Dec. 16, 1947. J. H. DRYER 2,432,610

SELF-CLASSIFYING BALL MILL

Filed Sept. 19, 1944 3 Sheets-Sheet 1

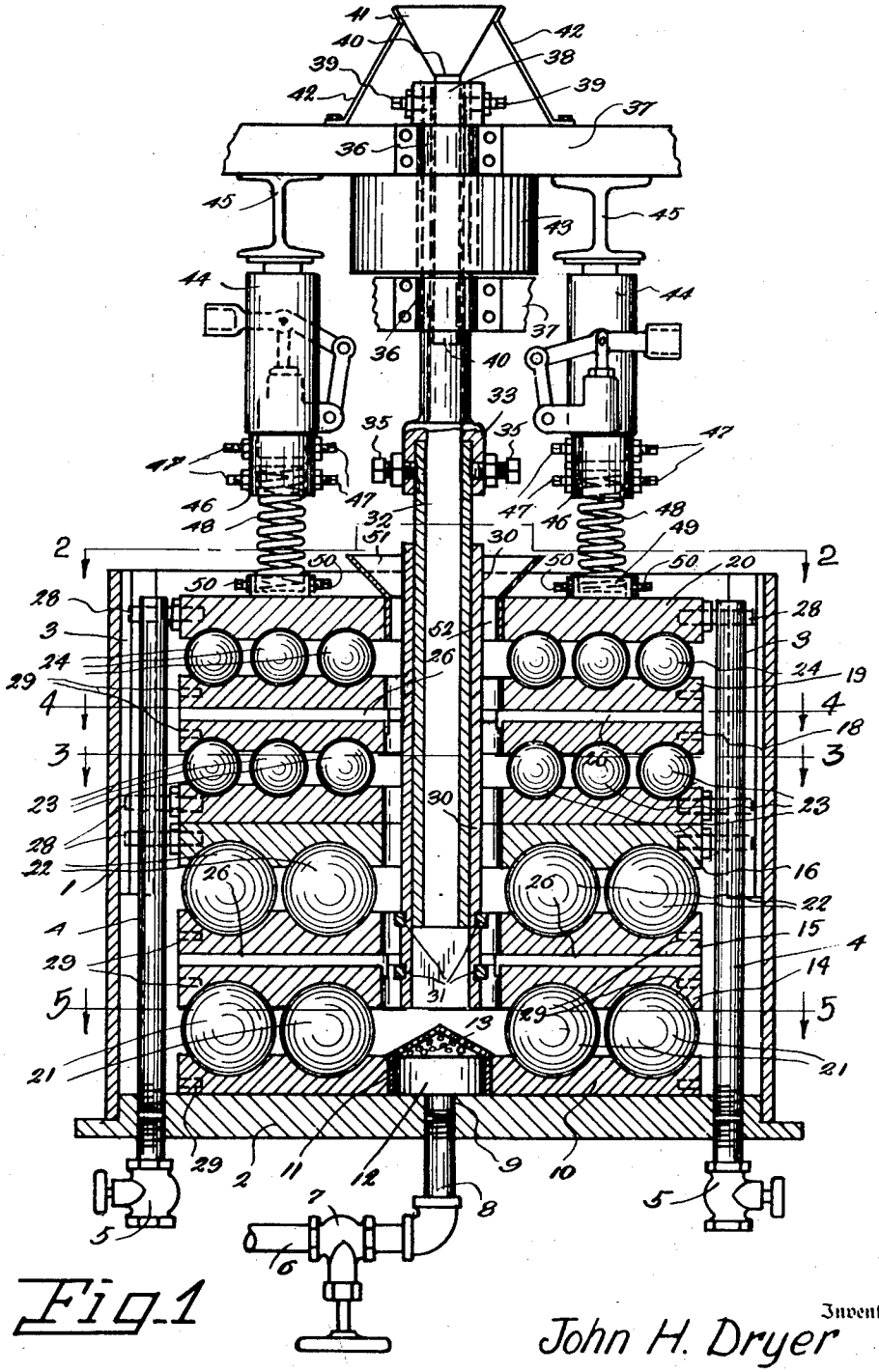


Fig. 1

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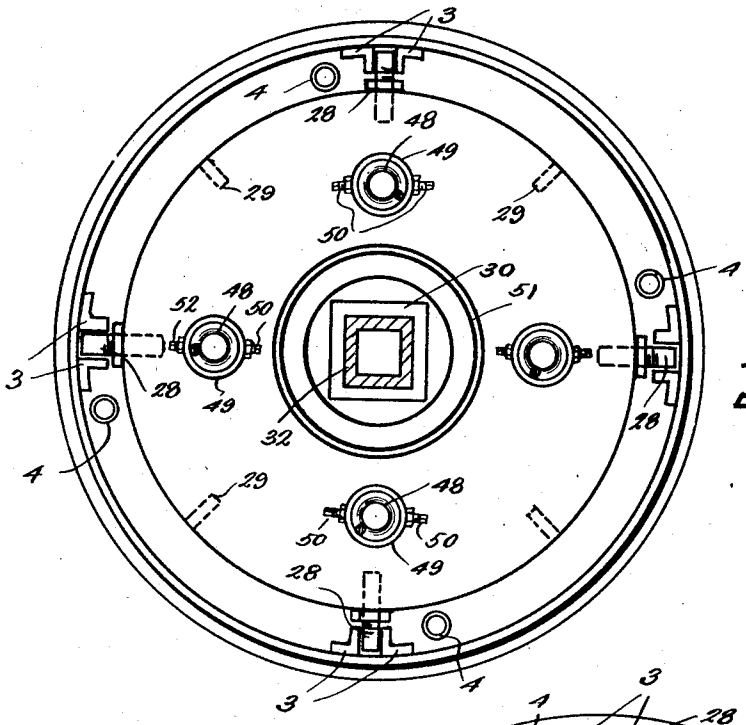


Fig. 2

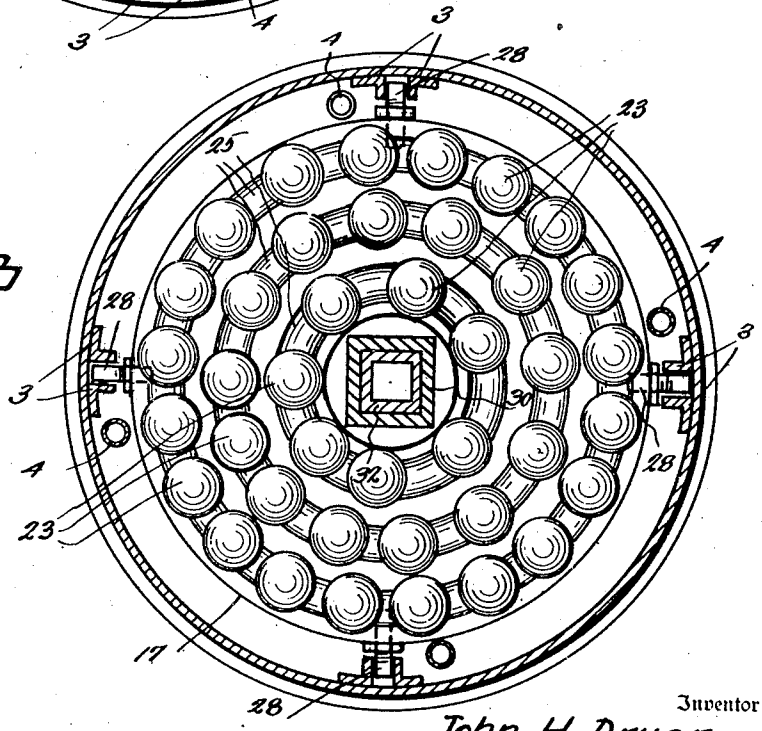


Fig. 3

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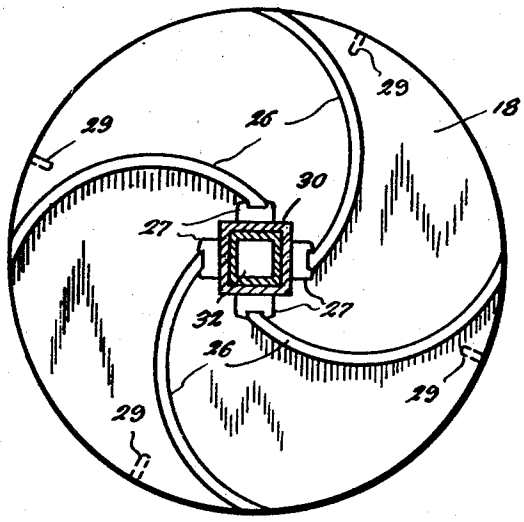


Fig. 4

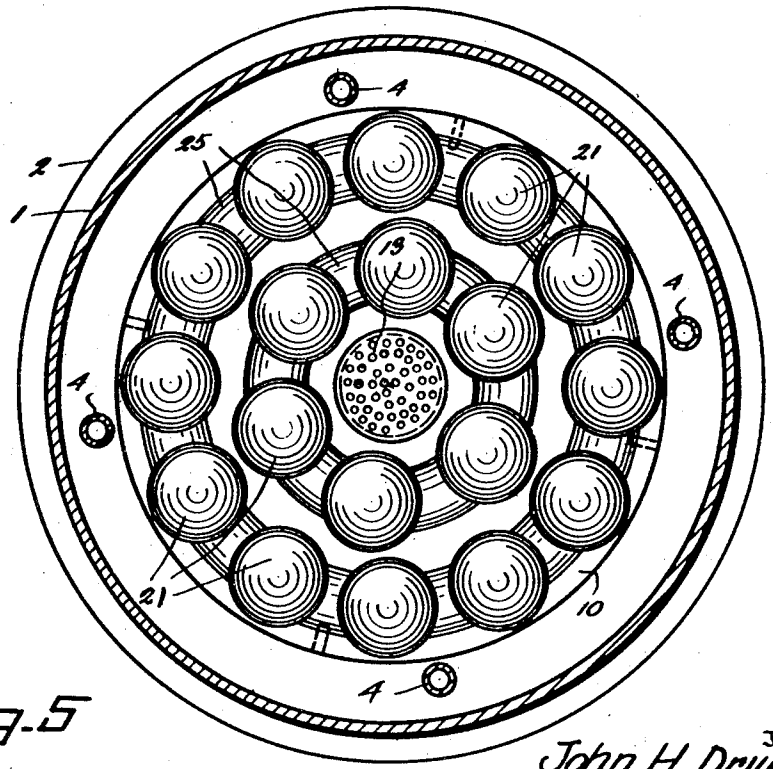


Fig. 5

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SELF-CLASSIFYING BALL MILL

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2 Claims. (Cl. 241—44)

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This invention relates to an ore grinder and it is one object of the invention to provide a mill of such construction that crushed ore may be reduced to fine particles in a container or casing filled with water and light material carried off with the water through overflow pipes.

Another object of the invention is to provide a grinder wherein water enters through the bottom of a casing and flows upwardly therein and out through upper ends of overflow pipes passing upwardly through the bottom of the casing and not only carry fine particles of ore upwardly to the surface of the water and out through the overflow pipes, but also carry coarse ore upwardly in step by step movements from one set of grinders to another.

Another object of the invention is to provide a grinder wherein the ore is delivered through a pipe extending vertically at the center of the casing and out through the lower end of the pipe at such point that it will be acted upon by a lower set of grinders and then carried upwardly to other grinders.

Another object of the invention is to provide grinders consisting of balls mounted between plates, certain of the plates being held against turning and others being rotated with a tubular shaft constituting an inlet pipe for the ore.

Another object of the invention is to provide the grinder with jacks for applying pressure to the uppermost disc and cause good grinding action to take place between the grinder balls and companion discs as certain of the discs turn with the center shaft.

Another object of the invention is to provide an ore grinder wherein discs are mounted in a casing in such manner that they may be readily removed through the open top of the casing when necessary.

Another object of the invention is to provide an ore grinder which is simple in construction and very efficient in operation.

In the accompanying drawings:

Fig. 1 is a sectional view taken vertically through the improved ore grinder.

Fig. 2 is a transverse sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a sectional view on the line 3—3 of Fig. 1.

Fig. 4 is a sectional view on the line 4—4 of Fig. 1.

Fig. 5 is a sectional view on the line 5—5 of Fig. 1.

This improved ore grinder has a casing 1

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formed of strong metal or other suitable material and provided with a base 2 upon which the wall of the casing rests. The casing is open at its upper end and the walls carry guides or tracks 3 which extend vertically and are spaced from each other circumferentially of the casing. Overflow pipes 4 extend vertically through the bottom or base of the casing in circumferentially spaced relation to each other and these pipes have their lower end portions threaded and screwed into opening in the base 2 and communicating with valves 5 for controlling flow of water through the pipes from a suitable source. There has also been provided a pipe line 6, controlled by a valve 7, and having a vertically disposed end portion or nipple 8 which is engaged in an opening 9 formed centrally of the base 2 so that water may be fed to the casing. A disc 10 rests upon the base 2 within the casing and this disc is formed with a central opening 11 in which is fitted a hood 12 defining a water inlet chamber and having a substantially conical top 13 formed of perforated metal so that water entering the chamber through pipe line 6 will be discharged therefrom as streams of water which flow upwardly in the casing to fill the casing with water. When the casing is filled to the upper ends of the pipes 4, water will overflow through pipes 4 and carry with it any material floating upon the water or of such lightness that it will be carried into the pipes with the water.

The grinding means within the casing includes the disc 10 and other discs 14, 15, 16, 17, 18, 19 and 20, together with balls 21, 22, 23 and 24, the balls 21 being located between the discs 10 and 14 and the balls 22 being located between the discs 15 and 16. These balls are large and, between the discs 17 and 18 and the discs 19 and 20, are disposed the balls 23 and 24, the balls 23 and 24 being of appreciably smaller diameter than the balls 21 and 22. Confronting faces of the companion discs are formed with circular grooves 25 constituting annular seats for the balls and permitting said balls to have rolling motion without moving out of their proper positions relative to the discs and each other, as shown in Figs. 3 and 5. The large balls 21 and 22 grind coarse ore and the smaller balls 23 and 24 grind finer ore carried upwardly to them by the flowing water. Spacers 26, which have the form of iron strips curved longitudinally, are disposed between discs 14 and 15 and between discs 18 and 19, and have their inner ends formed with hooks 26 engaged in openings 27 formed in the discs. The discs 14,

15, 18 and 19 are rotary discs but the discs 10, 16, 17 and 20 are held against rotation, and, referring to Fig. 1, it will be seen that they carry studs or stems 28 screwed into the discs and projecting radially therefrom for engagement in the tracks 3 formed by the companion bars shown in Figs. 2 and 3. Referring to these figures, it will be seen that the stems or pins 28 hold the discs carrying them against rotation and also guide vertical movement of these discs in the casing during use of the grinder. All of the discs are formed in their peripheral faces with sockets 29 so that pins may be fitted into the sockets and then engaged by a grapple for hoisting the discs out of the casing or lowering them into place.

A hollow shaft 30, rectangular in cross section, extends vertically in the casing over the nozzle 12 and through openings of the discs and is connected with the rotary discs 14 and 15 by keys 31 so that these discs turn with the shaft, the discs 18 and 19 being formed with openings having squared portions, (see Fig. 4), to snugly receive the shaft and cause them to turn with the shaft. The other discs are formed with circular openings through which the shaft passes and attention is called to the fact that the openings of the discs are of such size and shape that crushed ore and water may pass through them. The major portion of the crushed ore is fed into the casing through a tube 32 which fits snugly within the shaft 30 and has its upper portion protruding from the shaft and engaged in the socket 33 of a tubular shaft 34, where it is secured by set screws 35. The shaft 34 is rotatably mounted through bearings 36 carried by overhead beams 37 and, at its upper end, the shaft carries a thrust collar 38 held thereon by set screws 39. Within the hollow shaft fits the elongated spout 40 of a hopper 41 which is supported by a suitable number of braces 42 and may be of any size desired. The crushed ore is fed to the hopper and from the hopper it flows through its spout and into the shaft 40 down which it flows into the tube 32. After flowing through the tube the ore enters the lower portion of shaft 30 and is delivered therefrom directly over nozzle 13, so that the streams of water discharged from the nozzle will carry the crushed ore upwardly through the center openings of the discs. The heaviest ore remains upon the disc 10 for grinding by the balls 21 but the lighter ore is carried upwardly to the other discs, a portion of the ore being delivered between the discs 15 and 16 for grinding by the balls 22 and other portions being carried upwardly and deposited between discs 17 and 18 for grinding by balls 23 and between discs 19 and 20 for grinding by balls 24. It will thus be seen that the crushed ore will be progressively acted upon by the balls as it is carried upwardly. Eventually, the ore will be reduced to such state of fineness that it will float upon the water or be suspended in the water and pass out with the water through the overflow pipes 4. A pulley 43 is carried by shaft 40 and is preferably located between beams 37 where it will be out of the way, and, when a belt is engaged about this pulley, rotary motion may be transmitted from an engine to the shaft.

It is necessary to apply downward pressure to the discs so that wear upon the balls and discs will be compensated for and also sufficient pressure applied to grind the crushed ore. Therefore, there have been provided hydraulic jacks 44 carried by I-beams 45 and extending downwardly therefrom. These jacks carry collars 46 at their lower ends and these collars are provided with set

screws 47 so that the collars may be secured to the jacks and upper ends of coil springs 48 may be detachably secured in the collars. The springs have their lower ends engaged in sockets 49 carried by the upper disc 20 and in which the springs are secured by set screws 50. The springs apply downward pressure to the discs and, by adjusting the jacks, tension of the springs may be controlled. It will thus be seen that the desired pressure may be applied for efficient grinding of the ore carried to the discs by the upwardly moving stream of water.

In order that additional crushed ore may be fed to the grinding discs and balls, there has been provided an auxiliary hopper 51 which is disposed over the upper disc with its spout 52 fitting snugly into the center opening of this disc. The ore fed to this hopper or funnel passes downwardly through its spout and as it leaves the spout 52, it flows downwardly through openings of the other discs through the upwardly moving water which separates the crushed ore and allows heavy ore to reach the lower discs and delivers the lighter ore to the upper discs.

Having thus described the invention, what is claimed is:

1. An ore grinder comprising a casing having a water inlet at its bottom, a plurality of substantially horizontal discs in said casing, all having aligned openings at their centers, certain of said discs, including upper and lower ones, being non-rotatable, and others being rotatable and disposed between non-rotatable discs, balls between confronting faces of companion rotatable and non-rotatable discs, a hollow shaft non-circular in cross section disposed vertically in said casing over the water inlet and passing through the aligned openings formed in said discs centrally thereof, said shaft being connected with the rotatable discs for rotating the same, a tubular drive shaft disposed vertically over said casing and entering the first shaft through the upper end thereof, said drive shaft conforming to the cross sectional shape of the first shaft and fitting snugly therein for turning the first shaft with it, means for rotating the drive shaft, means for delivering crushed ore into the drive shaft through the upper end thereof, the openings in the discs through which the first shaft passes having portions of their walls spaced from the said shaft and providing ore passages about the first shaft through which ore is carried upwardly by water flowing upwardly from the water inlet, a hopper over the top disc surrounding the first shaft and having a depending neck fitting snugly into the opening of the top disc for delivering an additional supply of ore into the casing through the center passages of the discs, and means for applying downward pressure to the top disc.

2. An ore grinder comprising a casing open at its top and having a centrally located water inlet at its bottom, a plurality of substantially horizontal discs in said casing disposed one above another, and all having aligned openings at their centers, certain of said discs being rotatable, and others companion thereto being non-rotatable, the upper one of said discs being a non-rotatable disc, balls between confronting faces of companion rotatable and non-rotatable discs, a hollow shaft disposed vertically in said casing over the water inlet and passing downwardly through openings formed in said discs centrally thereof with its lower end spaced upwardly from the water inlet, said shaft being engaged with the rotatable discs for rotating same, with the shaft,

there being spaces between all the discs and side portions of the hollow shaft forming passages through which water may flow upwardly about the shaft, a tubular drive shaft disposed vertically over said casing and entering the first shaft through the upper end thereof, and having engagement with the first shaft for turning the first shaft with the drive shaft, means for rotating the drive shaft, means for delivering crushed ore into the drive shaft through the upper end thereof, ore leaving the lower ends of said shaft being carried upwardly through the water passages by the upwardly moving water, an overhead support provided with a bearing rotatably receiving the drive shaft, jacks depending from the support, the non-rotatable upper disc being provided with sockets, and springs between the sockets and the jacks for urging the discs downwardly.

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