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SIZE-REDUCING MILL

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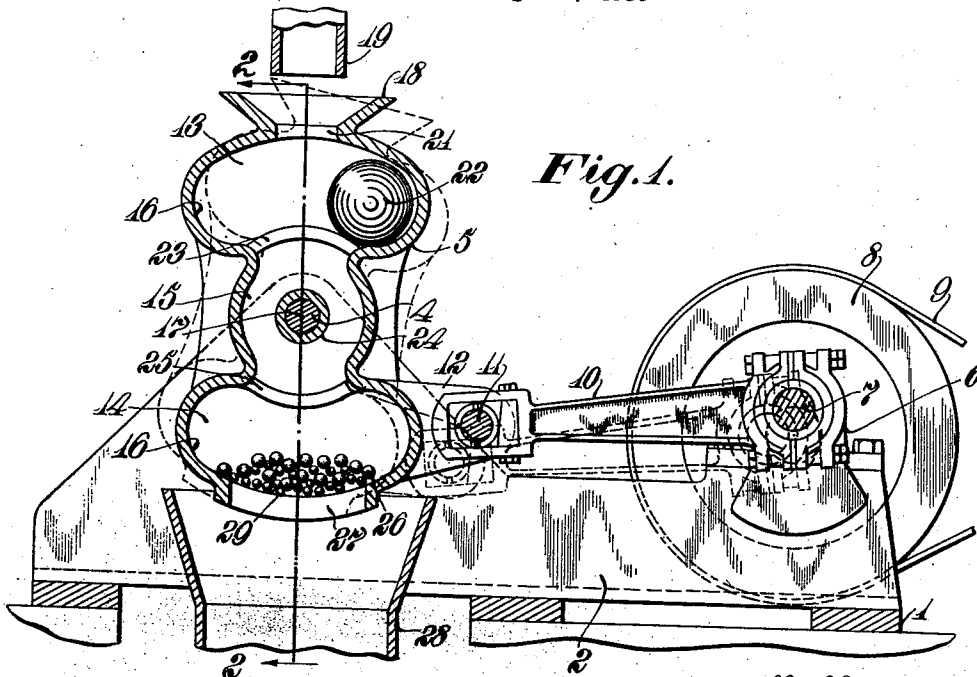


Fig. 1.

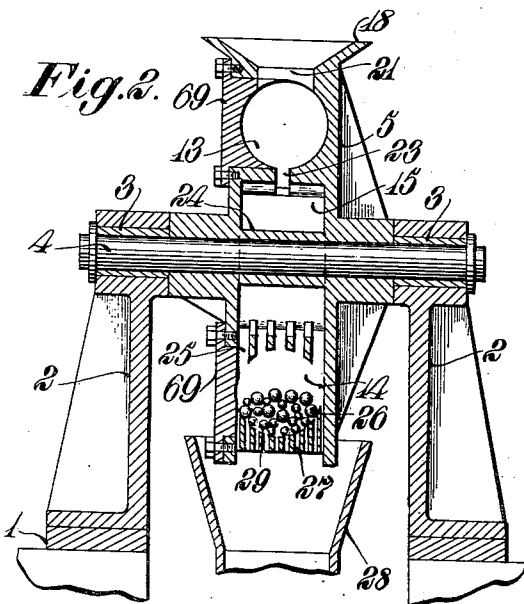


Fig. 2.

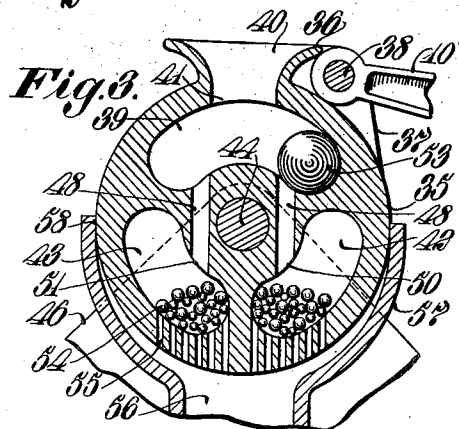


Fig. 3.

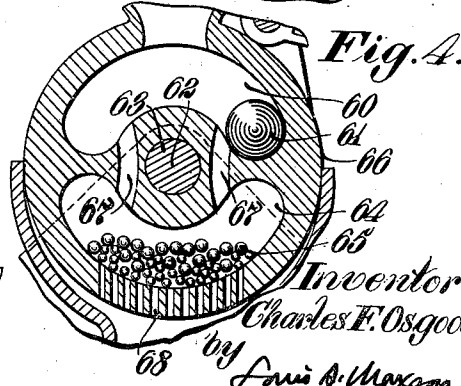


Fig. 4.

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SIZE-REDUCING MILL

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11 Claims. (Cl. 83—9)

My invention relates to size-reducing mills, and more particularly to mills which are especially suited for the reduction in size of masses of rock, ore, retort residues, coal or other materials from sizes of a maximum diameter of several inches to sizes which will pass through a comparatively small-mesh sieve.

An object of my invention is to provide an improved size-reducing mill. Another object of my invention is to provide an improved size-reducing mill requiring a minimum amount of power in proportion to the amount of useful work performed. Still another object is to provide an improved mill in which a plurality of stages of reduction may be effected in an apparatus so designed that the portions thereof in which different stages of size-reduction take place, so-to-speak, at least substantially counterbalance each other and thereby reduce the vibration of the machine and render the same much more smooth-running and uniform in its power requirements, and in which, further, bearing pressures due to unbalanced forces are kept at a minimum. A more specific object of my invention is to provide an improved size-reducing mill in which a plurality of size-reducing chambers are arranged in symmetrical relation with respect to an axis upon which the size-reducing chamber-providing means is pivotable. A more specific object of my invention is to provide, in one aspect of said invention, an improved size-reducing mill in which a plurality of size-reducing chambers, in at least some of which different stages of size-reduction take place, are arranged in equally spaced relation about an axis of oscillation. Other objects and advantages of the invention will hereinafter more fully appear.

In the accompanying drawing, in which for purposes of illustration three illustrative embodiments of the invention are shown,

Fig. 1 is a view largely in vertical section through a size-reducing mill constructed in accordance with one of the illustrative embodiments of the invention.

Fig. 2 is a vertical section on the plane of the line 2—2 of Fig. 1.

Fig. 3 is a somewhat fragmentary view through the size-reducing-chamber-providing member and associated parts, showing a modified form of construction.

Fig. 4 is a similar view showing a further modified form of construction.

Referring first to Figs. 1 and 2, it will be observed that a base 1 is provided with side frames 2, of which but one is shown in Fig. 1, providing

bearings 3, 3 for a shaft 4 supporting an oscillating size-reducing chamber-providing member 5, and further providing bearings as at 6 in which a crank shaft 7 is rotatably supported. The crank shaft 7 carries a combined driving pulley 8 and fly wheel 8 which may be driven by any suitable means, as, for example, a belt 9; and the crank shaft is connected by a connecting rod 10 to a pin 11 carried in projecting bosses 12, herein formed integral with the chamber-providing member 5.

The chamber-providing member in Fig. 1 comprises an upper size-reducing chamber 13 in which material of comparatively large size is adapted to be reduced to a size, say of a maximum dimension of one inch or thereabouts, or smaller, a lower size-reducing chamber 14 in which a pulverizing of the partially size-reduced product discharged from chamber 13 may take place, and an intermediate connecting passage portion 15 for conducting the crushed material from chamber 13 into chamber 14. Each of the chambers 13, 14 is arcuate in form and of substantially uniform cross section at all points along its length materially spaced from the approximately hemispherical ends 16 thereof. The arcs on which the chambers 13, 14 are struck have a common center in the axis 17 of the shaft 4. The top of the chamber-providing member 5 is provided with a flared funnel-like portion 18 providing a feed passage of extended dimension so that the stationary feed supply chute 19 through which material masses entering the initial size-reducing chamber 13 may find access to the latter irrespective of the oscillation of the chamber-providing member 5. A passage 21 connects the base of the funnel-like portion 18 with the top of the size-reducing chamber 13.

To promote the rapidity of size-reduction, a size-reducing medium is provided in the chamber 13, herein in the form of a single large ball of appropriate material, designated 22. The lower, radially inner wall of the chamber 13 is traversed by a slot 23 which opens into the annular material conducting space 15 which surrounds a hub-like portion 24 through which the central portion of the shaft 4 extends. The upper wall of the chamber 14 is traversed by a series of openings 25 through which the material passing through the annular space 15 may secure access into the lower size-reducing chamber 14. In that chamber, a size-reducing medium is also preferably used, this time a medium made up of a charge of relatively small size-reducing elements 26, desirably of graduated sizes so that some stratification

of material and size-reducing media may take place. Through the bottom wall of the chamber 14 there are provided a considerable number of discharge slots 27, and a suitable stationary chute 28 is arranged below the oscillatory size-reducing-chamber-providing member 5, to receive the reduced material therefrom.

The mode of operation of this form of the invention will be clear from the description given.

Material particles to be reduced in size supplied in any suitable manner to the stationary feed connection 19 enter the funnel-like portion 18 and pass through the opening 21 into the primary size-reducing chamber 13. Driving by the belt 9 of the flywheel and pulley 8 rotates the crank shaft 7 and causes the connecting rod 10 to oscillate the chamber-providing member 5 upon the axis 17. The oscillation of this member throws the contents of the chambers alternately in opposite directions, the contents moving in each direction a part of the time concurrently with and a part of the time relative to the walls of the chambers. The material entering the chamber 13 is subjected to a size-reducing action by the ball 22, and as the latter is thrown between the ends of the chamber 13, and the material also in part thrown between the ends of said chamber, the material is rapidly crushed sufficiently to escape through the sizable opening 23 in the bottom wall of the chamber 13. The material enters the chamber 13 through the opening 21 alternately at opposite sides of the ball 22 as the latter moves relative to the chamber, and so the size-reduction takes place at each end of the chamber 13. The material which passes through the discharge opening 23, of which but one is shown but of which there may be obviously be more if desired, enters the semi-annular spaces 15 and passes through the latter and through the slots 25 into the chamber 14. Here it mingles with the size-reducing medium 26, and the entire charge within the chamber 14 is thrown from end to end of the chamber and subjected to a combination of centrifugal pressure, internal working, and impact, whose proportions of the combined operation are determined by the design of the chamber and its oscillating means. The material, largely reduced to dust-like form within the chamber 14, is discharged into the collecting chute 28. It will be evident, noting that there is a thickening of the bottom wall of the chamber 14 at 29 throughout the length of the portion containing the slots 27, that the chamber forming member 5 may be balanced in large measure so that the weight of the mass thereof above the pivot and the weight of the mass below the pivot will substantially counterbalance each other or counterbalance each other with due allowance made for the effects of the connecting rod, crank pin, etc.; and a minimization of stresses on the shaft 4 secured. It will be noted, moreover, that the masses of the size-reducing media may be appropriately proportioned to maintain the balance of the entire oscillating system, and by appropriate determination of the feed rate and of the sizes of the discharge openings even the quantity of material undergoing reduction may be maintained so divided between the chambers as to provide a balanced relation of the entire system undergoing oscillation.

In Fig. 3, instead of using a somewhat irregular shaped size-reducing-chamber element 5, a substantially cylindrical size-reducing-chamber element 35 is provided, the periphery of this ele-

ment being, in the illustrative form shown, wholly cylindrical except for the projection therefrom of the feed funnel portion 36 and the webs 37 which support the pin 38 to which the connecting rod 10' is connected. Within the cylindrical body 35 there are formed three size-reducing chambers, a primary size-reducing chamber 39 with which the material conducting passage 40 of the funnel portion 36 communicates through an opening 41, and a pair of symmetrically arranged lower size-reducing chambers 42 and 43. Chambers 42 and 43 and the chamber 39 are struck on common arcs about the axis 44 of the supporting shaft of the chamber forming member 35. Said shaft is appropriately journaled in a frame of which a portion is shown at 46. Adjacent the ends of the inner wall of the chamber 39 there are provided a pair of passages 48 which open approximately centrally, as at 50, 51, through the inner walls of the secondary size-reducing chambers 42, 43. An appropriate crushing medium, herein a ball 53, is arranged in the chamber 39, and appropriate size-reducing media 54 desirably graduated in size are provided in the chambers 42, 43. Discharge orifices of suitable size and number, as shown at 55, are provided leading from the lower ends of each of the chambers 42, 43. The delivery of all the material discharged through the openings 55 through the discharge connection 56 is insured by an enclosure 57 whose upper portion at 58 is closely adjacent the horizontal diametric line of the size-reducing element 35.

The mode of operation of this arrangement will be readily appreciated. Here it will have been noted that the three chambers which are shown are symmetrically arranged with respect to a vertical plane passing through the axis of the shaft 44. It will be noted, moreover, that the several chambers are so distributed around that axis that a substantial balance of the cylindrical size-reducing chamber-providing member 35 is secured. It will be observed that the material crushed within the chamber 39 will discharge from adjacent the opposite ends thereof through the passages 48 into the chambers 42, 43 and there be reduced in size further to the desired degree. By proportioning the size of the discharge orifices 55 in a suitable manner, the ultimate fineness of the size-reduction may be made substantially anything called for. Due to the balancing secured by the design of the chamber and by the appropriate selection of the weights of the size-reducing media, the stresses upon the bearings of the shaft 44 set up during the oscillation of the chamber-forming member by the connecting rod 10' may be made not a great deal more than would result from the oscillation of a wheel of similar weight. The material discharged from opposite ends of the size-reducing chamber 39 is distributed nicely between the chambers 42, 43, and the size-reducing action at the lower ends of these chambers occurs in alternation as does also the secondary size-reducing action which takes place adjacent the upper ends of the chambers, though the latter is of less intensity. The material passing through the orifices 55 is prevented from escape by its delivery within the shield portion 57.

With reference to Fig. 4, this combines the structural features of the species of Figs. 1 and 2 and those of Fig. 3. A single, more elongated arcuate size-reducing chamber 60 containing, herein, a single large size-reducing element 61

is arranged above the center line 62 of the supporting shaft 63. A reversely-curved, arcuate secondary size-reducing chamber, also more elongated than in either of the previous forms, is shown at 64 and equipped with a charge of size-reducing media 65. The chambers 60 and 64 are arranged at opposite sides of a diametric plane through the substantially cylindrical size-reducing-chamber-providing member 66. Instead of employing the annular material conducting chamber 15 of the first species, a pair of material conducting passages 67 are symmetrically arranged at opposite sides of the shaft 63, and lead from points adjacent the ends of the inner lower wall of the chamber 60 to approximately corresponding positions in the inner upper wall of the secondary size-reducing chamber 64. Discharge orifices 68 lead from the chamber 64 opening through the lower wall of the latter.

A detailed discussion of the mode of operation of this form of the invention is unnecessary in view of the similarity of its different features to the features found in the other forms.

In all the forms of the invention it will be observed that I have provided a substantially balanced size-reducing-chamber-forming member mounted for oscillation and provided with chambers formed therein for the performance of size-reduction in a plurality of stages, the chambers being arranged in such relation to the axis of oscillation of the size-reducing-chamber-forming member as to maintain a desired balanced condition and also promote maximum efficiency in size-reduction. Of course it will be observed that access may be obtained to the interior of the chambers, for the removal of the size-reducing media, for example, in any appropriate manner; and removable side walls have been illustrated at 69 in Fig. 2 merely to serve as suggestions of this obvious feature.

Clearly the mill in each of its forms is simple, effective, very rugged, requires a minimum of power, reduces wear upon its bearings to the maximum possible extent; and, particularly in the species of Figs. 3 and 4, provides for an absolute maximum of size-reducing work in a minimum of space.

While there are in this application specifically described three forms which the invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a size-reducing mill, in combination, a size-reducing-chamber-providing member providing a primary size-reducing chamber above a horizontal axis of oscillation, a secondary size-reducing chamber below said horizontal axis of oscillation, said primary and secondary size-reducing chambers providing two-stage reduction of material fed to the primary chamber, means providing for the passing of predeterminedly-size-reduced material between said chambers, and means for oscillating said chamber-providing member on said axis through such an arc that a portion of said primary size-reducing chamber is always higher than the highest point in said secondary size-reducing chamber.

2. In a size-reducing mill, in combination, a size-reducing-chamber-providing member providing a primary size-reducing chamber above a

horizontal axis of oscillation and with its walls respectively nearer and more remote from said axis struck on arcs from the latter, a secondary size-reducing chamber below said horizontal axis of oscillation and with its walls respectively nearer and more remote from said axis struck on arcs from the latter, said primary and secondary size-reducing chambers providing two-stage reduction of material fed to the primary chamber, means providing for the passing of predeterminedly-size-reduced material between said chambers, and means for oscillating said chamber-providing member on said axis through such an arc that a portion of said primary size-reducing chamber is always higher than the highest point in said secondary size-reducing chamber.

3. In a size-reducing mill, in combination, a substantially cylindrical size-reducing-chamber-forming member, and means for oscillating said member on its axis, said member providing a plurality of arcuately-elongated size-reducing chambers therein arranged in a common annular zone and of a cumulative angular extent less than 360° and struck on radii of like lengths from the axis of oscillation of said chamber-forming member and each having concentric arcuate walls and each of radial dimension between its concentric arcuate walls materially less than the radii of their mean arcs, said chambers being connected and arranged for the serial size-reduction of material first in one and then in the remainder thereof.

4. In a size-reducing mill, in combination, a substantially cylindrical size-reducing-chamber-forming member journaled for oscillation on a horizontal axis, a downwardly concave primary size-reducing chamber being formed in said member above and radially spaced from the axis thereof, and a plurality of arcuate secondary size-reducing chambers being disposed in said member in a common annular zone with said first mentioned chamber, said common annular zone of the same radial dimension as said primary chamber and said secondary chambers being arranged and connected to receive material processed in said primary chamber, and means for oscillating said member on its axis through an angle of arc less than the angle of arc of said chambers.

5. In a size-reducing mill, in combination, a power oscillated size-reducing-chamber-forming element having at least three arcuate size-reducing chambers formed therein in a common annular zone and each with concentric arcuate walls respectively struck on the radii of the inner and outer walls of such zone, means for discharging size-reduced material from two of said chambers, means for introducing material to be processed initially into a chamber between said two chambers, and means for delivering material size-reduced in said third chamber to one or the other of said two chambers.

6. In a size-reducing mill, in combination, a power moved size-reducing-chamber-forming element having at least three arcuate size-reducing chambers formed therein in a common annular zone, means for introducing material to said mill having direct communication with but one of said chambers, separate passage means respectively connecting said one of said chambers at points spaced at opposite sides of the center of the latter directly with a plurality of said other chambers at points adjacent the centers of the latter, and means for discharging material from

the mill only after it has passed through at least two chambers.

7. In a size-reducing mill, an oscillatable size-reducing-chamber-providing element providing a pair of arcuate size-reducing chambers, one at one side and the other at the opposite side of a diametric plane including the axis of oscillation of said member, means for conducting material from one of said chambers to the other extending between said chambers and providing separated passage portions arranged in parallel at opposite sides of the axis of oscillation, and means for oscillating said member through an arc less than the arcuate length of said chambers, each of said chambers being offset from said axis and of an elongation arcuately at least twice its radial dimension and one having an elongated arcuate inner wall and the other an elongated arcuate outer wall along which its contents are slidable.

8. In a size-reducing mill, a generally cylindrical, oscillatable size-reducing-chamber-providing member providing a pair of elongated arcuate size-reducing chambers of relatively small radial dimension, one at one side and the other at the opposite side of a diametric plane including the axis of oscillation of said member, means for introducing all the material delivered into said mill into one of said chambers, means for discharging all the material discharged from the mill from the other chamber, and means for conducting material between said chambers providing separated passage portions arranged at opposite sides of the axis of oscillation and constituting the sole means of access for material that enters said first chamber to said second chamber, and means for oscillating said member on its axis through a small angle.

9. In a size-reducing mill, an oscillatable size-reducing-chamber-providing element providing a pair of elongated arcuate size-reducing chambers, one at one side and the other at the opposite side of a diametric plane including the axis of oscillation of said element, said chambers offset from such axis so that they have inner arcuate walls of substantial arcuate length, means for effecting a rapid power oscillation of said element while maintaining one of the chambers

therein with at least the major portion thereof at all times at the same side of a plane in which the axis of oscillation lies and which plane is perpendicular to a plane bisecting the path of oscillation of said chamber, means for delivering material to said last mentioned chamber, and means for conducting material from said last mentioned chamber to the other providing separated passage portions arranged at opposite sides of the axis of oscillation and connecting like portions of the adjacent sides of said chambers.

10. In a size-reducing mill, in combination, a substantially cylindrical size-reducing-chamber-forming member journaled for oscillation on a horizontal axis, a downwardly concave primary size-reducing chamber being formed in said member above the axis thereof, and a plurality of arcuate secondary size-reducing chambers being formed in said member in a common annular zone with said first mentioned chamber and so located in said member that in the mid-position of the latter, in respect to the oscillation thereof, said secondary chambers lie mainly below the horizontal diametric plane of said element, means for conducting material from said primary chamber to each of said secondary chambers, and means for effecting a rapid power oscillation of said member of a speed and amplitude to throw the contents of said several chambers back and forth between their several ends.

11. In a size-reducing mill, in combination, a substantially cylindrical size-reducing-chamber-forming member, and means for oscillating said member on its axis, said member providing a plurality of arcuately-elongated size-reducing chambers therein in a common annular zone and struck on radii of like lengths from the axis of oscillation of said chamber-forming member, said chambers so arranged that the corresponding ends of the several chambers are equally angularly spaced from each other, means for delivering material to be processed initially into one of said chambers, and means for delivering material size-reduced in said last mentioned chamber to each of the other remaining chambers.

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