United States Patent

Giebel

[15] **3,700,103**

[45] **Oct. 24, 1972**

[54] RECOVERY OF MINERALS

[72] Inventor: **Walter C. Giebel,** General Delivery, Sheridan, Mont.

[22] Filed: **July 17, 1969**

[21] Appl. No.: **842,528**

[52] **U.S. Cl.** **209/169,** 261/93

[51] **Int. Cl.** **B03d 1/14**

[58] **Field of Search** 209/169, 170; 261/87, 93

[56] **References Cited**

UNITED STATES PATENTS

1,935,190	11/1933	Munro	261/93
2,875,897	3/1959	Booth	209/169
2,944,802	7/1960	Daman	261/93 X
2,966,266	12/1960	Coke	261/93 X
2,973,095	2/1961	Anderson et al.	209/169
3,070,229	12/1962	Benozzo	209/170 X
3,098,818	7/1963	Daman et al.	209/169
3,327,851	6/1967	Anderson	209/169
3,378,141	4/1968	Warman	209/169
3,437,203	4/1969	Nakamura	209/169
3,491,880	1/1970	Reck	261/93

FOREIGN PATENTS OR APPLICATIONS

358,715	4/1938	Italy	209/169

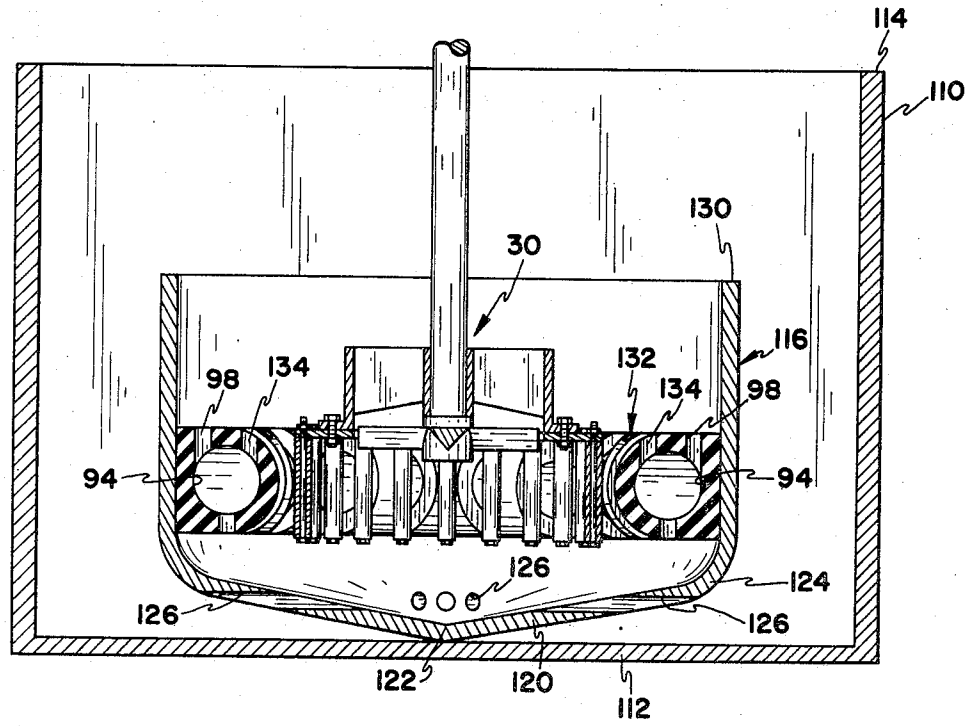
Primary Examiner—Tim R. Miles

Attorney—Lynn G. Foster

[57] **ABSTRACT**

Apparatus for treating ore pulp in a treatment cell attendant to recovery of minerals therefrom, the apparatus having a rotatable shaft with an attached impeller and a radially projecting annular disc, the disc including a plurality of projections attached thereto and a cylindrical collar disposed above the disc and joined thereto, thus forming a rotating standpipe so that the path of flow of ore pulp through the eye of the impeller is well defined. A stabilizer ring is joined to the cell adjacent the impeller so that a shear zone is developed in the ore pulp, the stabilizer ring being configurated to maximize turbulence in the shear zone and minimize surging and boiling of the ore pulp at the surface thereof. An insert is adapted to nest within a rectangular cell so that the rectangular cell operatively receives the stabilizer ring.

12 Claims, 17 Drawing Figures



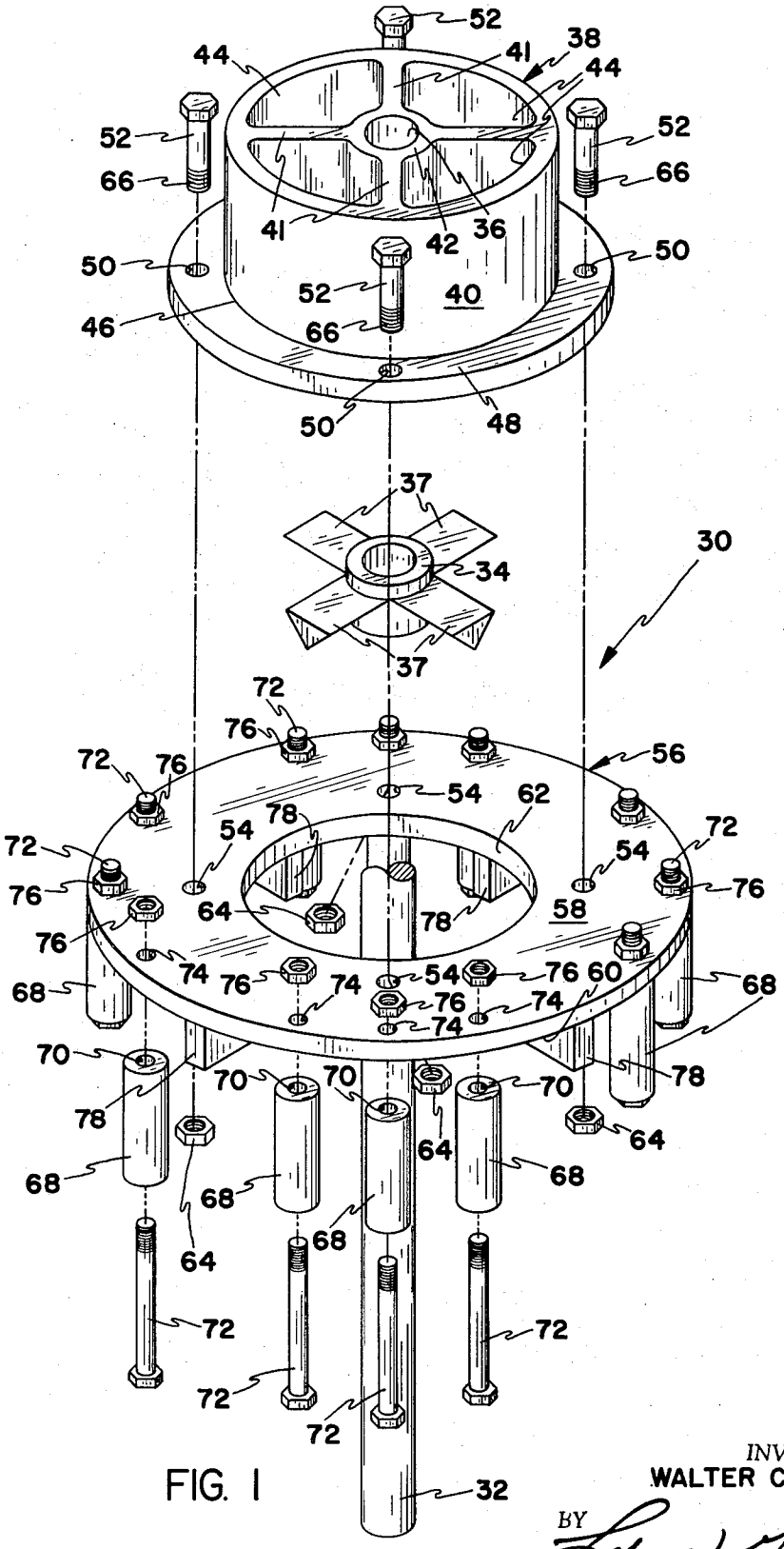


FIG. 1

INVENTOR.
WALTER C. GIEBEL
BY
ATTORNEY

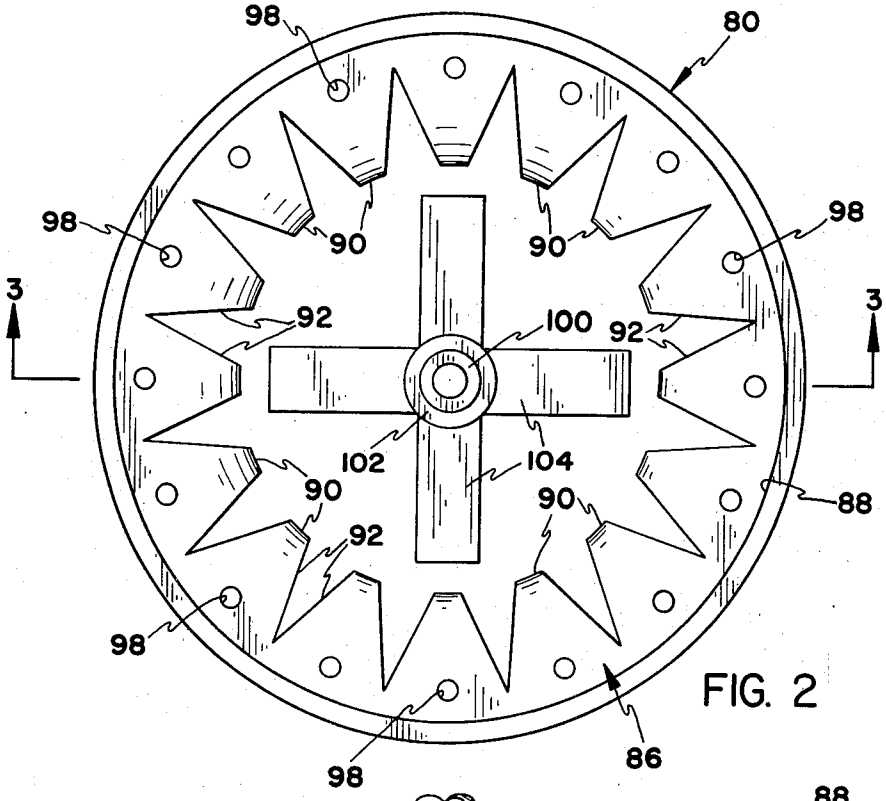


FIG. 2

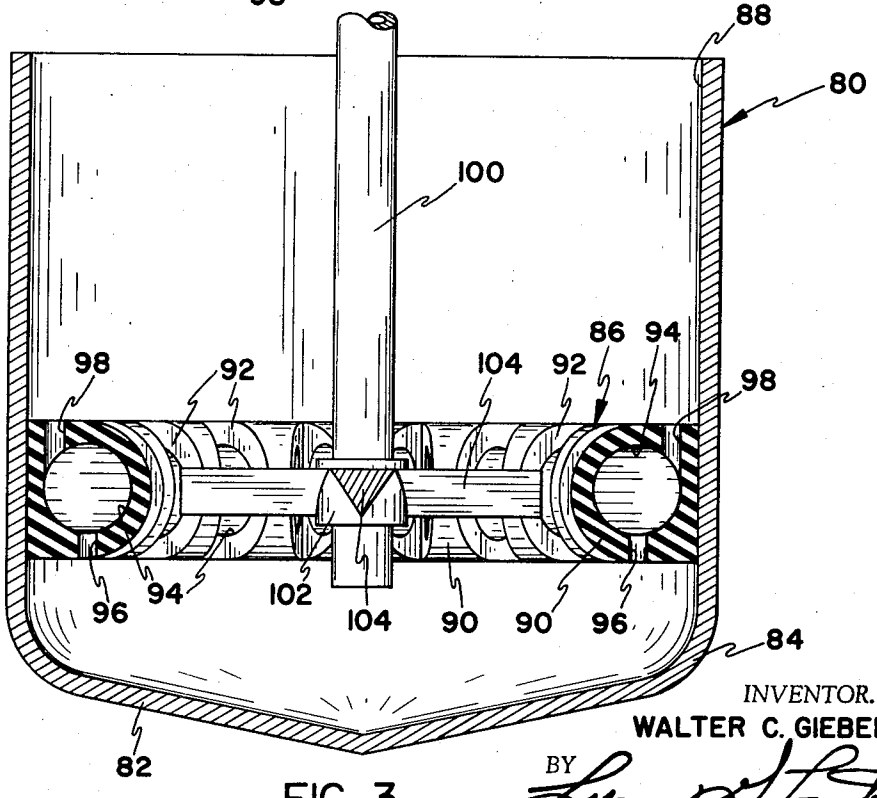


FIG. 3

INVENTOR.
WALTER C. GIEBEL
BY
ATTORNEY

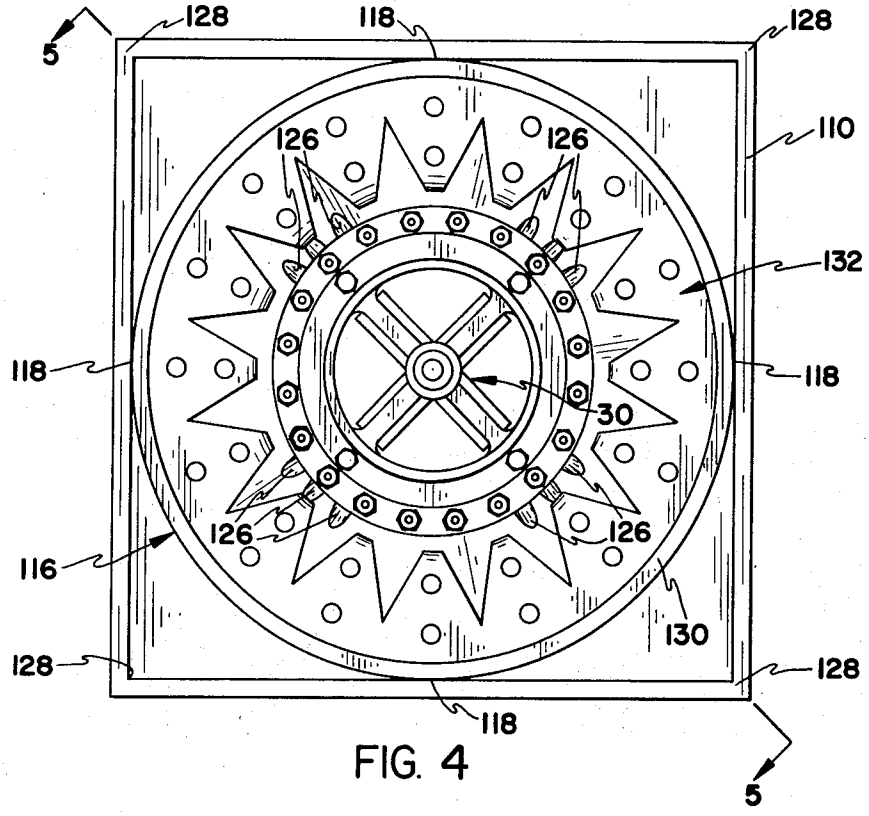


FIG. 4

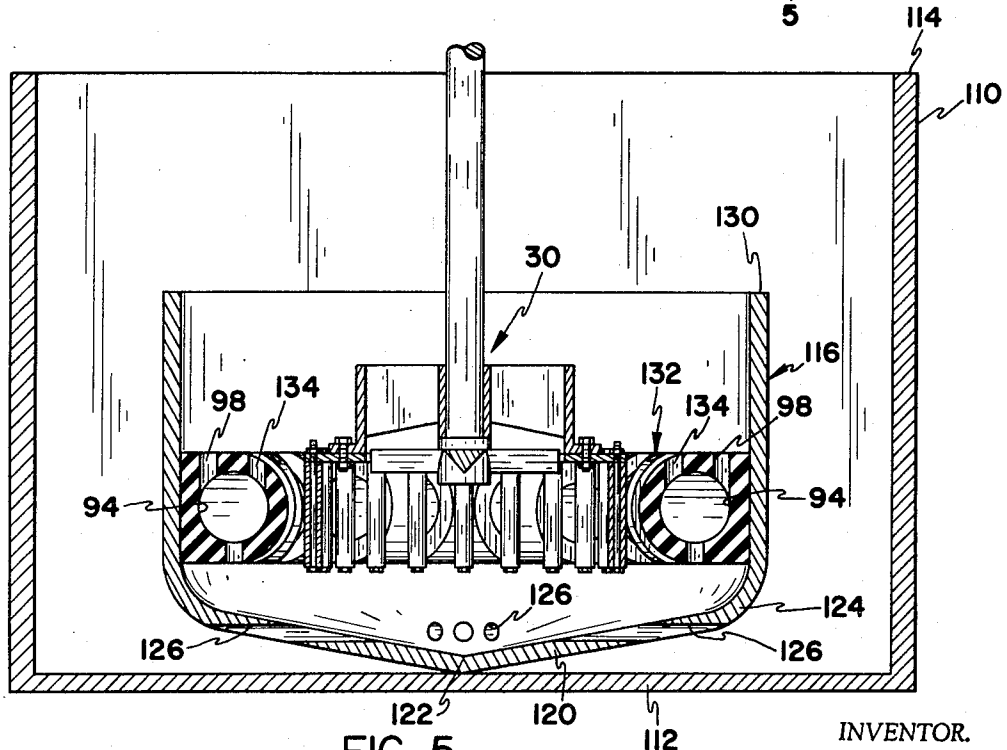


FIG. 5

INVENTOR.
WALTER C. GIEBEL

BY

ATTORNEY

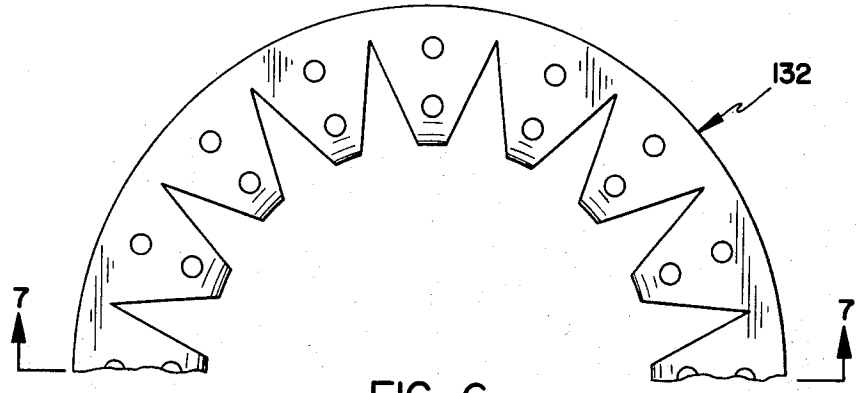


FIG. 6

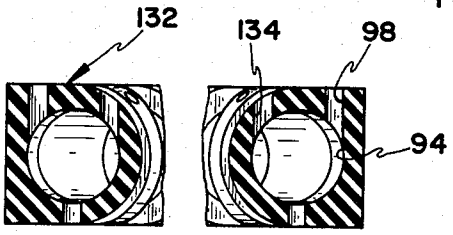


FIG. 7

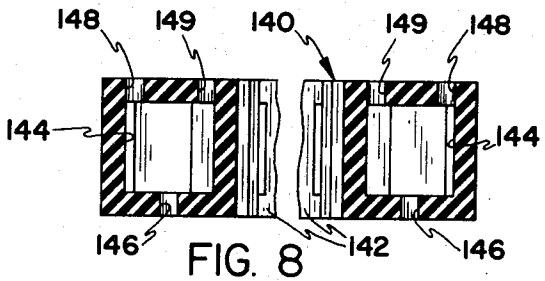


FIG. 8

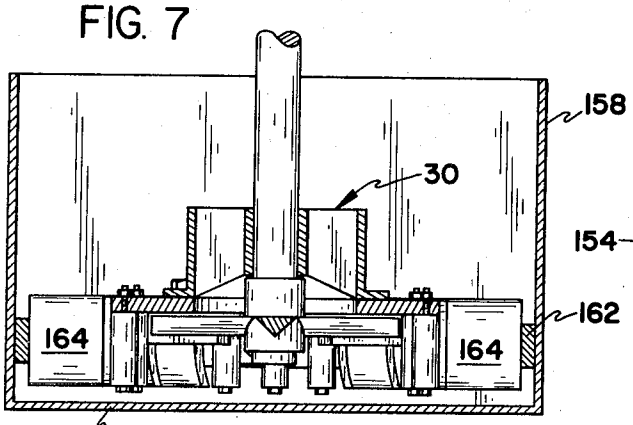


FIG. 10

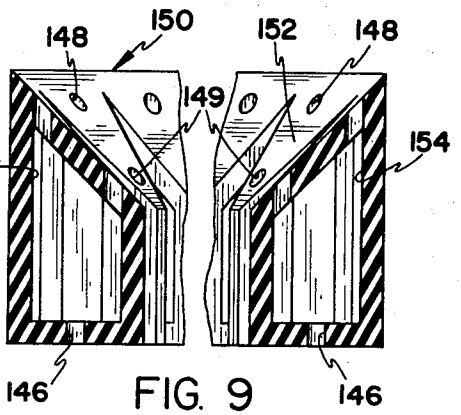


FIG. 9

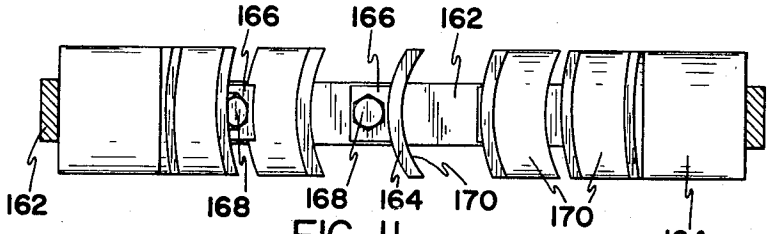


FIG. 11

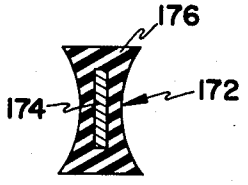


FIG. 12

INVENTOR.
WALTER C. GIEBEL

BY Lynn D. Foster

ATTORNEY

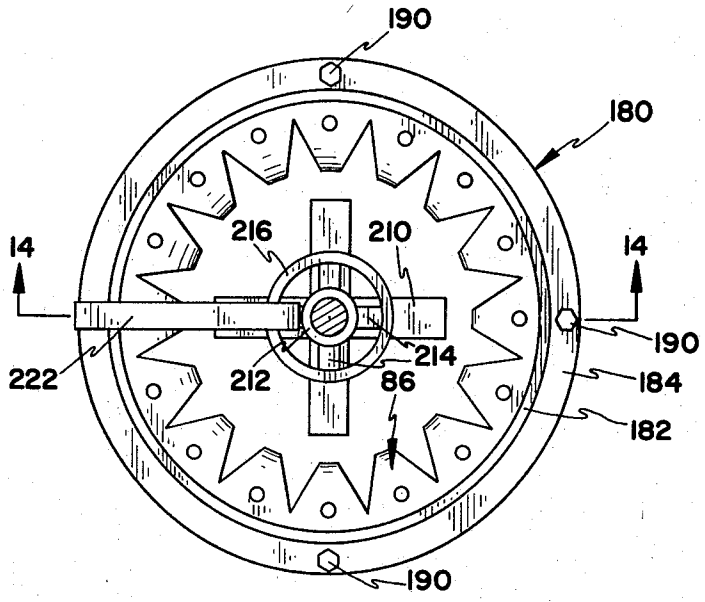


FIG. 13

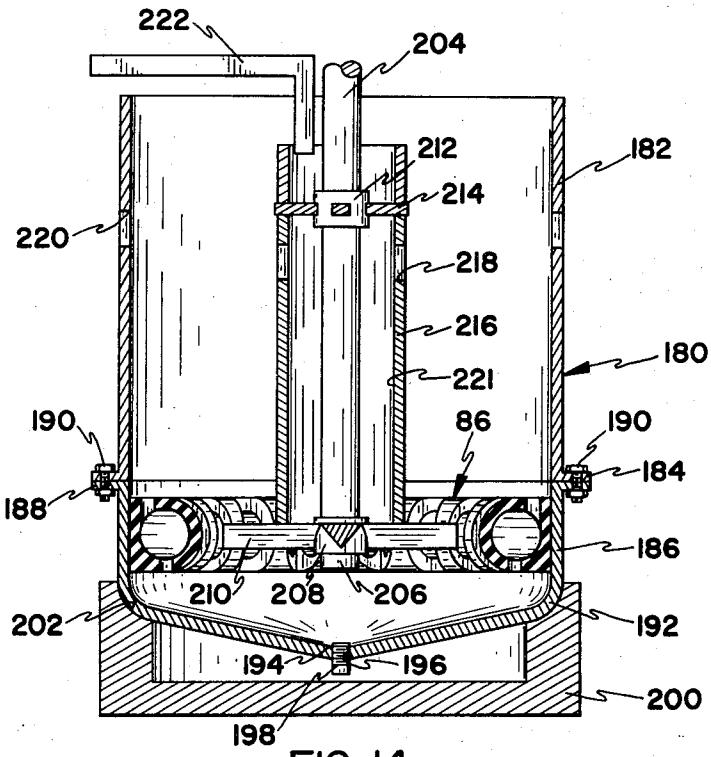


FIG. 14

INVENTOR.
WALTER C. GIEBEL

BY Lynn L. Foster

ATTORNEY

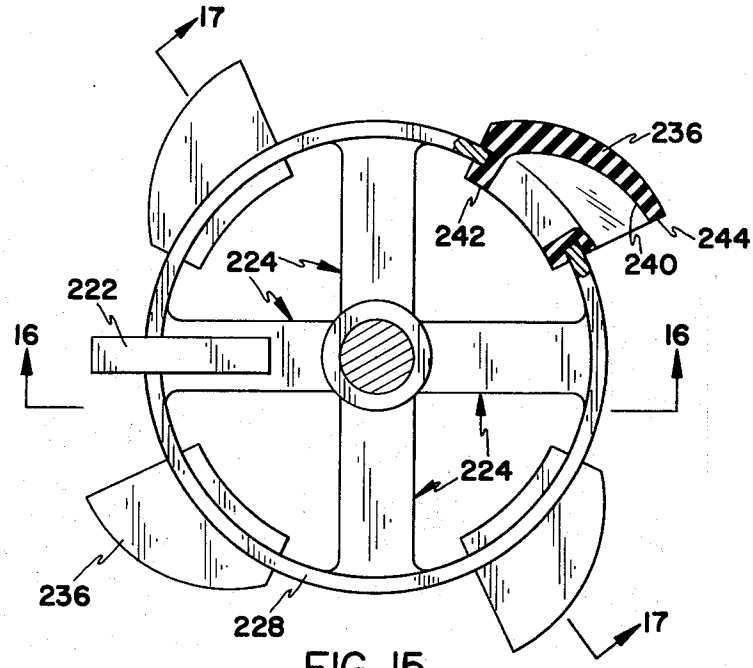


FIG. 15

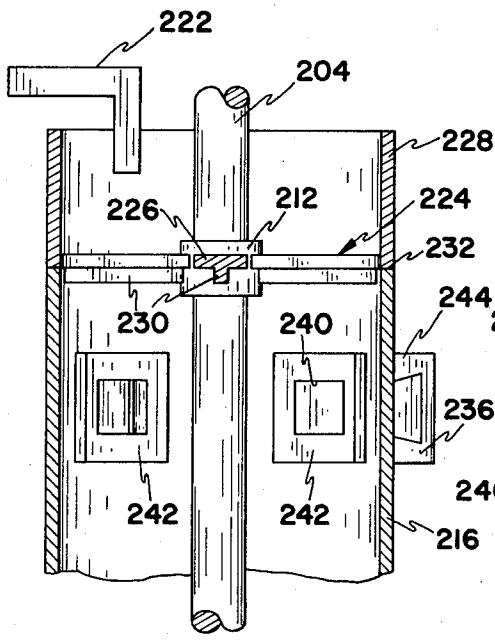


FIG. 16

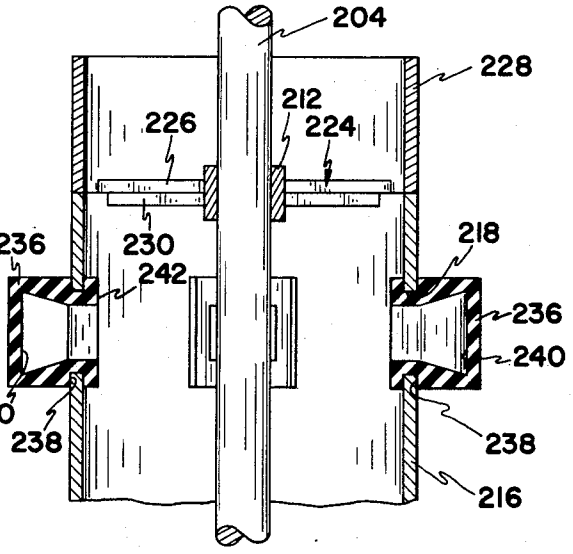


FIG. 17

INVENTOR.
WALTER C. GIEBEL

BY Lynn D. Foster

ATTORNEY

RECOVERY OF MINERALS

FIELD OF THE INVENTION

The present invention relates to apparatus for the recovery of minerals from ore pulp and more particularly to novel standpipe and impeller structure used with a mineral treating cell to improve the circulating, aerating and conditioning of ore pulp during the recovery of minerals therefrom. Also, the invention relates to improved stabilizing structure which causes increased contact of the ore pulp and treatment compounds in the cell while simultaneously avoiding excessive boiling at the surface of the pulp.

DESCRIPTION OF THE PRIOR ART

The recovery of minerals by froth flotation and related mineral treatment is well known. Generally, the well-known procedure includes circulating an ore pulp suspension or solution through a treatment cell and agitating the pulp to mix minerals within the pulp with frothing or other treatment compounds pursuant to recovery of the minerals.

It is also known to provide a series of rigid stator blades to break up air bubbles introduced into the ore pulp and expose minerals for attachment to the froth-forming bubbles. For example, see U. S. Pat. Nos. 2,767,964 and 2,973,095. Nevertheless, it has been found that impeller-stator combinations presently used create undesirable boiling of ore pulp at the surface of the treatment cell. The boiling and surging of the ore pulp cause minerals carried by froth bubbles upon the ore pulp surface to fall back into the ore pulp thereby substantially decreasing the effectiveness of mineral recovery and increasing the time and cost for recovery.

BRIEF SUMMARY AND OBJECTS OF THE INVENTION

It is a primary object of the present invention to provide improved turbulence and improved contact of ore pulp with air bubbles and treatment compounds within the treatment cell without causing a correspondingly high boiling of the pulp into the froth column formed by the mineral laden bubbles upon the surface of the said ore pulp.

The present invention provides novel impeller structure comprising improved fluid flow control through the impeller structure. A stabilizer ring is disposed adjacent the impeller structure, the stabilizer ring being uniquely configurated so as to form a shear zone adjacent the impeller wherein substantial turbulence and intimate contact with mineral-treatment compound mixture is accommodated. The unique configuration of the stabilizer ring and the relationship between the stabilizer ring and the impeller structure prevents excessive boiling at the surface of the ore pulp. In this specification, ore pulp means a solution and/or suspension of mineral bearing ore prior to the extraction of all valuable minerals therefrom.

It is, therefore, another important object of the present invention to provide novel impeller structure accommodating improved contact between minerals in the ore pulp with air bubbles and treatment compound.

Another important object of the present invention is to provide novel stabilizer ring structure which avoids excessive boiling of the ore pulp at the surface thereof.

One still further object of the present invention is to provide a novel cell adaptor to allow the improved stabilizer ring to be used with rectangular cells.

Another and no less important object of the present invention is the provision for an improved rotating standpipe combination including a cylindrical collar which defines a preferred path for flow of ore pulp into the impeller and which improves the mixing of ore pulp with air air bubbles and treatment compound.

A further and important object of the present invention is to provide additional novel structure in a stabelizer, or agitator ring, in combination with the novel impeller with rotating standpipe, wherein the said stabelizer comprises a plurality of radially placed blades which are concave, or curved, wherein the concavity, or curvature of the said blades is in the vertical plane of the said blade, and the said curvature extends from the bottom edge of the blade to the top edge of the blade.

These and other objects and features of the present invention will become more fully apparent from the following description and appended claims taken in conjuriction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view of one presently preferred embodiment of the impeller structure and cylindrical collar of the invention;

FIG. **2** is a top plan view of a stabilizer ring embodiment utilized in a circular treatment cell;

FIG. **3** is a transverse cross section taken along lines **3—3** of FIG. **2**;

FIG. **4** is a top plan view of a square treatment cell with a cell adapter and attached stabilizer ring nested therein;

FIG. **5** is a transverse cross section taken along lines **5—5** of FIG. **4**;

FIG. **6** is a fragmentary plan view of the stabilizer ring embodiment of FIG. **4**;

FIG. **7** is cross section taken along lines **7—7** of FIG. **6**;

FIGS. **8** and **9** are fragmentary cross sectional illustrations of alternative embodiments of the stabilizer ring of the invention;

FIG. **10** illustrates in cross section another stabilizer ring embodiment disposed within a treatment cell, the impeller structure of FIG. **1** being illustrated in normal position adjacent the stabilizer ring;

FIG. **11** is a elevational view shown partly in cross section illustrating the configuration of the blades of the stabilizer ring illustrated in the embodiment of FIG. **10**;

FIG. **12** illustrates in cross section another presently preferred stabilizer ring blade embodiment;

FIG. **13** is a top plan view of a cylindrical treatment cell with stabilizer ring in place and also illustrating another embodiment of the cylindrical rotating standpipe and impeller structure of the invention;

FIG. **14** is a transverse cross section taken along lines **14—14** of FIG. **13**;

FIG. **15** is a top plan view shown partially broken away to reveal the internal configuration of scoop structure comprising part of the improved cylindrical standpipe and impeller structure which may be used with the embodiment of FIGS. **13** and **14**; and

FIGS. 16 and 17 are fragmentary cross sections taken along lines 16—16 and 17—17 of FIG. 15 respectively.

DESCRIPTION OF PREFERRED EMBODIMENTS

The Embodiment of FIG. 1

The component parts of the impeller structure generally designated 30 is illustrated in exploded perspective in FIG. 1. The structure 30 comprises a central shaft 32 which may be a solid or tubular shaft as desired, and is normally telescopically disposed first through a cylindrical sleeve 34 having a plurality of impeller blades 37 radially projecting outwardly therefrom. Each of the impeller blades 37 has an inverted triangular configuration so that as the impeller blades are rotated with the sleeve 34, ore pulp (not shown) in contact therewith will be thrust generally downwardly. The shaft 32 is non-rotatably joined to the sleeve 34 such as with a spline joint or key or the like.

The shaft 32 is also telescopically disposed through aperture 36 comprising part of a cylindrical collar or standpipe generally designated 38. The collar 38 comprises an annular outer wall 40. The cylindrical collar 38 is interiorly hollow and is connected to a central hub 42 with spokes 41 radially projecting inwardly from the outer wall 40. The spokes 41 are preferably identical in number as and aligned with the impeller blades 37. The hub 42 defines aperture 36, aperture 36 being centrally disposed completely through the hub 42. Hub 42 is interiorly provided with a key in order to be non-rotatably joined to the shaft 32. Alternatively, hub 42 may be otherwise permanently non-rotatably secured to the shaft 32.

The outer wall 40 and the spokes 41 cooperate to define a plurality of passageways 44 which open above and below the cylindrical standpipe 38. The passageways 44 have an important purpose which will be hereinafter more fully described. The lower end 46 of the standpipe 38 is provided with a peripheral flange 48 which projects outwardly from the standpipe 38. The flange 48 is provided with spaced apertures 50 through which bolts 52 are normally disposed.

Bolts 52 are adapted to be similarly disposed through corresponding apertures 54 disposed at spaced locations in an annular disc 56. Annular disc 56 has a substantially smooth planar upper surface 58 and similarly, a substantially smooth lower planar surface 60. Disc 56 has an enlarged circular aperture 62 disposed central of the disc and having a dimension which is essentially the same as the inside dimension of the cylindrical standpipe 38. The cylindrical standpipe 38 may be disposed upon the upper surface 58 of the disc 56 and secured thereto by bolts 52 and made secure thereon by threading nuts 64 on the respective threaded ends 66 of bolts 52. Clearly, if desired, the disc 56 may be non-rotatably joined to shaft 32 by hub 34 and blades 37, making them integral with disc 56 so that spokes 41 and hub 42 of the standpipe 38 are unnecessary.

A plurality of downwardly depending fingers 68 is disposed adjacent the outer periphery of disc 56. Each finger comprises a cylindrical abrasive resistant rubber tube having a central throughbore 70. An elongated bolt 72 is adapted to be disposed through the bore 70 and also through apertures 74 spaced adjacent the periphery of disc 56. Nuts 76, threadedly secure bolts 72 and fingers 68 to the disc 56.

The attachment feature of the fingers 68 to the disc 56 is particularly important since prior to the instant invention, impeller fingers comprised a permanent part of the impeller structure. Frequently, the fingers would become broken or otherwise unusable and it was necessary for the entire impeller structure to be either discarded or substantially repaired. The above described embodiment accommodates placement and replacement of impeller fingers in a rapid and efficient manner without disturbing the remainder of the impeller structure.

The underside 60 of the disc 56 is also provided with radially downwardly projecting vanes 78. Vanes 78 are permanently secured to the disc 56 and radially traverse the lateral dimension of the disc from the apertures 62 to the peripheral edge thereof. If desired, the vanes 78 may also be removably attached to the disc 56.

The above-described impeller structure 30 accommodates downward channeling of ore pulp (not shown) through the passageways 44 in the standpipe 38 and through the impeller blades 37 which thrust the ore pulp downwardly. Depending fingers 68 and vanes 78, in addition, agitate and condition the ore pulp.

The Embodiment of FIGS. 2 and 3

FIGS. 2 and 3 illustrate a cylindrical treatment cell or vat generally designated 80. Although the treatment cell 80 may be used for any one of the mineral dressing procedures, the cell 80 will be discussed in connection with a froth flotation procedure for convenience of illustration. The cell 80, as best illustrated in FIG. 3, has a downwardly tapered bottom 82 and rounded corners 84 so that the bottom 82 has a configuration somewhat similar to a vortex. As can be appreciated from FIG. 2, the cell 80 is generally circular in plan view, which circular configuration is critical for the reasons which hereinafter follow.

An annular stabilizer ring or agitator ring 86 is disposed inside of the cell 80 and spaced somewhat above the corners 84 so as to be contiguous with the internal peripheral surface 88 of the cell 80. The stabilizer ring 86 is preferably formed of rubber or other resilient material and comprises spaced teeth or wedge-like segments 90 which comprise baffles and project toward the interior of the cell 80. Each segment 90 has side faces 92 which are acutely angularly related both with respect to opposed side faces of adjacent segments and with respect to each other.

The stabilizer ring 86 comprises an annular bore 94 disposed through each segment 90 so that a circular passageway exists throughout the annular length of the stabilizer ring, the passageway being broken only by the faces 92 of the segments 90. A vertically disposed port 96 (FIG. 3) communicates the lowermost portion of the aperture 94 with the bottom of the cell 80 so that air bubbles or mineral pulp trapped within the bore 94 can be expelled therethrough. Also, an upper port 98 communicates the outside peripheral edge of the bore 94 with the upper portion of the cell 80 so that air bubbles and ore pulp being agitated within the cell 80 can be communicated through the port 98 to flush trapped minerals and ore pulp out through the port 96.

FIGS. 2 and 3 also illustrate a conventional power driven solid or tubular shaft 100 which is suspended from a remote elevated location (not shown) and is non-rotatably secured to impeller structure 102 which

may be structure **30** (FIG. **1**) or, if desired, may be conventional as illustrated in FIGS. **2** and **3**. The impeller structure **102** has impeller blades **104** which radially project outwardly therefrom. The impeller blades **104** have sufficient length so as to pass substantially close to but not at any time touch the segments **90**. As best illustrated in FIG. **3**, the vertical position of the impeller blades **104** is preferred to be essentially central of the stabilizer ring **86**.

I have discovered that the above combination of elements creates a novel and advantageous shear zone when ore pulp and frothing or other treatment material are disposed in the cell **80**. In operation, the impellers **104** are rotated by a power source (not shown) to cause the ore pulp beneath the stabilizer ring **86** to revolve in one circular direction. Ore pulp and mineral laden air bubbles above the stabilizer ring **86** revolve in the cell **80** (in direction opposite to impeller rotation) due to the effect of the stabilizer ring **86**. Thus, the invented apparatus creates two distinct shear zones within the body of the ore pulp, one between the rotating impeller and the stationary stabelizer, and one in the pulp body where the reversal of pulp flow direction takes place; this is a new and beneficial method of agitation and aeration in a mineral dressing device. The shear zones cause substantially increased contact between minerals in the ore pulp and the air bubbles so that that frothing is more efficent in causing minerals to adhere to the frothing bubbles.

Moreover, the stabilizer ring **86** substantially reduces surging and boiling of the pulp into the froth column which builds upon the surface of the ore pulp near the top of the cell **80**. Thus, the tendency of the minerals adhering to and carried by the froth column at the top of the cell **80** to fall back into the mineral pulp is substantially reduced and the well-known problem of weeping of the floated minerals back into the mineral pulp is minimized. The mineral bearing froth is collected from the surface of cell **80** and the minerals are recovered therefrom in a conventional manner.

The Embodiments of FIGS. **4–7**

It has been found that the new and advantageous results provided as described above are not accomplished or achieved where the cell **80** is square in configuration. It is also well known that most conventional treatment cells are square in horizontal cross section. Therefore, in order to achieve the same useful result in conventional square cells, the adapter embodiment of FIGS. **4** and **5** is provided.

FIGS. **4** and **5** illustrate a conventional treatment cell **110** which is square in horizontal cross section. As best illustrated in FIG. **5**, the cell has a substantially flat bottom **112** and is open at the top **114**. A treatment cell adapter generally designated **116**, which has a circular horizontal cross section, is nested within the cell **110** so as to contact tangentially the side portions of the cell **110** as at **118**. The adapter **116** has a conical bottom **120** which tapers inwardly toward a vortex **122**. The bottom corners **124** are rounded and a plurality of radial spaced apertures **126** are disposed in the bottom **120** so as to open adjacent each corner **128** of the square cell **110**.

It is presently preferred that the upper edge **130** of the cell adapter **116** is disposed somewhat beneath the upper edge **114** of the cell **110**. Thus, ore pulp and treatment solution and air bubbles can easily pour from the cell **110** into the adapter **130** particularly at the location adjacent each corner **128**.

The adapter **116** is interiorally provided with a stabilizer ring **132**, the ring **132** being substantially similar to the stabilizer ring **86** illustrated in FIGS. **2** and **3** except ring **132** comprises an additional upper port **134** which aids the aperture **98** in preventing accumulation of ore pulp and reagent material within the passageway **94** (see FIGS. **6** and **7**). The embodiment of FIGS. **4** and **5** illustrates the stabilizer ring as used in conjunction with impeller structure **30** previously discussed above with respect to FIG. **1**.

The Embodiments of FIGS. **8** and **9**

If desired, the stabilizer ring generally designated **140** and illustrated in FIG. **8** may be substituted for the stabilizer rings **132** or **86** illustrated in FIGS. **5** and **3**, respectively. The stabilizer ring **140** is annular in plan view and is essentially square in transverse cross section as illustrated in FIG. **8**. The stabilizer ring **140** comprises a plurality of essentially wedge-shaped segments **142** and an essentially square bore **144** exists through each of the segments in order to form an annular passageway. The passageway is provided with a bottom port **146** and two top ports **148** and **149** which cooperate with the port **146** to flush the passageway **144** of ore pulp or treatment reagents or the like.

Alternatively, the stabilizer ring embodiment in FIG. **9** generally designated **150** could be used in place of the stabilizer rings **132** and **86**, respectively illustrated in FIGS. **5** and **3**. Stabilizer ring **150** differs from stabilizer ring **140** in that the upper surface **152** has a substantial downward slope or taper. This downward taper is particularly advantageous in preventing accumulation of ore pulp and treatment material upon the upper surface **152**. Also, the interior passageway or channel **154** has an upper surface which tapers downwardly toward the center of the stabilizer ring. Otherwise, stabilizer ring **150** is substantially similar to stabilizer ring **140** and like parts are designated with like numerals throughout.

The Embodiment of FIGS. **10–12**

FIG. **10** illustrates a treatment cell **158** which is circular in horizontal cross section and which has a flat bottom **160**. Impeller structure **30** which is substantially identical to the impeller structure **30** illustrated in FIG. **1**, is disposed within the treatment cell **158** essentially central thereof.

Adjacent the bottom of the treatment cell **158** is mounted an annular metal ring **162** (best shown in FIG. **11**). The metal ring **162** is rigidly mounted upon the interior surface of the cell **158** somewhat above the bottom **160** and is provided with a plurality of spaced rigid baffles or stabilizer blades **164**. Each blade **164** is provided with an L-shaped bracket **166** which has an aperture (not shown) adapted to be aligned with a bore hole (not shown) in the annular ring **162** so that a bolt **168** may be threadedly disposed therein to secure the stabilizer blades **164** in position around the annular ring.

It is particularly important that each of the stabilizer blades **164** is arcuately shaped so that the concave surface **170** of the stabilizer blade **164** faces a direction opposite the direction of rotation of the impeller structure **30**. It has been found that this particular configuration improves the contact between ore pulp and air

bubbles and other treatment material while simultaneously preventing excessive boiling and surging at the surface of the treatment cell **158**.

If desired, the stabilizer blade **172** may be substituted for the blade **164** above described. Stabilizer blade **172** comprises an inner metal core **174** which is disposed within resilient material **176** such as rubber having a biconcave configuration. When the stabilizer blade embodiment of FIG. **12** is rigidly joined to the annular ring **162**, the impeller structure **30** may be rotated in either direction to accomplish the same advantageous result above described.

The Embodiment of FIGS. **13–17**

FIGS. **13** and **14** illustrate a treatment cell **180** which comprises a cylindrical upper section **182** which is open at the top and terminates adjacent the bottom in an outwardly projecting annular flange **184**. Section **182** may have spaced ports **220** which communicate the interior of cell **180** with a source of ore pulp.

As best illustrated in FIG. **14**, the bottom section **186** of the cell **180** is open at the top so as to communicate directly with the upper section **182** and is provided with an upper peripheral flange **188** adapted to mate with flange **184** and to be secured thereto such as with bolts **190**. If desired, a seal or sealant may be interposed between the flanges **184** and **188** in order that the joint may be made water-tight.

Bottom section **186** has rounded corners **192** and tapers annularly downwardly to a vortex **194**. If desired, the vortex may be provided with a transverse aperture **196** which may be opened or closed with a threaded plug **198**. The treatment cell **180** is adapted to rest upon a rigid support **200** so that curved corner portions **192** nest upon mating contoured surface **202**. The interior surface of the bottom section **182** is provided with a suitable annular stabilizer ring such as stabilizer ring **86** above described.

A rotatable shaft **204** is disposed central of the cell **180** and suspended therein from a position above the cell (not shown). A lower end **206** of the shaft **204** is non-rotatably secured to an annular collar **208** having a plurality of radially-extending impeller blades **210** integral therewith. Intermediate the length of the shaft **204** is a second collar **212** (see FIG. **14**). Collar **212** has radially projecting spokes **214** which are normally essentially parallel to the projecting impeller blades **210**.

An elongated, diametrally enlarged tubular rotating standpipe **216** is preferably joined to the impeller blades **210** at the juncture therewith and is also joined to spokes **214** such as by keying or the like. The standpipe **216** has sufficient axial dimension so that the upper edge of the standpipe **216** is near the top of cell **180**. Standpipe **216** is provided with spaced apertures **218** which are disposed beneath the level of spokes **214** to communicate the interior **221** of the standpipe **216** with the interior of cell **180**. Standpipe **216** is open at the top and the bottom so that a passageway exists from the top of the standpipe **216** through the spokes **214** and to impeller blades **210** to the bottom of the cell **180**.

The embodiment of FIGS. **13** and **14** is particularly useful for agitators, aerators and conditioners other than flotation apparatus. In the operation of the embodiment, treatment or conditioning compounds are fed into the cell **180** and ore pulp may be communicated therein either through the ports **200** or through feed conduit **222** or both. The ore pulp carried by the conduit **222** is channeled directly into the collar or standpipe **216** between the spokes **214** so as to be channeled into the impeller blades **210**. A unique flow pattern results, which is identical in effect, as to the creation of two distinct shear zones, such as were described and under embodiments of FIGS. **4–7**, wherein the ore pulp passing through the collar or standpipe **216** is exposed to the treatment compounds in the shear zones developed by the agitator ring **86** and thereafter forced upwardly along the sides of the cell **180**. Ore pulp entering through the ports **220** will be caused to flow through the ports **218** to flow downwardly through the collar or standpipe **216** and into the impeller blades **210**. Thus, essentially all of the ore pulp entering into the cell **180** will be brought into intimate contact with the treatment and conditioning compounds.

If desired, the collar or standpipe **216** may be modified as illustrated in FIGS. **15–17** to improve the efficiency thereof. In the embodiment of FIGS. **15–17**, the upper sleeve **212** is provided with spokes **224** which have a T-configuration in cross section. The horizontal upper portion of **226** of the "T" (FIG. **16**) is integral with an upper collar insert **228**. The insert **228** is cylindrical in configuration and has substantially the same inside and outside diametral dimensions as the collar or standpipe **216**. The vertical portion **230** of the T-shaped spoke **224** has a smaller longitudinal dimension than the upper portion **226** and is disposed beneath the lower edge **232** of the insert **228**. Thus, when the insert **228** is placed upon the standpipe **204** the vertical portion **230** of the spokes **224** will be disposed within and abut the collar or standpipe **216** so that collar or standpipe **216** will remain centered about the shaft **204**. Also, the insert **228** will be coaxial and essentially coextensive the with collar or standpipe **216**.

Also, if desired, apertures **218** in collar or standpipe **216** (FIG. **14**) may be provided with scoops **236**. Each scoop **236** is preferably formed of deformable rubber or the like and is provided with a peripheral slot **238** (FIG. **17**) which allows the scoop **236** to be secured in the aperture **218**.

Each scoop **236** has an L-shaped channel **240** which opens at surface **242** to the interior of the cylindrical standpipe **216**. Channel **240** also opens to the exterior at surface **244** which surface is essentially normal to the surface of cylinder **216**. Surface **244** is positioned so as to face the direction of rotation of the standpipe **216** so that the channel **240** will gather ore pulp and treatment material and convey the pulp to the interior of standpipe **216** during rotation thereof.

It should be appreciated that scoops **236** can be oriented in either direction selectively so that even if the direction of rotation of the standpipe **216** is reversed, the direction of orientation of the scoop **236** may be disposed 180° from that illustrated by manually collapsing the scoop in the vicinity of peripheral slot **238**, removing the scoop from aperture **218** and replacing the scoop in the reverse orientation.

From the foregoing it is apparent that new and improved structure for treating ore pulp pursuant to the recovery of minerals therefrom has been provided by substantially increasing the effectiveness of aeration, agitation, conditioning and related treatment without

excessive surging and boiling adjacent the top of the treatment cell.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A mineral treating cell comprising a circular vat into which a mineral bearing pulp suspension and a treatment substance are disposed, the improvement comprising:

an impeller non-rotatably carried upon a centrally disposed rotatable shaft, the impeller comprising a plurality of blades having a configuration so that when the impeller is rotated in the mineral suspension, the suspension will be thrown downwardly toward the bottom of the vat; and

an agitator ring mounted upon the interior periphery of the vat adjacent the location of the impeller, the agitator ring comprising resiliently deformable essentially wedge-shaped segments the ends of which are spaced from the impeller blades so that as the impeller rotates within the mineral suspension, shear zones are developed by the agitator ring thereby generating maximum contact of treatment substance and minerals without excessive boiling of the suspension within the vat at the pulp surface.

2. A cell as defined in claim 1 wherein said agitator ring is hollow, each segment having apertures communicating the hollow thereof with the exterior to minimize clogging the hollow with sediment.

3. A cell as defined in claim 2 wherein said segments are semi-circular in cross section.

4. A cell as defined in claim 2 wherein said segments are square in cross section.

5. A cell as defined in claim 2 wherein said segments have an upper surface comprising an inclined ramp surface with the highest point disposed adjacent the vat and the lowest point disposed adjacent the impeller path.

6. A cell as defined in claim 1 wherein said central shaft upon which the impellers are mounted comprises a cylindrical standpipe concentrically disposed around and spaced from the central shaft, at least the lower end of the standpipe being disposed within the treatment substance and pulp suspension adjacent the impellers; and means disposed at the upper end of the standpipe for delivering the fresh pulp suspension to the upper end of the standpipe so that pulp suspension is communicated directly therethrough to the rotating impeller blades for shearing of large air bubbles into small ones, and dispersion into and throughout openings in the agitator ring.

7. A cell as defined in claim 6 wherein the cylindrical standpipe is provided with spaced apertures at an axial location adjacent the surface level of the treatment substance and pulp suspension.

8. A cell as defined in claim 6 wherein the standpipe is concentrically spaced from the central shaft for rotation therewith and further comprising scoop means mounted upon the standpipe adjacent each spaced aperture so that the opening of the scoop means is in the direction of rotation of the standpipe to recirculate the pulp suspension through the standpipe to the impeller blades.

9. A mineral recovery apparatus comprising in combination

a treatment cell adapted to receive a mineral suspension and a treatment substance;

a rotatable impeller shaft centrally disposed within and spaced from the side and bottom of the cell;

a hollow cylindrical collar concentrically spaced from the impeller shaft and non-rotatably associated therewith;

an impeller non-rotatably mounted upon the shaft and comprising a plurality of radially projecting blades, each having an inverted triangular cross section for downwardly throwing the mineral suspension; and

an annular disc having at least one aperture for passing the mineral suspension therethrough and being attached to and generally below the cylindrical standpipe for rotation therewith, the disc carrying on the underside thereof a plurality of downwardly projecting fingers disposed in spaced locations around the periphery of the disc.

10. An apparatus as defined in claim 9 wherein said fingers are mounted upon the disc by structure accommodating selective removal of the fingers and replacement thereof by similar fingers in the event of structural damage.

11. An apparatus as defined in claim 9 further comprising radially spaced, downwardly projecting paddle blades rigidly secured to the underside of the disc adjacent the fingers and directed radially outward from the axis of the impeller shaft and the rotating standpipe.

12. A mineral treating cell comprising a vat into which mineral bearing pulp suspension and a treatment substance are disposed, the improvement comprising:

a rotatable shaft and a disc member non-rotatably mounted upon the shaft, the disc member comprising (a) impeller blades spaced radially outward from the axis of the shaft, (b) at least one aperture adjacent the shaft, (c) a plurality of spaced depending fingers disposed adjacent the periphery thereof and (d) a standpipe non-rotatably mounted upon the disc member and spaced from the shaft for defining a flow path through the aperture.

* * * * *