March 28, 1939. R. S. TICE 2,152,108

ORE-BREAKING DEVICE

Filed March 6, 1936

FIG. 1.

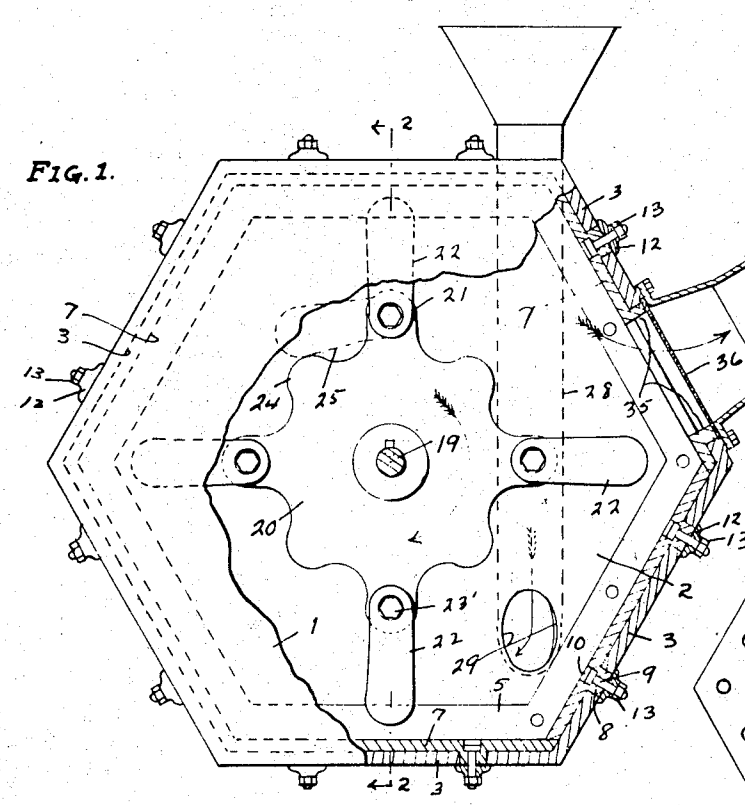


FIG. 4.

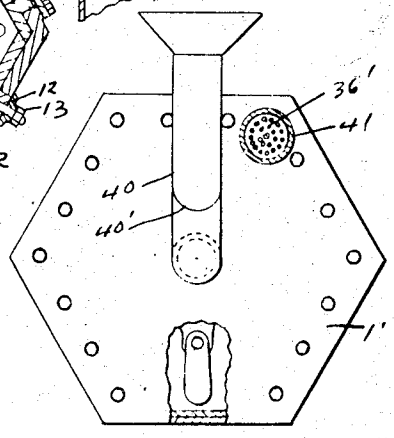


FIG. 2.

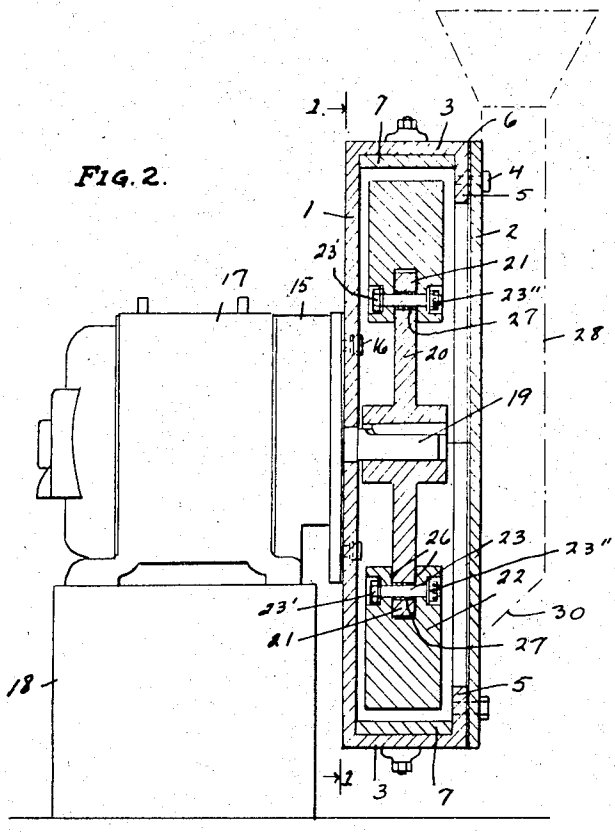
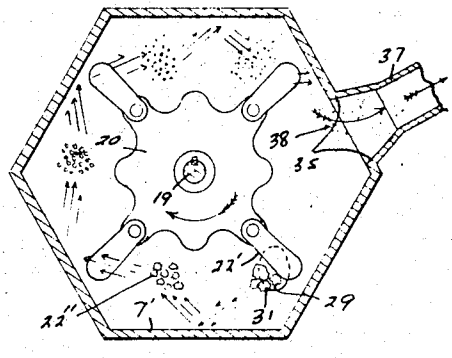


FIG. 3.



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ORE-BREAKING DEVICE

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7 Claims. (Cl. 83—11)

This invention relates to ore-breaking devices in which ore is reduced from relatively large chunks or pieces to substantially powder form for classifying and further treatment to separate the values therefrom.

One of the objects of the invention is to provide a simple, small, efficient and reliable device of the character described capable of continuously breaking ore in large quantities with little wear on the parts thereof. Another object is such device in which the broken or powdered ore is automatically blown from the machine when reduced to predetermined sized particles, and a further object is the device of the character described that is easily and quickly assembled and disassembled and in which replacements can be quickly made as may become necessary.

Other objects and advantages will appear in the specification and drawing annexed hereto.

In the drawing, Fig. 1 is a sectional view of a portion of my device as seen from the side of the device indicated by line 1—1 of Fig. 2 with part of the casing broken away and part of the device in section to show the internal construction of the device.

Fig. 2 is a sectional view of a portion of my device taken along the line 2—2 of Fig. 1, the motor being shown in elevation and the feed chute being shown in dotted line to indicate its position relative to the front of the casing although the section line is taken beyond the chute.

Fig. 3 is a reduced diagrammatic representation of the device of Fig. 1 to show the operation of the device in reducing ore to substantially powdered form.

Fig. 4 is a reduced elevational view, partly broken away, of a slightly different arrangement of feed and discharge means.

Briefly described, my invention comprises a machine adapted to reduce chunks of value-bearing ore, up to say several inches in diameter, to powdered form for blowing into a classifier or for further treatment for removing the values therefrom. By my machine this breaking up of the ore is accomplished by providing a plurality of pivotally connected hammers secured to a rotating shaft within a casing so that the hammers will be carried around the shaft radially extending therefrom. A feed means is provided through a side of the casing for feeding ore thereinto so that the ore will be ejected into the casing in front of the revolving hammers to be struck by the hammers and knocked against a peripheral wall of the casing. The peripheral wall of the casing against which the ore is knocked is formed to deflect the ore back to a position in front of the hammers so that the ore will again be struck by the hammers to strike the peripheral wall and again be thrown into the path of the hammers and so on until the ore is reduced to powder fineness and blown out through a screen and into a pipe leading to a classifier or other device as may be desirable, the casing, hammers and position of the feed means injecting ore into the casing being arranged so that the revolving hammers act as a blower for blowing the powdered ore into the powder discharge pipe, and out, the shaft mounting the hammers being rotated from 1600 to 3600 R. P. M., preferably about 1800 R. P. M. for ordinary value bearing quartz. By the hammers striking the ore against a rebounding surface, the ore is slowed up at each rebound into the path of the hammers so that a succession of sharp blows are delivered to the ore in its progress around the casing, and at each blow on the ore by the hammers and each striking of the ore against the peripheral wall of the casing, the ore is successively subjected to further shattering so that a chunk of ore dropped into the feed line and injected into the casing is reduced to powder almost instantly and discharged from the casing. There is no grinding or crushing action in my machine, as by forcing the ore between rollers, balls, or between such rollers, balls or hammers and the walls of a casing or between each other, since there is a clearance of approximately 1½ inches between the hammers and peripheral wall. In actual tests, using a $\frac{3}{16}$'' mesh perforated metal screen over the discharge opening and feeding hard chunks of quartz ore into the machine from about ¾ inch to several inches in diameter, my machine will handle 2½ tons of such material per hour, all of which will pass through the screen and over 90% of which is in condition for further treatment by the flotation process for removing the values therefrom.

In detail my device as shown in the drawing comprises a generally drum-shaped housing having opposed end walls 1, 2, and a plurality of flat, straight sides 3, six of such sides being shown in the drawing, said sides being arranged in hexagonal form, hence disposed in different planes.

The end wall 2 is removably secured by bolts 4 to flanges 5 extending inwardly from the sides 3 around the housing and gasket 6 is disposed between the end wall 2 and flanges 5 to provide an air-tight seal between the sides 3 and end

wall 2, the sides 3 and end 1 being cast together or formed integrally.

Plates 7 of manganese steel, or the like, are removably secured against the inner surfaces of walls 3, which plates have apertured bosses 8 formed therein that extend through openings in the walls 3. The plates are held in place by bolts 9 extending through the bosses to the outer sides of walls 3, said plates 7 being formed on their inner sides with recesses 10 for receiving the heads of the bolts so said heads will not project outwardly of the inner surface of said plates, but will in fact lie inwardly of such surface and hence not be subjected to excessive wear. Annular clamping members 12, and nuts 13, are at the outer ends of the bolts 8 outwardly of the walls 3, the clamps being washer-like members engaging the outer surfaces of walls 3 whereby the nut outwardly of the clamping member when screwed up will draw the plates 7 and members 12 tightly against opposite sides of the walls 3.

The drum-like housing in which plates 7 are secured is about 36 inches in diameter, although this may be varied to suit conditions, and the end walls 1, 2 are about 6 to 7 inches apart, thus the housing is of relatively small thickness as compared to breadth. The housing may be supported directly on a foundation or base, or end wall 1 may be tightly bolted to the flanged end of a motor housing 15 by bolts 16, the motor proper being indicated at 17, and thereby supported from the motor which in turn is supported on a suitable base 18.

Shaft 19 of the motor 17 centrally extends through end wall 1 to within the drum housing. Within the drum housing and secured on the outer end of shaft 19 is a hammer supporting disk or spider 20 formed with four equally spaced projections 21 around its periphery to which hammers 22 are pivotally secured at the inner ends of the hammers by bolts 23.

The hammers 22 are relatively heavy and elongated in a direction radially of the shaft when swung outwardly under centrifugal force when the shaft is rotated, and when idle they are free to fall, but between the projections 21 of the spider are smaller projections 24 adapted to support the uppermost hammer or hammers as indicated in dotted line at 25, when the machine is idle preparatory to starting.

Hammers 22 are spaced from one to two inches at their outer ends from plates 7 when in radially extended position and are rounded at their outer ends in the plane parallel to the ends of the drum, but square in the plane normal thereto. The opposite sides of the hammers lying adjacent the end walls 1, 2 are substantially parallel to the ends and spaced therefrom. The outer ends of the hammers are enlarged slightly to give greater weight to the outer ends, this enlargement being accomplished by the hammers being progressively thickened from about their pivotal points toward the outer ends so that their opposite faces lying in a direction transversely of their path of travel extend divergently inwardly from the outer ends of the hammers toward the axis of the shaft. This shape also contributes to the giving of the desired deflection to the ore adapted to be struck by the divergently extending faces of the hammers and also whereby the ore will be struck a sharper and more forcible blow than were the ore striking sides to extend parallel and radially of the axis of the shaft.

The inner ends of the hammers are slotted, as at 26, to receive the projections 21 of the spider therein and the sides of the hammers are recessed at opposite outer sides adjacent the slot to receive therein the one-headed end 23' of bolt 23 and a castellated nut 23'' at the opposite end of the bolt, the hammer being journaled to pass the bolt and a bronze bearing or bushing 27 being pressed into the opening through projection 21 to form a bearing for receiving the wear of the bolt. Thus the bolts including the headed ends and nuts thereon lie below the opposite sides of the hammers and are not subject to detrimental wear from the ore.

The end 2 of the drum housing carries a vertically or upwardly extending feed pipe 28 formed with a feed hopper at its upper end and opening at 29 at its lower end through the end 2 into the housing at a point adjacent the lower corner of the housing past which the hammers will first pass on descending when revolved about the shaft axis in the direction of the arrow indicated in the drawing.

The opening 29 is slightly spaced inwardly from the sides 3 and plates 7 toward the shaft axis and radially inwardly of the circle described by the outer ends of the hammers in revolving around the shaft. The lower end 30 of pipe 28 is inclined at about a 60° angle so that material being dropped into the pipe will be deflected by the lower end 30 to directly within the path of travel of the hammers at the outer ends of the latter, and the material consequently will be struck a sharp blow by the oncoming hammer.

In Fig. 3 the general action that takes place within the drum housing when the machine is in operation is indicated, the ore 31 in chunks up to several inches in diameter, preferably about one inch, is struck a blow by oncoming hammer 22'. This blow not only shatters the ore to a certain extent, but deflects the ore against plate 7' again causing a shattering of the ore, which rebounds to position 22'' where it is again struck by the hammer and further shattered, and so on around the drum, each blow by the hammers, and plates 7, causing a further shattering of the ore. It is important to the result that there be at least from 5 to 7 straight sides to the drum, preferably six sides, since a greater or lesser number of sides reduces the efficiency of the machine in that a greater number too closely approaches a true cylinder and a lesser number does not give the necessary breaking surfaces.

The peripheral side of the machine on the side of the shaft in which opening 29 is positioned, and substantially above the opening, is a discharge opening 35 over which is fitted a perforated plate 36 and extending from said opening 35 is a discharge pipe 37 that may lead to a classifier or other place for further treatment of the ore if desired.

The opening 35 is preferably at the end of one of the flat upper sides of the housing closest to the feed opening 29 since when the machine is in operation, the heavier ore particles will strike about the center of the plate 7 and not the screen or perforated plate, thereby reducing the possible undue wear on the perforated plate. the powdered material, indicated at 38 in Fig. 3, is blown out through the screen and discharge pipe 37 and any heavier particles that might not be sufficiently broken to pass the screen will fall into the path of travel of the hammers again passing around the machine. The shaft mounting the hammers is rotated preferably at about 1800 R. P. M., hence a strong blower action is

created by the hammers, the air entering with the ore radially inwardly of the sides of the housing.

It is of course obvious that the motor may be replaced by a pulley and belt driven from a motor and the shaft mounting the hammers extended through opposite ends of the housing and mounted in bearings, but the preferable construction is as described, being compact and eliminating the necessity for additional bearings.

The hammers and plates 7 may be quickly and easily examined, replaced, or repaired by removing end 2 and screen or perforated plate 36 can be replaced by finer or coarser mesh, or a new plate or screen, as desired, but a $\frac{3}{16}$'' mesh screen is found to be satisfactory for most work.

In the discharge pipe 37, a feed back pipe 37' is shown to prevent any particles of a size not readily blown to the classifier from filling the pipe 37, since the heavier particles will roll back by gravity into the pipe 37' to a collector or may be conveyed from the pipe 37 back to the feed pipe 28.

In Fig. 4 a form of device is shown in which the feed 40 and discharge pipes 41 are open into the housing through the removable side 1', and feed pipe feeds to the center of the housing, the pipe 40 being angularly bent at 40' to direct the material into the path of travel of the hammers.

A perforated plate 36' may be used over the discharge opening, which opening is in the upper corner of the cover plate 1' or the perforated plate may be omitted in this form of device since the material will all stay in the housing until broken into impalpable powder.

While the breakage of material in this form of device is more complete than in the form shown in Fig. 1, the capacity of the mill is somewhat lessened, but further classifying becomes unnecessary, hence this loss is fully compensated for.

Having thus described by invention, I claim:

1. A device for reducing relatively large pieces of ore to substantially powder-like fineness comprising a polygonal-sided drum-like casing having at least six abutting sides and having opposite end walls and disposed with its end walls substantially vertical in which casing the sides thereof are flat and substantially of the same dimensions, a shaft co-axial with the central horizontal axis of the casing that passes centrally through the end walls of the casing, said shaft rotatably extending through one of said end walls into the casing and a single row only of hammers within the casing secured to the shaft and radially extending therearound in a single vertical plane centrally of the casing for revolving with the shaft upon rotation of the latter the hammers extending closely adjacent the end walls of the casing, said hammers being spaced substantially equidistant at their outer ends from the central portions of said sides of the casing when said hammers are in radially extended position, the space providing said clearance being of a width radially of the drum axis to substantially prevent grinding of the relatively large pieces of ore between the sides and hammers, an outlet for the powdered ore in one of the sides of the casing positioned in the upper half thereof and an ore inlet for relatively large pieces of ore to be reduced to powder form positioned adjacent one of the lateral sides of the hammers closer to said axis than the outlet whereby the powdered ore will be blown out of the casing through the outlet by motion of the hammers.

2. Ore-breaking apparatus comprising a horizontally disposed shaft, an annular row of similar sized, substantially equally spaced, elongated hammers on said shaft, said hammers extending radially relative to the axis of the shaft and mounted thereon, a stationary polygonal-sided drum-like housing enclosing said hammers, said housing including opposite end walls at opposite lateral sides of the row of hammers disposed relatively close to said lateral sides, the sides of the housing being made up of a plurality of flat plates each being planar and said plates connected end to end and extending across the outer ends of the hammers of the row and equally spaced therefrom and from the axis of the shaft whereby upon revolution of the hammers around the axis of the shaft, said hammers will successively clear each of said plates by substantially the same distance, means for revolving the hammers around said axis, and each of the hammers having a substantially flat striking surface on the side facing the direction of movement of the hammers of a width extending the major distance between the opposed inner sides of the opposite end walls of the housing, an ore inlet to within the housing and an ore outlet for discharging ore therefrom.

3. In a construction as defined in claim 2, said outlet being disposed in one of said flat plates on the upper half of the casing and offset to one side of the axis of said shaft in the direction of rotation of the hammers positioned above said shaft during revolution of the hammers about said axis and the casing sides and ends being substantially imperforate and substantially hermetically sealed except for said inlet and outlet.

4. Ore breaking apparatus comprising an annular row of similarly sized and shaped, substantially equally spaced, elongated hammers extending radially outwardly from a central horizontally extending axis in a single vertical plane, means mounting said hammers for simultaneously revolving around said axis, the outer ends of said hammers terminating at substantially equal distances from said axis whereby their outer ends will describe a common circular path upon revolution of the hammers, a stationary, polygonal-sided drum-like housing having at least six sides enclosing said hammers, said housing including vertically disposed end walls substantially parallel to the plane of the row, said end walls being positioned on opposite lateral sides of the row of hammers and relatively close thereto, each of the side walls of said housing being flat planar and connected end to end with each other to substantially enclose the row of hammers and disposed a substantial distance outwardly of said circular path at equal distances therefrom, whereby said hammers will successively clear each of the inner flat surfaces of the side walls by substantially the same distance when the hammers are revolved.

5. In a construction as defined in claim 4, said hammers each being formed with substantially a flat and planar striking surface on the side thereof facing the direction of movement of the hammers, said surface being of greater length longitudinally of the hammer than the width thereof.

6. In a construction as defined in claim 4 said hammers each being formed with a substantially flat striking surface on the side thereof facing the direction of movement of the hammers, said surface being of greater length longitudinally of the hammer than the width thereof and an ore inlet in one of the end walls of housing positioned for feeding ore into the path of travel of said

hammers at a point adjacent their inner ends, and an outlet for the broken ore disposed in the upper portion of the housing close to said inlet but rearwardly thereof relative to the direction of rotation of the hammers, and all the walls of said housing being imperforate and arranged to substantially prevent ingress or egress of air to and from within the housing except through said inlet and outlet whereby ore pulverized by said hammers will be blown through said outlet solely by movement of the hammers, and means for revolving said hammers around said axis at a relatively high rate of speed sufficient to cause the pulverized ore to be blown through said outlet.

7. An ore breaking device comprising an enclosed casing having substantially parallel, vertical, lateral sides, a single annular row only of elongated hammers within said casing disposed in a single vertical plane, means mounting said hammers for revolving in a circular path about a central axis with the hammers extending longitudinally thereof radially outwardly of said axis, said hammers each having a flat substantially planar striking surface from substantially end to end thereof facing in the direction of revolution of the hammers, said casing including a plurality of flat and planar ore deflecting plates arranged in a row in end to end relationship extending completely round said circular path and radially outwardly of said hammers with their flat inner sides facing and substantially spaced equal distances from said central axis and from the outer ends of said hammers when the hammers are revolved about said axis, the lateral sides of said casing respectively being positioned relatively close to the opposite lateral sides of the hammers of said row, an ore inlet in one of the lateral sides of the casing and an ore outlet in one of said plates at a higher elevation than the ore inlet.

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