 35 in the end wall 34 is so proportioned, with respect to the inside diameter of the drum 16, that the drum will hold a definite depth of water or other fluid 37 and therefore, with means for regulating the rate of the water feed, the degree of fineness of the agglomerate decanted therefrom can be controlled.

The mill illustrated in Figures 4 and 5 of the drawings is substantially similar in construction and mode of operation to the mill described above, except for the differences which will be hereinafter pointed out. In the mill now to be described there is provided an inner centrifugal rotor 40 which is adapted to be driven at a high rotative speed in one direction and a second or outer centrifugal rotor 41 which is adapted to be driven at a high rotative speed in an opposite direction. These rotors are mounted upon suitable bearings carried by a pedestal 42 and are adapted to be driven by power transmitting belts 43 and 44 respectively. The belt 43 operates upon a pulley 45 carried by a shaft 46 which supports the inner rotor 40, and the belt 44 engages a pulley 47 that is formed upon a rotating support 48 which carries the outer rotor 41. The pedestal 42 is secured at one end of a suitable foundation base 49 and at the other end of this base there is an adjustable pedestal 50 which supports a hopper 51 having a discharge pipe or chute 52. Surrounding the centrifugal rotor elements 40 and 41 there is a rotatable drum 53. This drum 53, like the drum 16 previously described, is provided with externally disposed annular rails 17 which engage spaced rollers 18 to thus form a trunnion-like mounting therefor. In this embodiment the spaced rollers 18 are keyed upon parallel shafts 54 that carry pulleys 55, over which a connecting belt 56 is placed. In order to impart movement to the drum 53, one of the shafts 54 is provided with a pulley 57 having a belt 58 that connects with a suitable source of power.

As shown in the drawings, the end of the chute 52 is disposed in closely spaced relation with the rim of the inner centrifugal rotor 40 and projects through the outer centrifugal rotor 41 so that when the agglomerate is thrown out by the inner rotor 40 and against the outer rotor 41 it will fall or be thrown downwardly into the chute 52 where it will comingle with the agglomerate being fed to the mill. The unreduced agglomerate, which is not thus redeposited in the chute 52, will be picked up by a plurality of inclined pockets or scoops 59 formed upon the interior of the drum 53. These scoops 59 are so shaped and inclined that the agglomerate picked up thereby, as the drum 53 rotates, will be carried substantially to the top of the drum and then dropped clear of the rotor elements 40 and 41 and into the chute 52. While the scoops 59 are thus operating to return the unreduced agglomerate to the chute 52, the finer particles of the agglomerate will be decanted or floated from the mill by the water 37 which will accumulate in the bottom of the drum and spill out and into the discharge pipe 36 through a discharge opening 60 provided at the end of the drum 53.

In the drawings the openings 35 and 60, in the drums 16 and 53 respectively, are shown as having a flaring flange 61 which serves to direct the flow of water and finely reduced agglomerate into the discharge pipe 36. As an additional means for controlling the size of the agglomerate which may be carried or floated away from the mill with the excess water 37, there may be provided an annular screen 62 having any desired mesh. In the present invention advantage is taken of the well known fact that the fineness of the agglomerate discharged by the flotation method, described above, may be controlled by regulating the depth of the water at the bottom of the rotatable drums 16 and 53. Therefore, as stated above, the mill may be designed in this respect by varying the inside diameter of the discharge opening 60 at the end thereof to provide for a proper depth of fluid in the drum. If adjustability in these dimensions should be desired in a particular mill it can be obtained by providing a plurality of end walls having discharge openings of different size. The same result can also be accomplished by mounting a plurality of nesting rings in the discharge opening at the end of the mill to thus reduce its diameter.

Each of the centrifugal rotor elements 12 and 40, described above, is provided with a hardened steel ring 63 at its periphery which will reduce the possibility of excessive wear at this point by the discharge of the agglomerate therefrom by centrifugal force. The ring 63 is formed in accordance with the disclosure made in my above identified copending application for patent. It has an inwardly tapering inner surface that forms a restricted throat at the end of the rotor which will cause a portion of the agglomerate to be retained in the rotor to form a protecting layer of agglomerate upon the inside surface thereof. In order to prevent excessive wear at the end of the hopper discharge spout 15, there is provided a hardened steel lip 64 which will cooperate with the ring 63 to direct all but the finely reduced agglomerate into the centrifugal rotor 12. The hopper discharge chute 52 of the mill shown in Figure 4 of the drawings is likewise reinforced by the provision of a hardened steel lip 65 which will cooperate in the above manner with the ring 63 at the discharge end of the centrifugal rotor 40.

As an additional adjunct, the mills illustrated in the drawings are shown as having a source of water supply 66 with connections which will permit the water to be introduced either in the hoppers 14 and 51 or directly into the drums 16 and 53.

While the mills contemplated by this invention have been described above in a form which is particularly adapted to the reduction of wet agglomerate they are also suitable for the reduction of dry agglomerate. In this latter event, however, the reduced agglomerate can not be withdrawn from the mills by the flotation process described above and, therefore, other means for discharging the fine agglomerate from the mills must be provided.

In Figure 6 of the drawings there is shown a rotatable drum 67 for a dry grinding mill. As here illustrated, the rotatable drum 67 is provided with screens 68 of proper mesh located between the scoops or pockets which are formed upon the inside of the drum, as is the case with the drums previously described. When the mill is equipped with such a rotatable drum it will be necessary to provide an additional housing or shroud over the drum 67 in order to collect the finely powdered agglomerate.

Before describing the operation of the mills illustrated in the drawings it should be stated that, as shown, the parts are assumed to be in movement and that the centrifugally projected particles thrown out by the rotor elements have been omitted in order to fully disclose the details of the several parts of the mills with which they contact. When the mills are in operation these omitted particles will be projected in the direction indicated by the dot and dash arrows that have been applied to the drawings. In other words, when the mills are in operation the hopper discharge spouts or feeding chutes will contain more agglomerate than is illustrated. The upper limit of the agglomerate illustrated is intended to represent the slip surface between the moving particles of the agglomerate and a portion thereof which will feed more slowly at the bottom of the spouts or chutes. The rotor elements are also shown as partially filled with agglomerate which will be retained by centrifugal force. The conical formation of the agglomerate represents the nominal slip line along which the excess agglomerate will be thrown out of the rotor elements by centrifugal force.

The operation of the mill illustrated in Figure 1 of the drawings may be described as follows:

When the rotor 12 is driven at a high rotative speed and the agglomerate is fed thereto by means of the hopper discharge spout 15, the agglomerate picked up by the rotor 12 will be thrown outwardly at a high velocity by centrifugal force and against the impact ring 20. It will then rebound or be directed back into the spout 15 where it will be carried back into the rotor element 12 until it is reduced to the desired degree of fineness. The unreduced particles that are not thus redirected back into the spout 15, but which escape around the sides thereof, will fall down into the drum 16, where they will be picked up by the scoops or pockets 38 and carried up to a point directly above the rotor element 12 and the spout 15 and dropped back into the spout 15, or into the path of the agglomerate projected outwardly by the rotor 12 to be carried along therewith and against the impact plate 28, from which they will be projected into the spout 15. As the particles of the agglomerate are thus reduced some will escape downwardly between the ring 63 upon the rotor element 12 and the lip 64 upon the spout 15 and the remainder will fall down clear of the spout 15 and into the bottom of the rotatable drum 16.

The agglomerate will preferably be fed to the mill in a wet condition and sufficient additional water will be introduced with or independently of the agglomerate to provide for an overflow of water through a discharge opening 35 formed in one end of the drum 16. This water will pick up the finer particles of the agglomerate in the drum 16 by suspension and/or flotation and thus cause them to be decanted or floated from the mill in a continuous manner. A discharge pipe 36 is shown for the purpose of carrying the overflow from the drum 16 to any desired point. As the drum 16 rotates, the scoops 38 carried thereby will agitate the water, wash the larger particles, and thus leave the finer particles in suspension in the water 37.

From the above it will be seen that the larger particles of the agglomerate will be acted upon in a continuous manner until they have been reduced to the required degree of fineness. It will

be also apparent that, since the velocity of a centrifugally projected body is proportioned to its mass, the intensity of the impact feature of the mill may be varied by increasing or decreasing the speed of the centrifugal rotor 12. The coarseness of the finished material decanted from the drum 16 may be also controlled by varying the depth and/or the rate of flow of the water from the bottom of the drum 16.

In this mill the impact ring 20 is shown as carried by the drum 16 and as rotating therewith. While this is a preferred arrangement it is to be understood that the impact ring may be held stationary if so desired. However, when this ring is rotated, as shown, the wear upon the inner surface thereof will be uniform throughout its circumference and as a result it will last considerably longer than if it is stationary.

The operation of the mill illustrated in Figure 4 of the drawings is substantially similar to that described above, except that the centrifugally thrown agglomerate, instead of striking the steel impact ring 20, will strike a mass of agglomerate which will be held by centrifugal force in the outer centrifugal rotor 41. This difference in the construction of the two mills illustrated greatly intensifies the impact feature of the latter mill, as the centrifugally thrown particles will contact with the swiftly moving surface of the agglomerate held in the rotor 41 which will be moving in an opposite direction to that in which the particles are thrown. The particular construction of the outer rotor 41, which provides for an accumulation of agglomerate therein, will present a continuously renewing surface of the agglomerate and thus form a protecting surface that will prevent a wearing away of the metallic parts of the rotor element 41. The speeds of the inner rotor 40 and the outer rotor 41 will be so regulated that the agglomerate fed to the inner rotor will be thrown out near the upper edge thereof and contact the outer centrifugal rotor 41 over an area immediately above the chute 52 so that the major portion, if not all of the agglomerate thus thrown, will be directed back into the chute 52 where it will comingle with the agglomerate being fed from the hopper 51.

As shown, the scoops 59 are inclined in such a direction that they will drop the larger particles, picked up thereby, directly into the chute 52, rather than in the path of the thrown agglomerate, as is the case in the mill illustrated in Figure 1 of the drawings. In this mill the decanting of the finely reduced agglomerate from the drum 53 will be accomplished in a manner similar to that described above.

In the mills contemplated by this invention the action which takes place, in so far as the impact feature of reduction is concerned, is somewhat similar to that which takes place in the well known "Hatsell mill", wherein the particles are picked up by a rotating drum having a comparatively large diameter and dropped by gravity upon an anvil disposed within the ring. However, in the present disclosure the agglomerate is thrown, at a high velocity, by centrifugal force against an impact member and as a result the impact is more intense than is the case in the "Hatsell mill", wherein the agglomerate is merely dropped upon an anvil.

If the mills are to be used for the reduction of dry agglomerate, and a drum 67, such as is illustrated in Figure 6 of the drawings, is provided about the centrifugal rotor elements, the finely reduced agglomerate will sift out through the screens 68 where it can be collected by any suitable means.

The expressions "decanted" and "floated", as used above in describing the action which takes place when the finely pulverized agglomerate is discharged from the mill, are intended to include the condition where, due to a lack of water, the pulverized agglomerate may be discharged from the mill as a thick muddy mass.

While I have, for the sake of clearness and in order to disclose the invention so that the same can be readily understood, described and illustrated specific devices and arrangements, I desire to have it understood that this invention is not limited to the specific means disclosed, but may be embodied in other ways that will suggest themselves, in view of this broad disclosure, to persons skilled in the art. It is believed that this invention is broadly new and it is desired to claim it as such so that all such changes as come within the scope of the appended claims are to be considered as part of this invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. In a pulverizing mill, the combination of a centrifugal bowl-like rotor adapted to rotate about a horizontal axis, means for driving said rotor at high speed, an inwardly extending lip about the open end of said bowl-like rotor for retaining a layer of material therein against displacement by centrifugal force when the bowl-like rotor is in rotation, and means adjacent the open end of said rotor for feeding material to be pulverized over said lip and into said rotor, the inward extension of the lip about the open end of said rotor being sufficient to retain a protective layer of the material being pulverized over the entire inner surface of said rotor.

2. In a pulverizing mill, the combination of a bowl-like rotor adapted to receive and throw material therefrom by centrifugal force, means for driving said rotor at high speed, an inwardly extending ring secured to the open end of said bowl-like rotor for retaining a layer of material therein against displacement by centrifugal force when the mill is in operation, and a feed chute adjacent the open end of said rotor for directing material to be pulverized over said ring and into said rotor, the inner diameter of said ring being substantially smaller than the inside diameter of the rotor to retain a protective layer of the material being pulverized over the entire inner surface of said rotor.

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