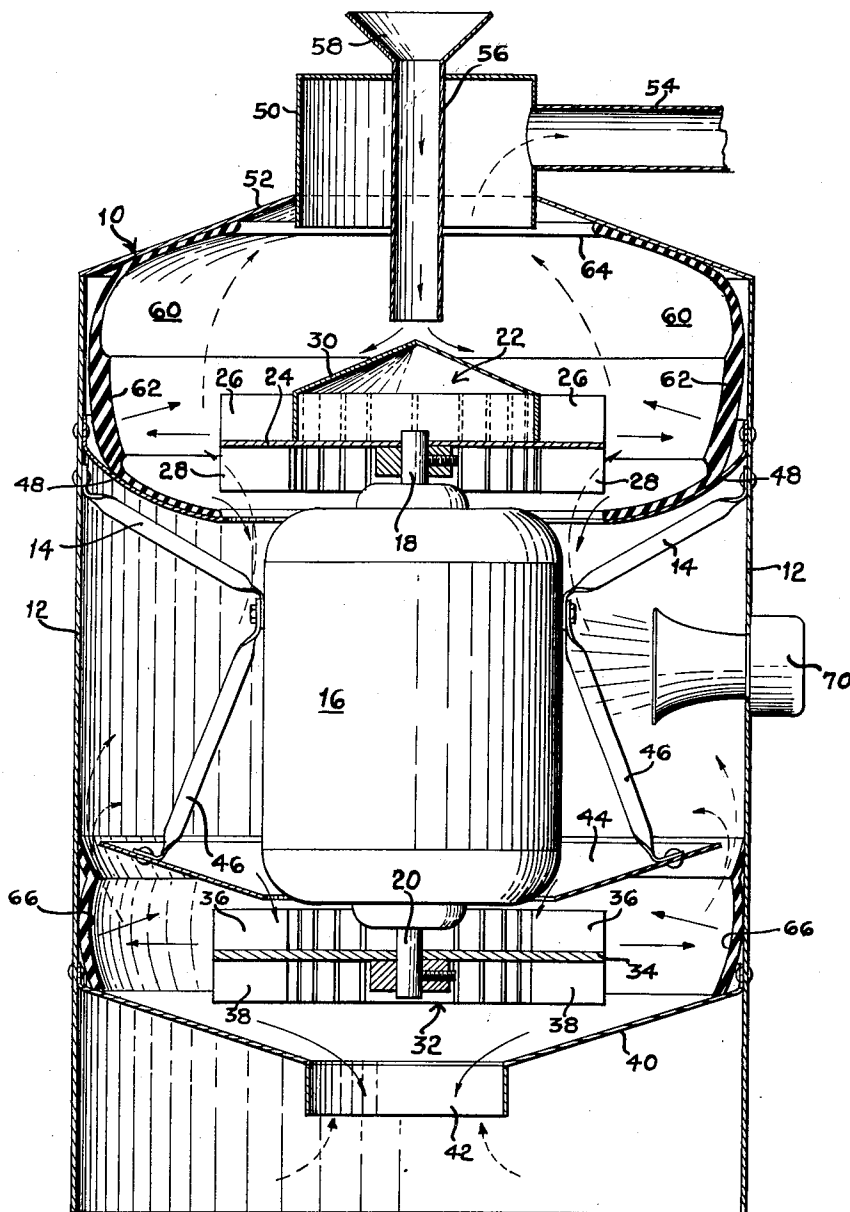


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TWO STAGE CENTRIFUGAL IMPACT PULVERIZING APPARATUS WITH
ANNULAR ELASTOMERIC CONCAVES
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TWO STAGE CENTRIFUGAL IMPACT PULVERIZ- ING APPARATUS WITH ANNULAR ELASTO- MERIC CONCAVES

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5 Claims. (Cl. 241-43)

This invention relates to an ore upgrader and more particularly to a mechanical process for extracting minerals from the ore in which they are found. The invention constitutes an improvement upon the ore upgrader and process for extracting minerals described in my co-pending application Serial No. 682,763, filed September 9, 1957, for an Ore Upgrader.

Mineral bearing ores frequently comprise a soft sandstone wherein the minerals are deposited on the surfaces and in the crevices of granules or crystals of sand and function as a cement to join the sand granules in a stony mass. Uranium and vanadium ores found in the United States are typical of this type of ore formation. Always the amount of valuable chemical elements in these ores represents an extremely small fraction of the total ore body and an obstacle to commercial processing of such ores is the expense of separating the valuable minerals from the ore body. In some instances chemical processing is used. However, this requires that the entire ore body be subjected to chemical treatment to leach the valuable minerals from the gangue and therefore is very costly.

An object of this invention is to provide means for mechanically extracting the minerals from an ore body.

Another object of this invention is to provide an ore upgrader for mechanically abrading mineral deposits adhered to the surface of the ore granules so as to free the mineral deposits for separation from the granules.

Another object of this invention is to provide apparatus for subjecting ore granules to ballistic interaction so as to abrade minerals deposited on the surfaces of the granules to thereby free the minerals from the granules.

Still another object of this invention is to provide an improved method for separating minerals from granular ore materials.

Other objects and advantages reside in the construction of parts, the combination thereof, the method of manufacture and the mode of operation, as will become more apparent from the following description.

The FIGURE of the drawing is a sectional elevational view of an improved apparatus for subjecting ore granules to abrasive ballistic collisions.

Referring to the drawing in detail, the apparatus of the figure, which will hereinafter be referred to as a ballistic interaction tank, has been assigned the reference numeral 10. The tank 10 includes a cylindrical housing 12 within which are mounted brackets 14 supporting an electric motor 16. The armature for the motor 16 terminates at its opposite ends in shafts 18 and 20. For convenience of design and assembly, the shafts 18 and 20 are located substantially at the geometric center of the housing 12.

Secured to the upper shaft 18 is an impeller designated generally with the reference numeral 22. This impeller includes a circular plate 24 occupying a plane normal to the axis of the shaft 18, a plurality of radially disposed impeller blades 26 secured to the upper surface of the plate 24, and a plurality of radially disposed vanes 28 secured to the lower surface of the plate 24. A generally conical cowling 30 rises upwardly from the center of the plate 24 between the impeller blades 26. As the drawing suggests, the blades 26 and the vanes 28 may be substantially identical in size, shape, and number. However, this is not required. It will become apparent in the description which follows that the elements 26 function primarily to strike sand granules, impelling them outward-

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ly from the impeller, and the elements 28 function primarily to move air through the tank 10. In consideration of this difference in function, the elements 26 are called blades and the elements 28 are called vanes. Each may be designed to perform its particular function with optimum efficiency.

The lower shaft 20 of the motor supports a second impeller designated generally by the reference numeral 32. This second impeller is similar to the impeller 22, in that it includes a circular plate 34 supported normal to the axis of the shaft 20, radially disposed impeller blades 36 mounted on the upper surface of the plate 34, and radially disposed vanes 38 secured to the lower surface of the plate 34.

Mounted in the housing 12 below the impeller 32 is a generally conical baffle 40. This baffle 40 has an open center set off by an annular downwardly projecting flange 42. Below the baffle 40 the base of the housing 12 is open.

Above the impeller 32 an open centered conical baffle 44 is supported within the housing 12 by means of brackets 46 secured to the motor 16. A gap exists between the outer margin of the baffle 44 and the wall of the housing 12. A gap also exists between the inner margin of the baffle 44 and the lower end of the motor 16.

Upon rotation of the impeller 32, through operation of the motor 16, the baffles 40 and 44 cooperate to deflect air moved by the impeller 32 upwardly through the housing 12. Thus, as the impeller 32 rotates, the vanes 38 which are located below the plate 34 move air radially outwardly from under the plate 34, creating a central low pressure zone under the plate 34 and a high pressure area beyond the periphery of the plate 34. The low pressure zone under the plate 44 draws air into the housing 12 through the central opening in the baffle 40. The high pressure area beyond the periphery of the plate 34 forces air upwardly in the housing through the gap between the outer margin of the baffle 44 and the wall of the housing.

The impeller blades 36 above the plate 34 create a low pressure zone at the lower end of the motor 16 and cooperate with the vanes 38 to create a high pressure area beyond the periphery of the plate 34. The central low pressure zone above the plate 34 will be operative to draw air downwardly through the central opening in the baffle 44. However, due to obstruction from the motor 16 which projects into this opening, the volume of this downwardly moving air will be small in comparison to the volume of air which moves upwardly through the gap between the outer margin of the baffle 44 and the wall of the housing 12. The net result of rotation of the impeller 32 is a movement of air upwardly through the housing 12.

Below the impeller 22 is a generally conical baffle 48 having an open center into which the motor 16 projects. A gap exists between the inner margin of the baffle 48 and the upper end of the motor 16. The vanes 28 secured to the underside of the plate 24 in the impeller 22 are operative, upon rotation of the impeller, to draw air upwardly through the central opening in the baffle 48 and thus cooperate with the impeller 32 to establish an upward movement of air in the housing 12.

Above the impeller 22, the housing 12 is enclosed by a conical top 52 the center of which receives a duct 50. A conduit 54 connecting with the duct 50 provides an outlet for air moved upwardly through the housing. The basic movement of air through the housing is indicated with broken line arrows.

Centrally located within the duct 50 at the top of the housing 12 is a vertical conduit 56 which terminates at its upper end in a flared tunnel portion 58. The lower end of the conduit 56 terminates just above the cowling 30 associated with the impeller 22. It is to be noted

that upon rotation of the impeller 22, the impeller blades 26 located above the plate 24 will be effective to create a moderate low pressure zone above the cowling 30 and will thus serve to draw air downwardly through the conduit 56. The volume of downwardly moving air in the conduit 56 is small in comparison to the volume of upwardly moving air in the housing 12 and hence does not interfere with the basic movement of air in the housing 12, however, it is effective to prevent escape of air in the housing 12 through the conduit 56.

Mounted between the baffle 48 and the top of the housing is an elastomeric reflector 60. This member is annular in shape, having generally the shape of an annular segment of a hollow toroid. In actual practice the reflector 60 may take the form of an automobile tire from which one bead has been removed so that the tire may be turned inside out. Thus, the reflector illustrated at 60 in the figure has a portion 62 on its inner concave surface which represents the tread of an automobile tire and a portion 64 at its upper margin which represents one bead of an automobile tire. The position of the member 60 within the housing 12 is such that the tread portion 62 forms an upwardly diverging conical section coplanar with the impeller blades 26.

Between the baffles 40 and 44 in the lower portion of the housing 12, a second elastomeric reflector 66 encircles the impeller 32. This member, like the reflector 60 may be formed from an automobile tire. In forming this reflector, both beads of the tire are removed and the tread portion is turned inside out. Like the reflector 60, the reflector 66 forms an upwardly diverging conical section in the portion thereof which is coplanar with the impeller blades 36.

The ballistic interaction tank 10 operates as follows. Ore granules are continuously introduced into the tank 10 through the conduit 56. The ore granules fall down the conduit 56 upon the cowling 30 and are guided by this cowling into the spaces between the impeller blades 26. The impeller blades 26 which are driven at high rotary speeds by the motor 16 impel the ore granules radially outwardly against the tread portion 62 of the elastomeric reflector 60. The ore granules, as they impinge upon the tread portion 62, are reflected backward toward the impeller. Since the tread portion 62 has upwardly diverging sides, the ore granules are reflected slightly upwardly and, as they return toward the impeller, they collide with granules emerging from the impeller. As a result of such collision, the ore granules are scattered about and will go through a large number of successive collisions in the space between the reflector and the impeller.

The repeated ballistic interactions or collisions between the ore granules in the region between the impeller and the reflector establish a field of violently agitated granules through which all ore introduced into the interaction tank must pass. The chance that any given granule introduced into the tank will pass through this zone of interaction without repeated collision with other granules is exceedingly small.

Eventually, sand granules introduced in the top of the interaction tank fall through the opening in the baffle 43 under the impeller 22. From there the granules fall upon the baffle 44 above the impeller 32. These granules slide on the baffle 44 to the center of the upper portion of the impeller 32 and from there are impelled radially outwardly by the rapidly rotating blades 36. These radially outwardly moving granules will impinge upon the reflector 66 and be reflected back toward the impeller in a slightly upward course, producing a second zone of violently agitated ore granules in the region between the impeller 32 and the reflector 66. Particles scattered downwardly from this zone of interaction are permitted to escape from the interaction tank through the central opening of the baffle 40.

Within the interaction tank 10, the ore granules are subjected to a large number of ballistic collisions which are

effective to abrade the minerals from the surfaces thereof. The minerals thus freed are in a finely divided state and are easily drawn upwardly in the tank 10 by the upwardly moving air stream.

Removal of the freed minerals from the interaction tank is most efficient if the particles are maintained in their finely divided state. It is therefore beneficial to introduce high frequency sound waves into the interaction tank. These high frequency sound waves are found to impede recombination of the freed minerals. The sound waves may be supplied by a siren, such as illustrated at 70 in the figure, or by any other suitable means. The siren 70 is located in the interaction tank between the impellers 22 and 32 in a region where the ore granules travelling downwardly through the interaction tank are not in a state of violent agitation.

It is evident that the elastomeric reflectors 60 and 66, and the impeller blades 26 and 36 will be subject to wear due to repeated bombardment by the sand granules. Accordingly, the interaction tank is preferably designed for periodic disassembly for replacement of the impeller blades and for replacement or retreading of the tire sections which form the reflectors.

The end result of operation of the interaction tank 10 is that ore granules introduced in the inlet conduit 56 are separated into minerals and gangue. The minerals leave the tank through the outlet conduit 54. The gangue drops out of the bottom of the tank.

Although the preferred embodiment of the device has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportion and arrangement of parts, the combination thereof and mode of operation, which generally stated consist in a device capable of carrying out the objects set forth, as disclosed and defined in the appended claims.

Having thus described my invention, I claim:

1. An apparatus for separating minerals from ore granules including an upright tank having an open base and having an air outlet at its top, means for moving air upwardly through the tank, means providing an inlet in the top of the tank through which ore granules may be dropped into the tank, said inlet establishing a restricted path for vertical fall of the ore granules, impeller means supported in said tank in the path of vertical fall and operative to impel the granules horizontally outwardly from their vertical path at a predetermined elevation in the tank, and elastomeric reflector means supported within the tank in encircling relation to said impeller means and in the path of the outwardly impelled granules, said reflector means having an inner reflecting surface which is inclined to the vertical for reflecting the granules upwardly and back toward the impeller to induce collision between the granules, the upwardly moving air serving to draw minerals freed from the granules as a result of such collision upwardly through the air outlet for the tank, the open base permitting granules which have been acted upon within the tank to fall downwardly out of the tank.

2. An apparatus for separating minerals from ore granules including an upright tank having an open base, means providing an ore inlet in the top of the tank through which the ore granules may be dropped so as to fall vertically into the tank, said inlet defining a restricted channel for vertical fall of the granules, an impeller supported in the tank for rotation about an axis parallel to said channel, the impeller comprising a plate positioned normal to the axis of rotation, and at least one radially disposed impeller blade mounted upon the plate, means for rotating the impeller, the ore granules after falling upon the rotating impeller being hurled radially outwardly therefrom, annular reflector means mounted in the tank in coplanar encircling relation to the impeller, said reflector means comprising a body of elastomeric material formed essentially into an annular segment of a toroidal ring, the inner surface of said

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ring being concave, the reflector operating to reflect the granules impinging thereon back toward the impeller thereby inducing collision between the granules, blower means for moving air upwardly through the tank to draw minerals freed from the granules upwardly through the tank, and means providing an outlet at the top of the tank for escape of the mineral laden air, the open base permitting granules which have been acted upon within the tank to fall downwardly out of the tank.

3. The apparatus according to claim 2 wherein the blower means includes an assembly of radially disposed vanes secured to the underside of the plate of the impeller, and baffle means mounted in said tank forming a constriction under the impeller and operative to deflect air moved radially outwardly by the vanes upwardly in the tank.

4. In an apparatus for continuously separating minerals from ore granules, said apparatus including an upright tank having an open bottom and means for introducing ore granules into the top of the tank for vertical fall toward the bottom thereof, the combination including a shaft mounted in said tank for rotation about a vertical axis coincident with the path of fall of the ore granules, means for rotating the shaft, a pair of impellers mounted in vertically spaced relation upon the shaft, the uppermost of the impellers being arranged to intercept the falling ore granules and operative to hurl the granules radially outwardly therefrom, a first elastomeric reflector means mounted in the tank in encircling relation to the uppermost impeller operative to reflect the radially outwardly moving ore granules back toward the impeller to induce collision between the granules, baffle means mounted in the tank for directing downwardly scattered ore granules upon the lowermost of said impellers, and second elastomeric reflector means mounted in the tank in encircling relation to the lowermost impeller for reflecting ore granules emerging from the lowermost impeller back toward that impeller.

5. In an apparatus for continuously separating minerals from ore granules, said apparatus including an upright

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tank having an open bottom and inlet means for introduction of ore granules into the top thereof for vertical fall therein, the combination including an impeller mounted for rotation within the tank about a vertical axis coincident with the path of fall of the ore granules, an annular elastomeric reflector element encircling the impeller in a plane normal to the axis of rotation thereof, the reflector element comprising an annular segment of a toroidal ring having a concave inner surface, an annular baffle forming a constriction in the tank under the impeller supporting the lower portion of the reflector element, and means for rotating the impeller, said impeller comprising a plate disposed normal to the axis of rotation, at least one blade mounted on top of the plate for impelling ore granules falling upon the plate radially outwardly toward the reflector, and a plurality of radially disposed vanes mounted on the underside of the plate cooperating to form a centrifugal air impeller, the reflector and the impeller blade cooperating to bring said ore granules into repeated collision, and the baffle and vanes cooperating to move air upwardly through the tank to draw minerals freed from the granules upwardly in the tank away from the granules.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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Arthur G. Dearing

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 55, for "gas" read -- gap --; line 70, for "tunnel" read -- funnel --.

Signed and sealed this 16th day of April 1963.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

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Commissioner of Patents