Jan. 9, 1940. J. H. SPOHN, JR 2,186,596

GYRATORY CRUSHER

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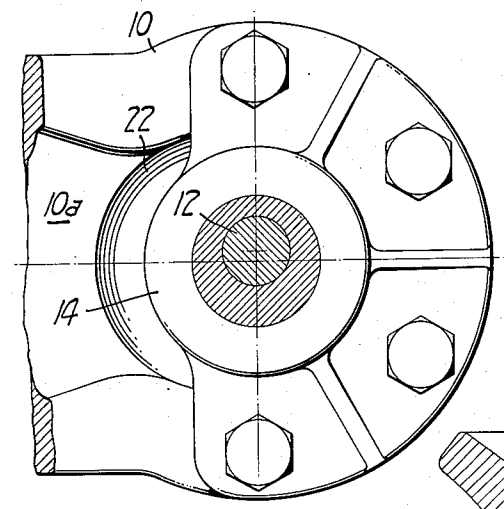


FIG_2_

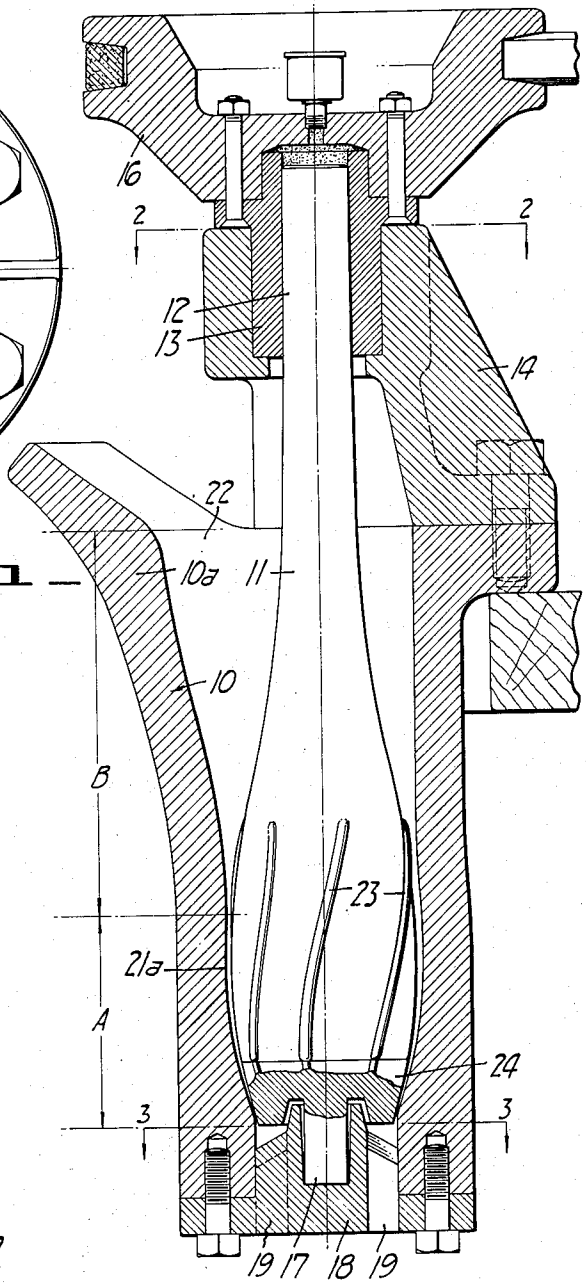


FIG_1_

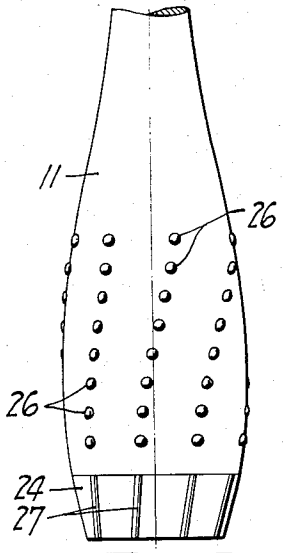


FIG_4_

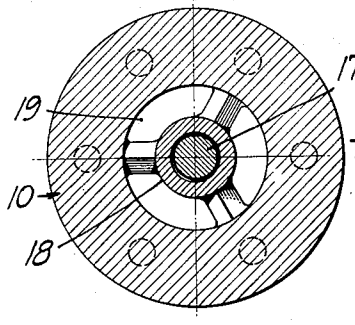


FIG_3_

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GYRATORY CRUSHER

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FIG_7_

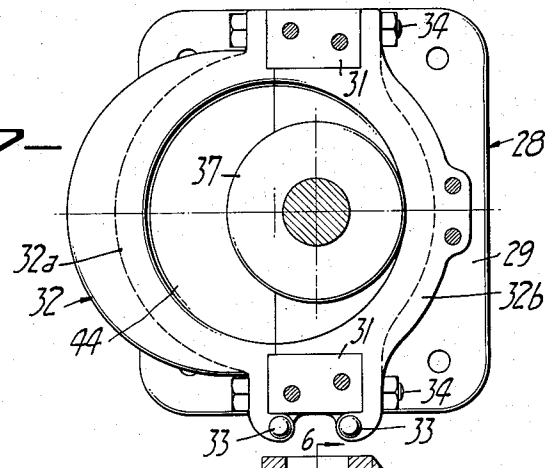
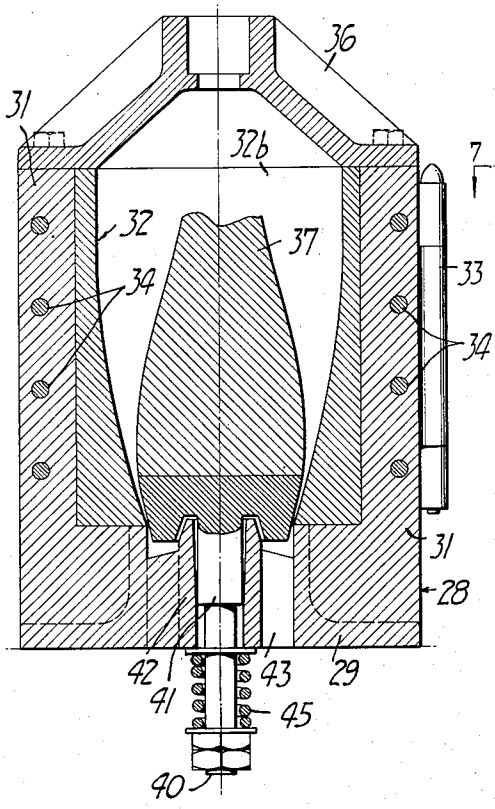


FIG_6_



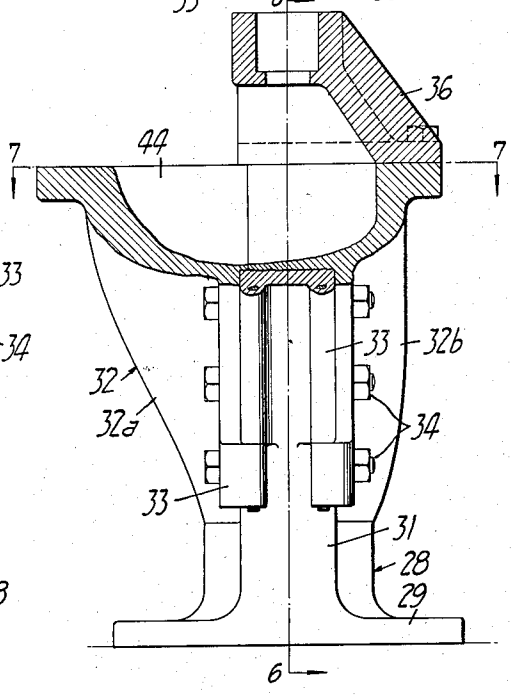


FIG_5_

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GYRATORY CRUSHER

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FIG_8_

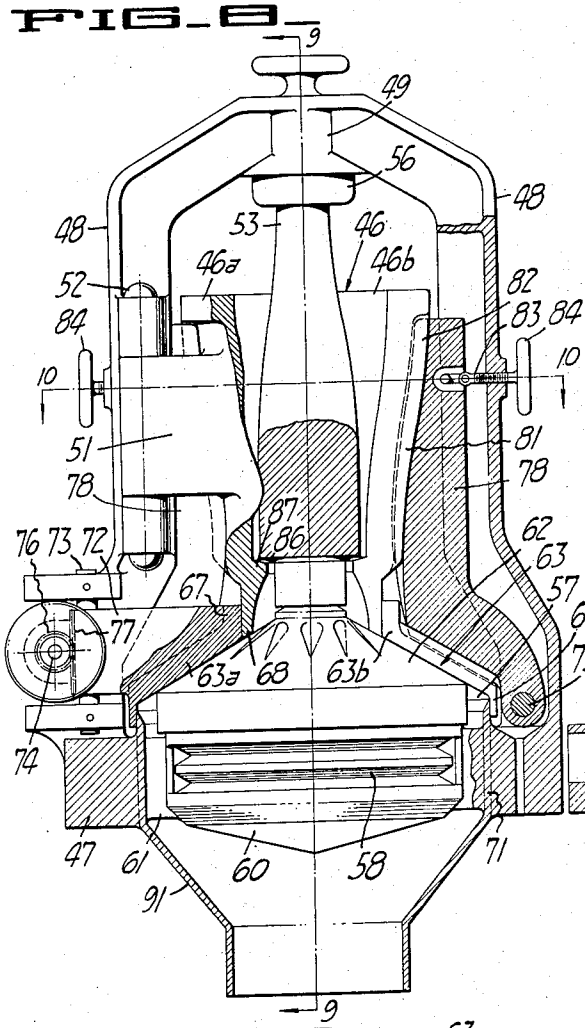
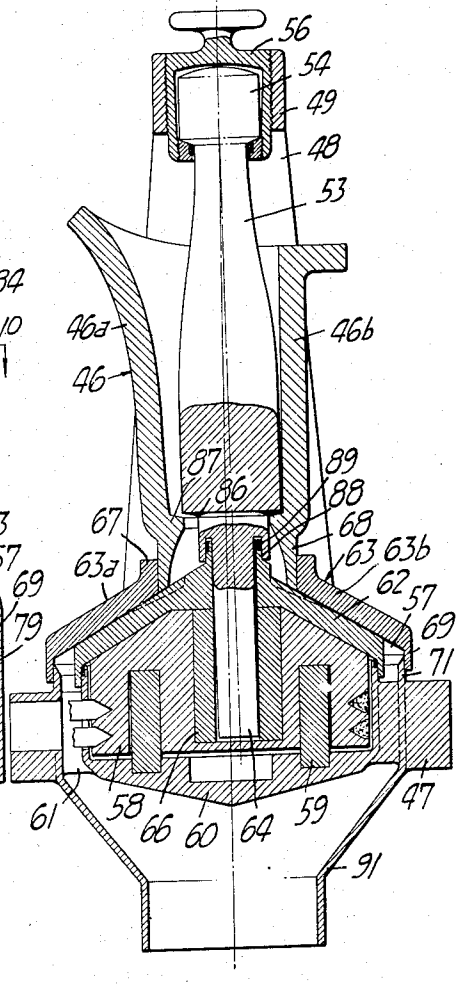


FIG_9_



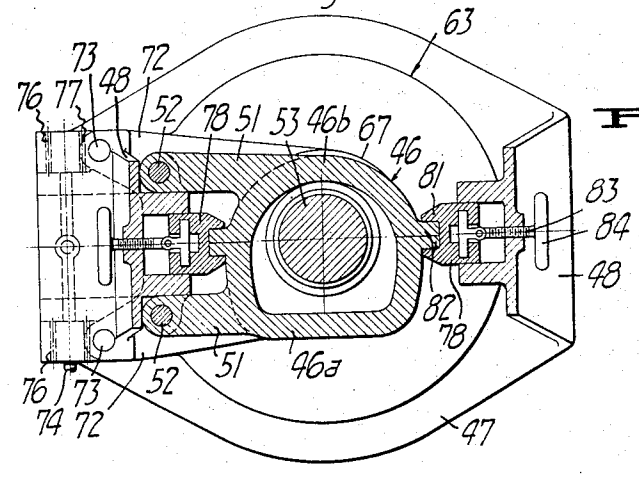


FIG_10_

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FIG. 12.

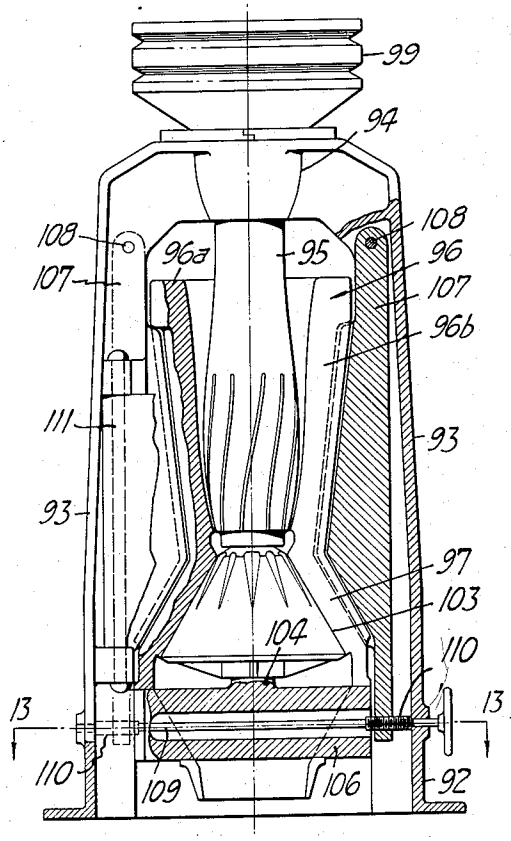
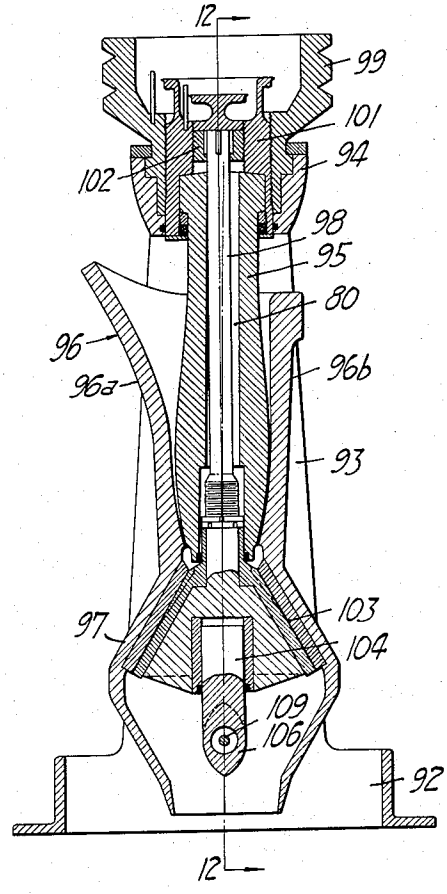


FIG. 11.



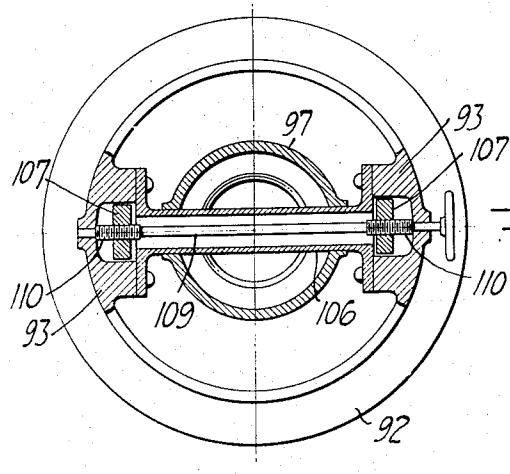


FIG. 13.

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2,186,596

GYRATORY CRUSHER

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Application April 17, 1936, Serial No. 74,956

3 Claims. (Cl. 83—10)

This invention relates generally to machines of the type commonly known as gyratory crushers, which are used for the crushing or grinding of ore and like solids. Such machines make use of a gyrating pestle disposed with a stationary bowl.

Various objects of the invention can be outlined as follows: To provide a machine capable of crushing ores to a relatively high degree of fineness, as distinguished from preliminary or coarse crushing operations; to extend the latitude of sizes of material which such machines can handle; to facilitate the downward movement of material between the opposed surfaces of the pestle and the bowl; to simplify cleaning of the bowl and the pestle; and to provide a machine particularly useful for assay purposes.

Additional objects of the invention will appear from the following description, in which certain embodiments of the invention have been described in detail, in conjunction with the accompanying drawings.

Referring to the drawings:

Fig. 1 is a side elevational view, in cross section, illustrating a gyratory provided with a top drive, incorporating the present invention.

Fig. 2 is a cross sectional detail taken along the line 2—2 of Fig. 1.

Fig. 3 is a cross sectional detail taken along the line 3—3 of Fig. 1.

Fig. 4 is a side elevational view of the pestle, incorporated in the machine of Fig. 1.

Fig. 5 is a side elevational view, partly in cross-section, illustrating a modified form of sectional bowl, which can be used in place of the bowl illustrated in Fig. 1.

Fig. 6 is a cross sectional detail taken along the line 6—6 of Fig. 5, and showing a portion of a pestle disposed within the bowl.

Fig. 7 is a cross sectional view taken along the line 7—7 of Fig. 5, and also showing the pestle incorporated in Fig. 6.

Fig. 8 is a side elevational view, partly in cross section, illustrating a modified form of machine having a bottom drive, and incorporating an attrition mill in addition to the parts forming a gyratory crusher.

Fig. 9 is a cross sectional view taken along the line 9—9 of Fig. 8.

Fig. 10 is a cross sectional view taken along the line 10—10 of Fig. 8.

Fig. 11 is a side elevational view, in cross section, illustrating a further modified form of the machine, in which a spindle extends through the pestle, for driving a supplemental attrition mill.

Fig. 12 is a cross sectional view taken along the line 12—12 of Fig. 11.

Fig. 13 is a cross sectional view taken along the line 13—13 of Fig. 12.

Referring first to that form of the invention illustrated in Figs. 1 to 4 inclusive, the machine consists of a stationary bowl 10, in conjunction with a pestle 11. The upper end portion 12 of the pestle is of reduced diameter, and is journalled within an eccentric bushing 13. This bushing is in turn carried by the journal bracket 14, and is fixed to the drive pulley 16. The lower end of the pestle 11 carries a stub shaft 17 of reduced diameter, which is concentric with the axis of the pestle. This stub shaft is in turn carried by a casting 18, which is secured to the lower end of the bowl 10. Casting 18 is provided with openings 19, for the discharge of crushed material. It will be evident that when the drive pulley 16, together with bushing 13, is rotated, the upper end of the pestle is caused to gyrate through a circular path, about the main central vertical axis of the machine, and that while the stub shaft 17 permits such gyratory movement, it serves to retain the lower end of the pestle substantially aligned with the vertical axis.

The lower portion of the bowl, as for example that part within the vertical limits indicated by letter A, are formed symmetrical with respect to the vertical axis of the machine. In other words the surfaces 21*a* of this portion of the bowl, upon which the ore is ground, are circular in transverse cross section, and are concentric with respect to the vertical axis. On the other hand, the upper portion of the bowl, through vertical limits such as exemplified by letter B, are non-symmetrical with respect to the vertical axis of the machine. This is because one side wall portion 10*a* is flared laterally to provide an enlarged opening or mouth 22, for receiving the material to be crushed or ground.

In order to insure proper continuous downward movement of the material being ground, during operation of the machine, the machine of Fig. 1 is shown having its pestle provided with projecting ribs 23. Instead of having these ribs extend in planes coincident with the axis of the pestle, they are disposed in a generally helicoidal fashion as illustrated, and are arranged at circumferentially spaced intervals about the pestle. The lower portion 24, or collar of the pestle, can be made as a separate part, secured to the main body of the pestle by suitable means, such as by welding. Since this collar forms the lower extremity of the pestle it is suitably dimensioned

so that the clearance between it and the adjacent surfaces of the bowl will pass only material of the fineness desired. Ribs 23 can be extended over the surface of collar 24, as illustrated.

The contours of the pestle and of the cooperating inner surfaces of the bowl, are proportioned in accordance with the type of crushing or grinding desired. As illustrated the pestle has a maximum diameter within the limits of the symmetrical portion of the bowl. Above the plane of maximum diameter the pestle gradually decreases in diameter, and likewise it gradually decreases in diameter towards its lower end. On horizontal planes taken through the machine at various elevations, opposed crushing surfaces which engage the material passing through the machine, assume various angles with respect to each other. Such angles as measured only in a vertical plane, coincident with the central axis of the machine, can be termed angles of nip. By inspecting either half of Fig. 1, it will be evident that the angles of the nip are relatively small at the upper end of the machine, that they gradually increase downwardly, and again decrease to a relatively small value about the lower portion of the pestle. Proportioning the angle of nip in this manner tends to more effectively cause downward movement of the material being crushed, thereby enabling the machine to operate at maximum capacity. It should also be noted that the bowl, as shown in Fig. 1, is undercut a slight amount. Thus for a region near the largest diameter of the pestle, the inner surfaces of the bowl are contoured to diameters larger than the zone immediately above the same. Such undercutting serves to maintain the pestle in its lowermost position, without the use of special retaining means.

Because of the shaping of the pestle, the area displaced by the gyrating pestle is less near the top of the machine, greatest at the plane of largest diameter, and again less near the lower end of the pestle.

Operation of the machine described above can now be reviewed as follows: Drive pulley 16 is driven at a suitable speed, to move the upper end of the pestle through a circular path about the central axis of the machine. Material to be crushed, which may vary as to size and which may be wet or dry, is introduced into the mouth 22 of the bowl. Some preliminary crushing takes place within the mouth of the bowl, particularly with respect to the larger sizes, and some of the material progresses about the pestle, while another portion of the material immediately feeds downwardly towards the large diameter of the pestle. As the pestle operates upon the material, it rotates about its own axis, in a direction opposite to the direction of rotation of the fly wheel 16. Such rotation of the pestle about its own axis causes the veins 23 to act upon the material to urge it downwardly, and to minimize any tendency for the material to clog or pack. Before the crushed material can pass out of the machine, it must be of proper fineness to pass the collar 24.

It should be understood that the ribs 23 need not be continuous for their entire extent. In fact satisfactory results have been obtained by using studs 26, such as shown in Fig. 4. Such studs can be arranged in spaced rows which are disposed helicoidally, as illustrated. In such event the collar 24 can be provided with ribs 27, serving as extensions of the rows of studs 26.

For many purposes, as for example assay operations, it is desirable to provide a construction enabling quick removal of the bowl for cleaning. In the modification of Figs. 5 to 7 inclusive, this is made possible by splitting the bowl on a vertical plane, and by providing a hinged mounting, whereby the two sections of the bowl can be swung away from the pestle. Thus a frame 28 is provided, which includes a base 29, and rigid spaced uprights 31. The bowl 32 is formed of two side sections 32*a* and 32*b*. These sections have hinge connections 33 with one of the uprights 31, whereby they may be swung on a vertical axis. For releasably clamping the bowl sections to the uprights 31, removable clamp bolts 34 are provided, which extend through flanges formed on the bowl sections, and through the uprights 31. The journal bracket 36, for the upper end of the pestle, is removably clamped by bolts to the upper end of bowl section 32*b*, and to the upper ends of the uprights 31.

When it is desired to clean the machine in Figs. 5 to 7 inclusive, the bolts attaching journal bracket 36 to the bowl section 32*b*, are removed, and then after removal of the clamp bolts 34, the two bowl sections can be swung apart away from the pestle. As illustrated in Fig. 6, the pestle 37 in this instance is proportioned differently than the pestle illustrated in Figs. 1 to 4 inclusive, and the inner faces of the bowl likewise have a different proportioning. The stub shaft 41 extending from the lower end of the pestle, is shown seated in a socket 42, provided in the base portion 29. This base portion of the frame is also shown provided with openings 43, for discharge of crushed material. By an inspection of Fig. 7 in conjunction with Fig. 5, it will be noted that the enlarged mouth 44 for receiving material fed to the machine, is formed by modifying the dimensioning of both the bowl sections. In this instance the contour of the upper portion of the bowl, taken on a plane normal to the axis of the machine, is substantially circular, but offset with respect to the vertical axis of the machine.

Since the bowl of Figs. 5 to 7 inclusive is not undercut, means is provided for holding down the pestle in proper operating position. Thus a pin 40 is shown extending from shaft 41, and nuts carried by this pin are engaged by the compression spring 45.

Figs. 8 to 10 inclusive illustrate a further species of the machine, having a mechanism which can be more conveniently operated for cleaning the machine, and also which incorporates an attrition mill, together with the gyratory crusher. Thus in this case the bowl 46 is formed of two side sections 46*a* and 46*b*. The frame is in the form of a yoke, including the base portion 47, the two spaced uprights 48, and the top portion 49 connecting the upper ends of the uprights. The bowl sections are provided with projecting arms 51, which in turn have hinge connections 52 with one of the uprights 48. The upper end of the pestle 53 is provided with an enlarged head 54, which is swivelled within a cage 56. This cage in turn is mounted in the top portion 49 of the frame, for vertical adjustment, as by means of a threaded connection.

The attrition mill acts upon the material delivered from the lower end of the pestle, and can be constructed as follows:— Mounted below the bowl 46, and within an opening 57 provided in the base of the frame, there is a combined drive pulley and fly wheel 58. This drive pulley is journalled to a ring 59, which in turn is carried

by the frame of the machine. Thus the ring is shown secured to an underlying casting 60, which is connected to the main part of the frame by webs 61. The upper face of drive pulley 58 carries the hardened grinding cone 62, which cooperates with a conical shaped housing 63. The stub shaft 64, extending from the lower end of the pestle 53, is accommodated by a bushing 66 in the drive wheel 58, and this bushing is disposed eccentric to impart the desired gyrating movement to the pestle.

The cone shaped housing 63 of the attrition mill is made in two sections 63a and 63b, which are preferably adjustable in a vertical direction. The upper part of the housing 63 is provided with a collar 67, which slidably fits a lower annular extension 68 of the bowl 46. Likewise the lower peripheral portion of the housing 63 is provided with a depending flange 69, which slidably fits an upstanding annular flange 71, formed upon the base 47. Each of the housing sections is provided with a laterally extending arm 72, which are pivotally carried on the vertical rods 73. Extending at right angles to the rods 73 and adjacent the same, there is a shaft 74, the end portions of which carry pinions 76. When the two sections 63a and 63b of the attrition mill housing are closed, rack teeth 77 formed upon the ends of arms 72, engage the pinions 76, whereby upon turning the shaft 74, the assembled housing 63 can be raised or lowered a slight amount.

To provide convenient means for releasably clamping together the two sections of the bowl 46, and the two sections of the attrition mill housing 63, a pair of clamp bars 78 are provided. The lower ends of these bars have pivotal connections 79 with the base 47. Their inner faces are provided with grooves 81 to engage flanges 82 formed upon the sections of the bowl 46, and to engage similar flanges formed on the sections of the housing 63. These bars can be advanced or retracted by means of threaded rods 83, which carry hand wheels 84. Upon retracting the bar 78 the two sections of the attrition mill housing 63, and also the two sections of the bowl 46, can be swung outwardly away from the pestle, to facilitate cleaning operations.

In the form of pestle illustrated in Figs. 8 and 9, a lower shoulder 86 is provided, which is formed on a relatively flat angle. This shoulder cooperates wtih a shoulder 87 formed in the lower portion of the bowl, and the clearance between the surfaces afforded by collar 86 and the shoulder 87, definitely limits the size of material permitted to pass from the bowl, to the attrition mill. Without such cooperating shoulders, a bottom drive machine of this character would not be capable of comparatively fine grinding, by action of the pestle.

With respect to the attrition mill, and its connection with the pestle, suitable means can be employed to prevent entrance of fine solids into the bushing 66. For example, the upper end of the attrition cone 62 is shown provided with an annular portion 88, which is accommodated in an annular recess formed in the lower end of the pestle. Suitable packing means 89, is provided at this point, to form an effective seal.

To suitably direct the discharge of ground material from the attrition mill, a discharge conduit 91 can be applied to the bottom of the machine as illustrated. This conduit may direct the ground material to any further apparatus being employed to operate upon the material.

The machine described with respect to Figs. 8 to 10 inclusive will operate substantially the same as the other machines, except that after the material has been reduced to a certain fineness by action of the pestle, it is delivered to the attrition mill, where it is subjected to further grinding to reduce it to a fineness suitable say for assay purposes. Application of gyratory movement to the bottom of the pestle does not modify the crushing action to a material extent, except that in this case the greatest amplitude of gyrating movement is applied at a point where the finer material is being crushed.

That form of the invention illustrated in Figs. 11 to 13 inclusive, also makes use of an attrition mill in conjunction with gyratory crushing, but the drive in this instance is applied to the top of the machine instead of to the bottom. The frame of the machine in this instance consists of a base 92, together with the spaced uprights 93, and the top portion 94 connecting the upper ends of the uprights. The bowl 96 in this instance is likewise formed in two sections 96a and 96b, and is integral with lower portions 97, which provide a housing for the attrition mill. The pestle 95 is formed to provide a longitudinal opening 80, to accommodate the spindle 98. The upper end of spindle 98 is connected to be driven by the pulley wheel 99, which likewise is associated with means for imparting gyratory movement to the upper end of the pestle 95. Thus the pulley itself is journalled to the upper portion 94 of the machine frame. Adjustably mounted within this pulley, as by means of a threaded connection, there is a cage 101, which eccentrically carries the upper end of the pestle 95. Adjustably carried within the cage 101, as by means of a threaded connection, there is a plug 102, having a concentric drive connection with the upper end of spindle 98. Thus when pulley 99 is rotated the upper end of the pestle is gyrated, while the spindle 98 is rotated and is maintained aligned with respect to the vertical center line of the machine.

The lower end of the spindle 98 has a drive connection with the inner conical part 103 of the attrition mill. This part of the attrition mill is separately journalled upon the stub shaft 104, which in turn is suitably supported by the frame of the machine. For example a hollow strut 106 can extend across the lower portion of the frame, to serve as a mounting for the stub shaft 104. To facilitate releasably clamping the two sections of the bowl together, clamping bars 107 are provided, which are somewhat similar to the clamping bars 78 of Fig. 8, except that in this case their upper ends have pivotal connections 108 with the frame of the machine. Extending through the hollow strut 106 there is a rotatable shaft 109, having threaded portions 110, engaging the lower ends of the clamp bars 107. By turning the shaft 109 the bars 107 can be swung outwardly, to release the two sections of the bowl, and thus permit them to be swung outwardly away from the pestle, about the hinge connections 111. The machine just described is particularly desirable for assay purposes, because of the ease with which it can be cleaned and adjusted for various grinding operations.

I claim:

1. In a machine for crushing ore and like material, a pestle disposed in a generally upright position, a bowl surrounding the pestle, one side of the upper portion of the bowl being flared laterally to provide an enlarged opening for receiving material to be ground, the walls forming

said one side affording coarse crushing surfaces in cooperation with the upper portion of the pestle, the opposite side of the upper bowl portion being materially closer to the upper portion of the pestle for finer crushing, the walls of the bowl being curvilinear in horizontal planes and gradually converging with the pestle from the flared portion of the bowl to said opposite side, and means for gyrating one end of the pestle.

2. In a machine for crushing ore and like material, a pestle disposed in a generally upright position, a bowl surrounding the pestle, the lower portion of the bowl affording crushing surfaces symmetrically disposed about the pestle, the upper portion of the bowl affording both coarse and fine crushing surfaces entirely surrounding the upper portion of the pestle and non-symmetrically disposed about the same, said last named crushing surfaces being formed by bowl walls which on one side of the pestle are offset laterally from the pestle by an amount substantially greater than the walls forming the diametrically opposite side of the bowl, the walls of the bowl being curvilinear in horizontal planes and gradually converging with the pestle from the side of maximum offset laterally from the pestle to said opposite side of the bowl, and means for gyrating one end of the pestle in a circular path.

3. In a machine for crushing ore and like material, a pestle disposed in a generally upright position, a bowl surrounding the pestle, the lower portion of the bowl affording crushing surfaces symmetrically disposed about the pestle, the upper portion of the bowl affording both coarse and fine crushing surfaces entirely surrounding the upper portion of the pestle and non-symmetrically disposed about the same, said last named crushing surfaces being formed by bowl walls which on one side of the pestle are offset laterally from the pestle by an amount substantially greater than the walls forming the diametrically opposite side of the bowl, the inner peripheral contour of the bowl on planes normal to the axis of the pestle being substantially circular for both said upper and lower bowl portions, and means for gyrating one end of the pestle in a circular path.

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