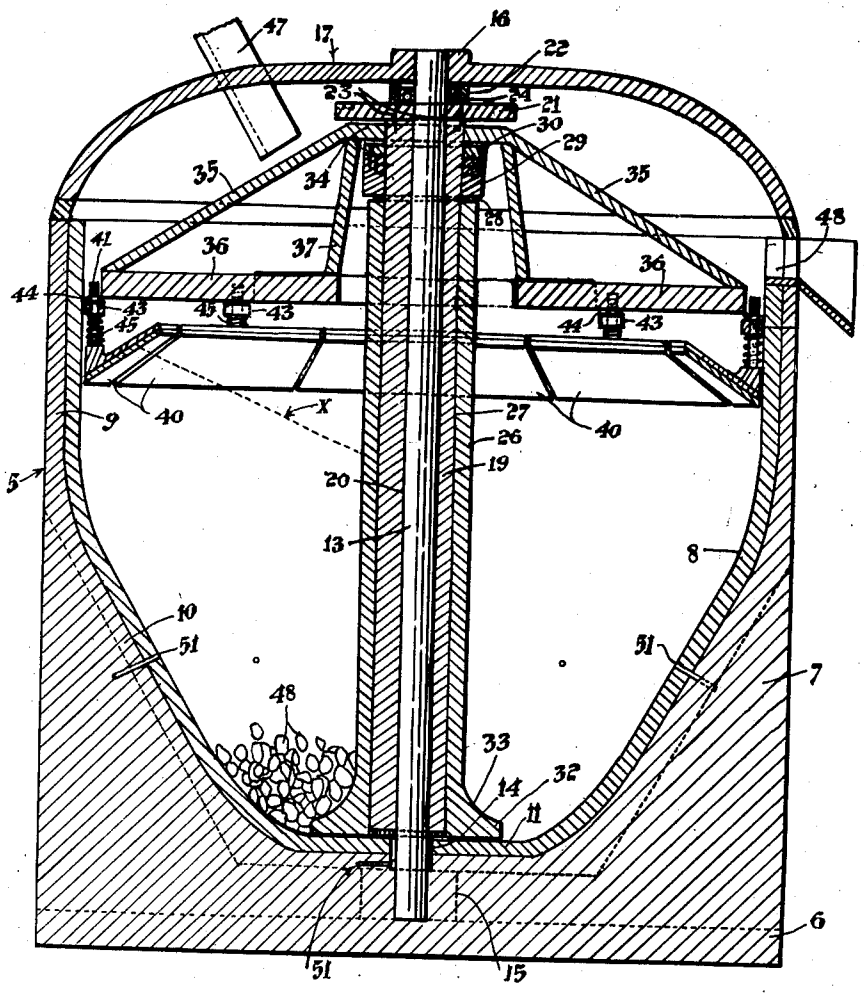
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PULVERIZING AND CLASSIFYING MACHINE

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PULVERIZING AND CLASSIFYING MACHINE

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This invention relates to improvements in the pulverization and classification of rock, ore, charcoal and other materials and the object is to provide a simple and efficient pulverizing and classifying apparatus wherein the particles of material being treated are pulverized in a novel and efficient manner by the application of crushing pressure thereto.

More particularly, the invention consists in the provision of a pulverizing and classifying machine wherein the motion of an eccentric is utilized to effect a circulatory movement of a charge of steel balls or other crushing elements and to thereby cause the particles of material being treated to be subjected to direct crushing pressure between crushing surfaces afforded by the eccentric, the crushing elements and a receptacle containing the eccentric and the crushing elements.

A preferred embodiment of the invention is disclosed in the accompanying drawings, in which the single figure is a vertical sectional view of my improved pulverizing and classifying machine.

Referring more particularly to the drawings, 5 designates a stationary bowl-shaped receptacle integrally joined to a base 6 by reinforcing ribs or webs 7. The entire inside surface of receptacle 5 is protected by a hard wear-resistant lining 8 shaped to conform closely to the shape of said surface.

The circumferential wall of receptacle 5 includes an upper cylindrical portion 9 of relatively large diameter and a lower conical portion 10 of gradually decreasing diameter toward the bottom wall 11 which is substantially flat and of relatively small diameter.

A vertically extending stationary shaft 13 is centrally disposed in receptacle 5 with the lower end of the shaft extending downwardly through a hole 14 in the bottom wall of the receptacle and into a step-bearing 15 carried by the base 6. The upper end of shaft 13 is fitted in a bearing 16 afforded by the central portion of a spider 17 mounted on and rigidly secured to the rim of receptacle 5.

Shaft 13 carries a rotatable eccentric in the form of a sleeve 19 provided with an eccentric bore 20 through which the shaft extends. A gear 21 and a sectional bearing housing 22 are rigidly secured to the upper end of sleeve 19 by suitable fastening means 23. Bearing housing 22 encloses and is rotatably supported by a bearing ring 24 rigidly secured to the upper portion of shaft 13. The bearing housing 22 and the bearing ring 24 serve to rotatably support eccentric sleeve 19 on shaft 13 with the lower end of the sleeve spaced a slight distance above the bottom wall 11 of receptacle 5. Eccentric sleeve 19 is surrounded by a closely fitting rotatable member 26 provided with a concentric bore 27 through which said sleeve extends. The upper end of tubular member 26 is welded, as indicated at 28, to a sectional bearing housing 29 which encloses and is rotatably supported by a bearing ring 30 rigidly secured to the upper portion of eccentric sleeve 19. By virtue of the bearing housing 29 and bearing ring 30 the tubular member 26 is supported for free rotation on eccentric sleeve 19 with the lower end of the tubular member spaced a slight distance above the bottom wall 11 of receptacle 5. The lower portion of tubular member 26 is enlarged radially to provide a flange-like foot member 32 having its upper surface 33 concavely curved as shown in the drawing.

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A plate 34 is rigidly secured to the upper portion of eccentric sleeve 19 so that said plate lies between the gear 21 and the bearing casing 29 secured to the upper end of tubular member 26. A plurality of radially extending arms 35 are formed integral with the periphery of plate 34 and incline downwardly and outwardly therefrom. The outer lower ends of the inclined arms 35 are rigidly secured to the outer ends of horizontally extending arms 36 arranged radially around the tubular member 26 at some distance below the upper end of said member. The inner ends of the horizontally extending arms 36 are rigidly secured to the lower end of supporting members 37 whose upper ends are rigidly secured to plate 34.

A circular series of adjustable plates 40 are arranged around the circumferential wall of receptacle 6 a short distance below the radially extending horizontal arms 36. The plates 40 are inclined vertically so that their outer edges are lower than their inner edges and are positioned relatively close to the inner surface of the cylindrical circumferential wall portion 9 of receptacle 5. The outer portions of plates 40 are equipped with rigidly attached supporting guide rods 41 extending upwardly therefrom through openings provided in suitable lugs 43 rigidly secured to the lining 8 of receptacle 5. The rods 41 are slidably fitted in the lugs 43 and are provided with threaded adjusting collars 44 engageable with the upper surfaces of the lugs 43 to limit the downward movement of the rods and the attached plates 40.

Coiled springs 45 encircle the lower portion of

rods 41 and are confined between the outer portions of the plates 40 and the lugs 42. These springs normally serve to force the plates 40 downwardly to the lowest position to which the plates are permitted to travel by the top collars 44.

The material to be pulverized is introduced into the receptacle 5 through a suitable feed chute 47 and is pulverized as hereinafter described by the motion of the eccentric sleeve 19 and the tubular member 26 acting in conjunction with a mass of pulverizing or crushing elements 48 which are similar to the pulverizing elements employed in conventional ball mills and may consist of hardened steel balls, cubes, or other suitable shapes.

In the operation of the machine described herein the receptacle 5 is charged with the material to be crushed and with a mass of the crushing elements 48 so that the level of the total charge is approximately as indicated at X. The eccentric sleeve 19 is then continuously rotated about shaft 13 by means of a suitable driving gear (not shown) meshing with gear 21. This produces an eccentric movement of the independently rotatable tubular crushing member 26 which, in turn, has the effect of producing a circulating movement of the crushing elements 48 and the charge of crushable material introduced into receptacle 5. This circulating movement is such that the crushing elements and the crushable material are caused to travel downwardly adjacent the tubular crushing member 26 and upwardly in a spiral fashion adjacent the inner surface of the circumferential wall of the receptacle 5 and this circulation of the crushing elements and crushable material is aided by the provision of the curve shape of the foot member 32 provided at the lower end of the tubular crushing member 26.

An important characteristic feature of the machine described herein is that the crushing or pulverization of the crushable material is effected, not by impact, but by the direct application of crushing pressure applied by the circulating movement of the crushing elements 48 in conjunction with the eccentric motion of the tubular crushing member 26 and the crushing surface afforded by the circumferential wall of the receptacle 5. In this connection it appears that the particles of material being crushed or pulverized tend to wedge themselves between the crushing elements 48 and the crushing surfaces afforded by the tubular crushing member 26 and the circumferential wall of vessel 5 and to resist the movement of the crushing elements 48 so that the latter are forced to overcome this resistance by crushing the particles of crushable material by the application of direct crushing pressure.

The classification of the pulverized material and the discharge thereof through the outlet 48 is effective by forcing upwardly directed streams of air, water or flotation liquid into the receptacle 5 through suitable openings 51 provided for this purpose. This classification and discharge of the crushable material also improves the crushing action.

In the case of wet pulverization involving the injection of water or flotation liquid through the openings 51 the classification is aided by the rotary movement and agitating effect of the arms 35 and 36 which are carried by and rotate with the eccentric sleeve 19. The continuous removal of the fines as they reach the level of the outlet 48 prevents sliming and contributes to the efficiency of the crushing or pulverizing action of the machine.

In order to obtain the most efficient results it is important that the level of the charge of crushing elements 48 and the crushable material contained in the receptacle 5 during the crushing action be predetermined in relation to the size and shape of the receptacle. If the height of the charge contained in the receptacle is too great the required movement of the eccentric tubular crushing member 26 will be prevented or retarded to an undesirable degree. On the other hand, if the charge of crushing elements 48 and crushable material contained in the receptacle is too small the crushing elements will circulate too freely in the receptacle under the influence of the eccentric motion of the tubular member 26 and the efficiency of the crushing of the crushable material by the application of direct crushing pressure thereto will be impaired. It is possible, however, for a skilled operator to soon determine the proper charging of the receptacle 5 to suit the shape and size of the receptacle in such manner as to give the most efficient pulverizing results.

The plates 40 form a substantially continuous ring around the inside of the receptacle 5 and serve to increase the wedging and direct crushing pressure effect to which the crushable material is subjected by the crushing surfaces afforded by the crushing elements 48, the tubular crushing member 26 and the inside surface of the receptacle 5.

In some cases the plates 40 may be omitted and the upper or rim portion of the receptacle 5 curved or inclined inwardly to provide a wedging surface corresponding to that afforded by said plates.

As previously stated, stop collars 44 carried by the supporting and guide rods 41 of the plates 40 may be threadedly engaged with said rods to provide a means for adjusting said plates vertically to vary the height of the plates when the latter are in their lowermost position. Such adjustment of the plates 40 in relation to the height of the charge of crushing elements 48 and the crushable material contained in the receptacle 5 assist the operator in adjusting operating conditions to obtain the best results.

In dry pulverizing procedures employing currents of gas instead of water or other liquids the top of receptacle 5 may be closed by a suitable cover overlying spider 17.

Having thus described the nature of my invention and a preferred embodiment thereof, it will be understood that various modifications may be resorted to within the scope and spirit of the invention as defined by the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

I claim:

1. A pulverizing and classifying machine comprising a receptacle having a peripheral outlet and an inlet into which the material to be pulverized is introduced, a vertically extending tubular crushing member centrally arranged in said receptacle, actuating means rotatably supporting the tubular member thereon and operable to cause said member to travel in an arcuate path about a vertical axis offset from the central vertical axis of said member, the latter being freely rotatable relative to said actuating means and about its own central vertical axis, a plural-

ity of loose crushing elements in said receptacle and movable, in response to movement of said tubular crushing member by said actuating means to transmit crushing pressure to the crushable material contained in said receptacle, means for injecting streams of fluid upwardly into said receptacle to effect classification of the crushable material during the crushing operation and means for ejecting material which has been crushed to the desired particle size from the upper portion of the receptacle through said outlet, said last mentioned means comprising a plurality of arms arranged in the upper portion of the receptacle, said arms being secured and rotated by said actuating means.

2. A pulverizing and classifying machine comprising a vertical receptacle having a bottom wall and a peripheral wall extending upwardly from said bottom wall, said receptacle being provided with an inlet to which the material to be pulverized is delivered and with a peripheral outlet for discharge of pulverized material located at the top of said receptacle, a vertically extending tubular crushing member centrally arranged in said receptacle and extending from the bottom to the top of the receptacle, actuating means rotatably supporting the tubular member thereon and operable to cause said member to travel in an arcuate path about a vertical axis offset from the central vertical axis of said member, the latter being freely rotatable relatively to said actuating means and about its own vertical axis and a plurality of loose crushing elements in said receptacle and movable in response to movement of said tubular crushing member by said actuating means to transmit crushing pressure to the crushable material contained in said receptacle.

3. A pulverizing and classifying machine as set forth in claim 2 including means for injecting streams of fluid upwardly into said receptacle to effect classification of the crushable material during the crushing operation.

4. A pulverizing and classifying machine as set forth in claim 2, including means for ejecting material which has been crushed to the desired particle size from the upper portion of the receptacle through said outlet, said ejecting means comprising a plurality of arms arranged in the upper portion of the receptacle, said arms being secured and rotated by said actuating means.

5. A pulverizing and classifying machine comprising a receptacle having a bottom wall and a peripheral wall extending upwardly from said bottom wall, said receptacle being provided with an inlet to which the material to be pulverized is delivered and with a peripheral outlet for discharge of pulverized material located a substantial distance above said bottom wall, an elongated vertically extending tubular crushing member centrally arranged in said receptacle and extending from the bottom to the top of the receptacle, actuating means supporting the tubular crushing member and operable to cause said member to travel in an arcuate path about a vertical axis offset from the central axis of said member, and a plurality of loose crushing elements in said receptacle and movable, in response to movement of said tubular crushing member by said actuating means, to transmit crushing pressure to the crushable material contained in said receptacle.

6. A pulverizing and classifying machine as set forth in claim 5, in which the elongated tubular crushing member is rotatably supported by said actuating means so that said tubular member is

freely rotatable relatively to said actuating means and about its own central vertical axis.

7. A pulverizing and classifying machine comprising a stationary open-top receptacle having a bottom wall and a peripheral wall extending upwardly from the bottom wall and provided with a peripheral outlet located adjacent the top of said receptacle, means for introducing the material to be pulverized into said receptacle, a vertical shaft centrally located in said receptacle and extending from the bottom to the top of the receptacle, a cylindrical sleeve rotatably mounted on said shaft and extending from the bottom to the top of said receptacle, said sleeve being provided with an eccentric bore through which the shaft extends, an elongated tubular crushing member encircling said sleeve and rotatably mounted thereon, said tubular member being provided with a concentric bore through which said sleeve extends, means for rotating said sleeve about said shaft to thereby cause said tubular crushing member to travel in an arcuate path about a vertical axis offset from the central vertical axis of said member and a plurality of loose crushing elements in said receptacle and movable, in response to movement of said tubular crushing member in said arcuate path, to transmit crushing pressure to the crushable material contained in said receptacle.

8. A machine as set forth in claim 7, including radially extending arms positioned in the upper portion of said receptacle and rotatable with said sleeve, said arms being secured to an upper portion of the sleeve projecting above the upper end of said tubular crushing member.

9. A machine as set forth in claim 7, including an annular crushing surface extending around and projecting inwardly from the upper portion of the peripheral wall of the receptacle, said annular crushing surface being positioned below but adjacent said peripheral outlet.

10. A machine as set forth in claim 7, including an annular crushing surface extending around and projecting inwardly from the upper portion of the peripheral wall of the receptacle, said annular crushing surface being positioned below but adjacent said peripheral outlet and consisting of a circular series of plates and means yieldingly suspending said plates from the circumferential wall of the receptacle so that said plates are permitted to have a limited independent vertical movement.

11. A machine of the character described comprising a stationary vertical receptacle presenting a bottom wall and a peripheral wall extending upwardly from said bottom wall and provided with a peripheral outlet located adjacent the top of the receptacle, means for introducing the material to be crushed into said receptacle, an elongated vertically extending tubular crushing member centrally arranged in said receptacle and extending from the bottom to the top of the receptacle, actuating means supporting the tubular member and operable to cause said member to travel in an arcuate path about a vertical axis offset from the central vertical axis of said member, a plurality of loose crushing elements in said receptacle and movable, in response to movement of said tubular crushing member in said arcuate path, to transmit crushing pressure to the crushable material contained in said receptacle, means forming an annular crushing surface extending around and projecting inwardly from the upper portion of the peripheral wall of the receptacle, said annular crushing sur-

face being located below but adjacent said peripheral outlet and a plurality of radially extending arms arranged in the upper portion of the receptacle above said annular crushing surface, said arms being secured to and rotated by said actuating means.

12. A machine as set forth in claim 11, in which said annular crushing surface comprises a circular series of plates and yielding means mounting each plate for independent vertical movement, said last mentioned means comprising guide rods extending upwardly from each plate through guide members attached to the peripheral wall of the receptacle and provided with threaded adjusting collars supported by the upper surfaces of said guide members and springs encircling the guide rods and positioned between the plate and said guide members.

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