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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B03D 1/14, 1/22 — A1

(11) International Publication Number: WO 90/11133

(43) International Publication Date: 4 October 1990 (04.10.90)

(21) International Application Number: PCT/US90/01234

(22) International Filing Date: 6 March 1990 (06.03.90)

(30) Priority data:
329,294 27 March 1989 (27.03.89) US

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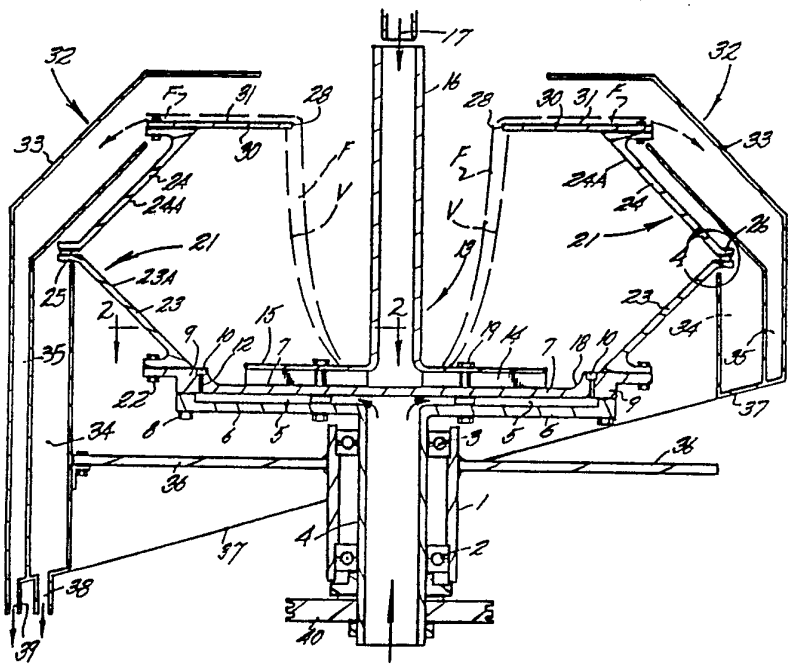
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), + CH, CH (European patent), CM (OAPI patent), DE, DE + (Utility model), DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP (Utility model), KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent).

Published
With international search report.

(54) Title: CENTRIFUGAL FLOTATION APPARATUS AND METHOD



(57) Abstract

A powered bowl assembly includes walls (21) and a tubular shaft (4) journalled within a base (1) of the apparatus. A pressurized air flow is discharged into slurry in the bowl assembly via a circular array of bubble generators (10). An impeller (13) discharges the slurry outwardly against an upwardly inclined annular surface (18) of the bowl assembly to cause the slurry to merge upwardly with the streams to promote flotation. Slurry within the bowl assembly forms a vortex (V) with particle flotation forming a froth layer (F) inwardly of the slurry vortex (V). The froth exits the bowl assembly upwardly past a barrier (30) partially closing the bowl assembly. Heavier gangue particles exit via an outlet (29) about the bowl assembly periphery. A collector shroud (32) is partitioned to receive the froth and the heavier waste material. A modified form of the apparatus includes an independently powered bowl assembly and impeller.

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Description

Centrifugal Flotation Apparatus and Method

Technical Field

The present invention pertains generally to equipment and methods utilized for the separation of mineral or metallic particles by flotation.

The scarcity of high grade ore has placed greater emphasis on the recovering of small particles, termed fines, during processing. In certain instances in the past, such efforts were not economically justified. Presently tailing from past and present mineral processing operations are believed to be a valuable resource assuming such tailings can be economically processed.

Background Art

In the prior art are flotation systems wherein a slurry flow is fed into the flotation unit above an injected airflow. Briefly, the mineral particles adhere to airflow bubbles and result in a concentrate forming at the flotation units upper surface. To the extent known, such systems rely entirely on the effect of differential gravity in such a flotation process. The flotation process is widely used for processing material containing fine particles which, in many instances, are not recovered.

Disclosure of Invention

The present invention is embodied in a machine for recovering fines from a slurry utilizing both flotation and centrifugal force.

The present machine subjects a slurry flow to centrifugal force with the flow forcefully directed toward bubble streams. Impeller means distributes the slurry flow for mergence with the streams of minute or fine size bubbles. The slurry is subjected to a curtain of bubbles to initiate the flotation process. A first outlet of the bowl discharges a heavy material while a second outlet discharges a mineral-enriched froth. The second opening of the bowl is offset from the first opening. The outlets discharge into separate collectors.

The method for separating mineral or metallic particles from a slurry by flotation comprises the following steps: dispersing a slurry about an impeller axis, discharging gaseous bubble streams about the impeller axis and merging the discharged gaseous bubble streams into the dispersed slurry, rotating the slurry containing the gaseous bubble streams about the impeller axis to subject it to centrifugal force, and separating the resulting froth from the remainder of the slurry.

Important objectives include the provision of a centrifuge type flotation cell for the efficient treating of a slurry flow for the retrieval of fines heretofore, practically speaking, not retrievable; the provision of a flotation cell utilizing centrifugal force and bubble streams to act on a slurry flow to effect flotation at an accelerated rate to permit treating tailings for the recovery of fines as small as approximately 20 microns and less; the provision of a centrifugal flotation cell having readily altered or replaceable components to permit cell modification to best treat the material being processed; the provision of a flotation cell which achieves a high degree of air and particle mixing by the propagation of fine sized bubbles to enhance flotation.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiment of the invention is illustrated in the accompanying drawings which are briefly described as follows:

Fig. 1 is a vertical section through the present apparatus;

Fig. 2 is a horizontal fragmentary view taken along line 2-2 of Fig. 1;

Fig. 3 is an elevational view taken along line 3-3 of Fig. 2;

Fig. 4 is an enlarged detail view of that part of the apparatus encircled at 4 in Fig. 1; and

Fig. 5 is a vertical sectional view of a modified impeller.

Best Mode for Carrying Out the Invention

With continuing attention to the drawings wherein applied reference numerals indicate parts similarly hereinafter identified, the

reference numeral 1 indicates a portion of the base component of the present machine. Attendant base structure is not shown for the sake of clarity.

Base 1 serves as a bearing housing receiving suitable bearings at 2 and 3 in which is journalled a tubular air conduit shaft 4 with an air flow from a source of pressure being indicated by arrows.

A bowl assembly includes a plenum 5 served by conduit 4 and defined by a shaft-mounted plate 6 and a closure 7 therefor of corresponding circular shape in plan view. A ring of fasteners at 8 join the plate and closure. Aerators or gaseous bubble generating means at 10 are circumferentially spaced in a recessed manner about an annular shoulder 9 of closure 7. The aerators 10 may be of a porous ceramic nature, each being served by a gas passageway or conduit means 12 and suitably secured in place as by a bonding agent. The gas supplied to aerators 10 will normally be air, but other gases may be used when desired.

An impeller 13 receives a slurry flow and includes vanes 14 interposed between a circular plate 15 and plenum closure 7. A slurry intake tube at 16 of the impeller receives a controlled slurry flow represented by arrow 17.

The impeller discharge impinges on an upwardly curved inclined surface 18 outwardly adjacent to the impeller vanes 14. Inclined annular surface 18 imparts an upward component to the slurry discharged by the impeller for upward mergence and mixing with the several gaseous bubble streams issued by the aerators 10. To allow convenient impeller alteration, the fasteners at 19 removably secure the impeller in place to plenum closure 7. Spacer elements at 19A-19B (Fig.3) isolate the fasteners 19 from the air and slurry flows.

With attention again to the bowl assembly, the same additionally includes wall structure generally at 21 carried by shoulder 9 of plenum closure 7 with a ring of fasteners at 22. The wall structure

utilizes frusto-conical members 23 and 24 which have outwardly convergent, conical wall surfaces at 23A-24A which converge toward a first outlet or discharge opening 29 (Fig. 4) defined by opposed annular wall flanges at 25 and 26. Spacers at 27 (Fig. 4) are replaceable with spacer sets of different height enabling the outlet size to be varied. A rim at 28 on an annular barrier plate 30 constitutes a barrier to aerated slurry in the bowl assembly. Particle laden froth at F will migrate past rim 28 and outwardly along plate surface 31 during operation of the apparatus.

Collector means generally at 32 are defined by a circular partitioned housing 33 with inner and outer chambers at 34 and 35 the former receiving the non-floating gangue material from first discharge outlet 29. A mounting plate at 36 supports collector 32 which, in turn, is supported by base 1. A collector bottom wall 37 is inclined to direct the collected material to outlets at 38 and 39.

Drive means for the bowl assembly includes a sheave 40 driven by a variable speed motor not shown. While a single drive is shown for both bowl assembly and the impeller means, it will be understood that the impeller means may be driven in a similar manner by a separate variable speed motor per Fig. 5 wherein the impeller 13' is separate from a closure plate 7' and provided with a plate 42 corresponding to plate 15'. Tube 16 of the impeller would be journalled in a manner similar to but independent of the bowl assembly.

As the incoming slurry (arrow 17) received through the intake tube 16 is dispersed about the axis of impeller 13, the gaseous bubble streams issuing from aerators 10 merge into the dispersed slurry. The slurry containing the gaseous bubble streams is constantly rotated about the impeller axis to subject it to centrifugal force. The resulting froth and entrained mineral values can then be separated from the remainder of the slurry by directing these components to different discharges at 28 and 26, respectively.

In operation, froth formation at F occurs inwardly of the slurry vortex at V. Slurry entry via conduit 16 is regulated to avoid discharge of heavier materials with the froth. It will be appreciated that flow rates both of slurry and gas, as well as bowl assembly speed, may vary to best suit the material being processed.

By subjecting the slurry made up of water and various mineral particles along with flotation reagents to centrifugal force and gaseous bubbles, the froth so formed in the flotation cell is made heavier by a factor determined by the G loading resulting from the rotational speed of the cell i.e., the greater the RPM of the cell the greater the G load on cell contents.

Accordingly the particles in the slurry settle at a greater rate than the known flotation cells; bubble flow, opposite to G loading is at an increased rate due to the increased differential weight or mass between the slurry and the bubbles; and bubble size will be smaller due to the increased weight of the slurry.

Increased infusion of bubbles in the slurry greatly enhances bubble contact with small particles of mineral versus such contact in a typical flotation cell. Unwanted particles or gangue which would ordinarily be carried upward by a bubble stream into the enriched froth of a typical flotation cell are, in the present apparatus, drawn to a separate discharge due to their increased settling speed.

While I have shown but one embodiment of the invention, it will be apparent to those skilled in the art that the invention may be embodied still otherwise without departing from the spirit and scope of the invention.

Claims

1. A centrifugal apparatus for separating mineral or metallic particles from a slurry by flotation, said apparatus comprising,

a base,

impeller means for dispersing a slurry about an impeller axis,

a bowl assembly about said impeller means and into which the slurry is discharged by the impeller means, the bowl assembly including a first bowl outlet and a second bowl outlet offset from said first outlet,

drive means for said bowl assembly,

gaseous bubble generating means for discharging gaseous bubble streams and merging the discharged gaseous bubble streams into the slurry dispersed by the impeller means,

conduit means in communication with a source of gas for providing a gaseous flow to the gaseous bubble generating means, and

collector means disposed about said bowl assembly and defining chambers for separately collecting material from the first and second outlets.

2. The apparatus claimed in claim 1 wherein said impeller means is coupled to and driven by said bowl assembly.

3. The apparatus claimed in claim 1 further comprising:

a continuous inclined surface positioned outwardly of the impeller means and against which the slurry impinges prior to merging with the gaseous bubble streams.

4. The apparatus claimed in claim 3 wherein said inclined surface is of curved section.

5. The apparatus claimed in claim 1 wherein said bubble generating means include ceramic inserts inset in said bowl assembly

outwardly adjacent said inclined surface.

6. The apparatus claimed in claim 5 wherein said inserts are in a circular array.

7. The apparatus claimed in claim 1 wherein said bowl assembly has outwardly convergent surfaces terminating at said first outlet.

8. The apparatus claimed in claim 7 wherein said bowl assembly has an annular barrier, said second outlet embodied in a barrier rim past which slurry froth moves.

9. The apparatus claimed in claim 7 wherein said outwardly convergent surfaces terminate in opposed flanges,

spacers interposed between said flanges, and

means removably securing said spacers in place to permit spacer replacement to vary the size of said first bowl outlet.

10. The centrifugal apparatus claimed in claim 1 wherein said collector means is in the form of a shroud disposed about the bowl assembly.

11. The centrifugal apparatus claimed in claim 10 wherein said second bowl outlet is defined by an annular barrier plate partially closing the bowl assembly.

12. A method for separating mineral or metallic particles from a slurry by flotation comprising the following steps:

dispersing a slurry about an impeller axis,

discharging gaseous bubble streams about the impeller axis and merging the discharged gaseous bubble streams into the dispersed

slurry

rotating the slurry containing the gaseous bubble streams about the impeller axis to subject it to centrifugal force, and

separating the resulting froth from the remainder of the slurry.

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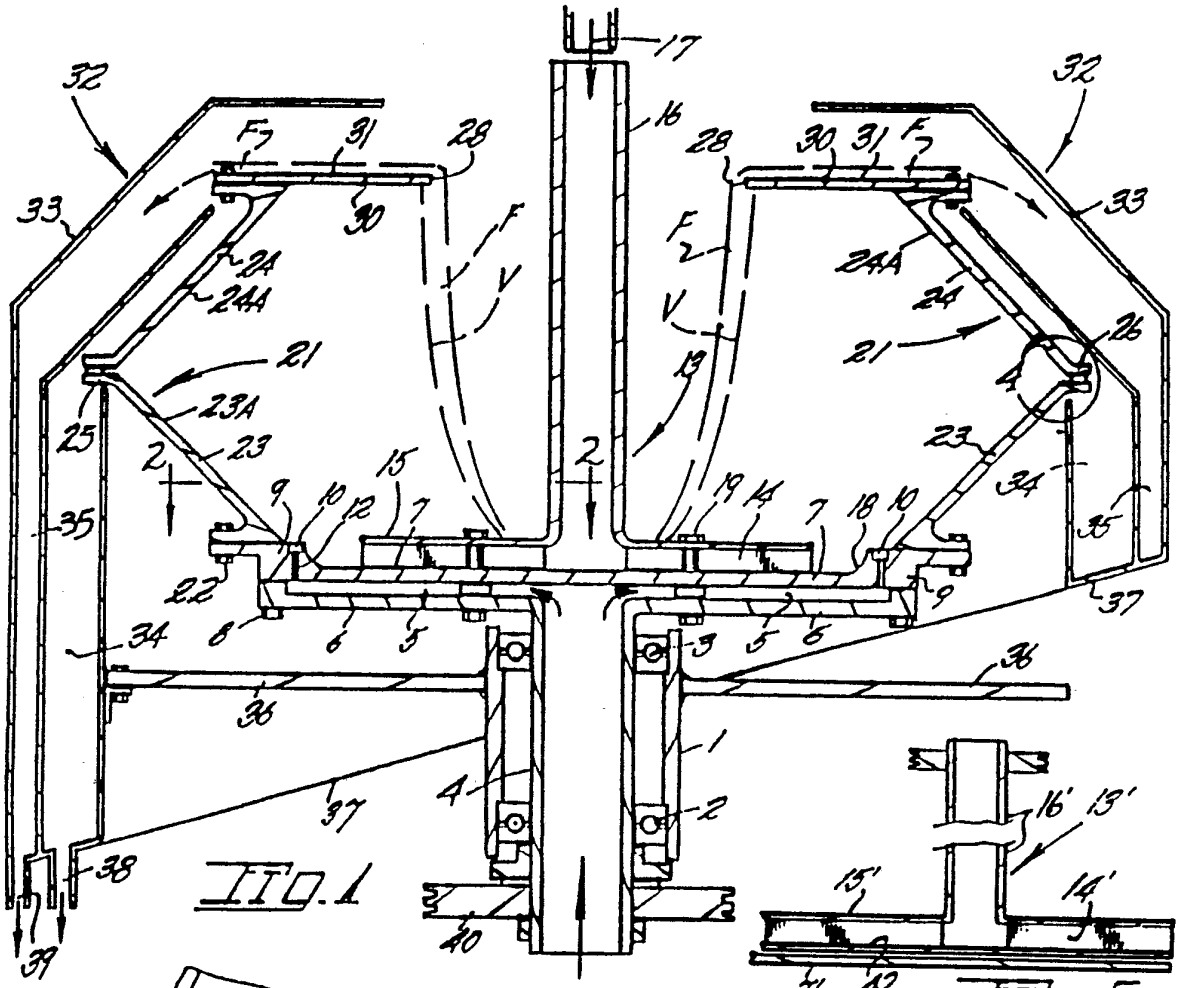
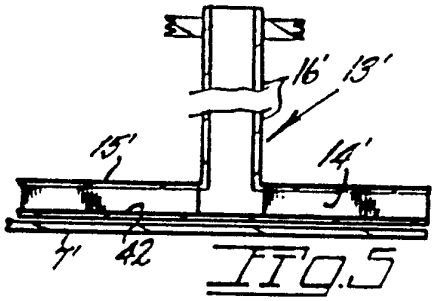
13. The method claimed in claim 12, including the following additional step:

angularly deflecting the dispersed slurry as the gaseous bubble streams are merged into the slurry.



ФИГ.1



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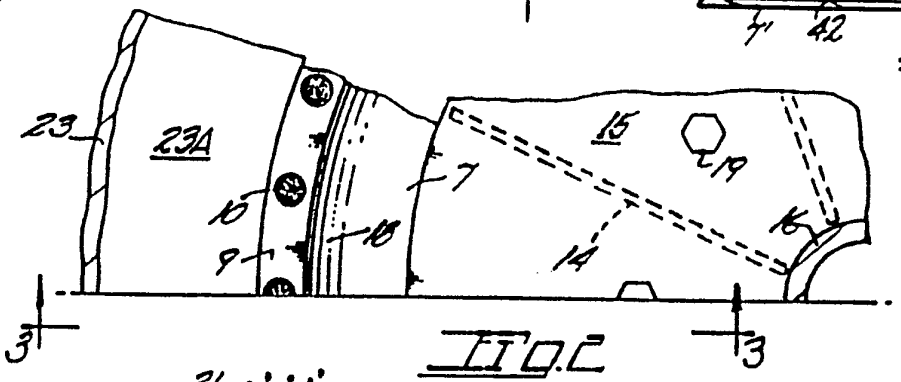

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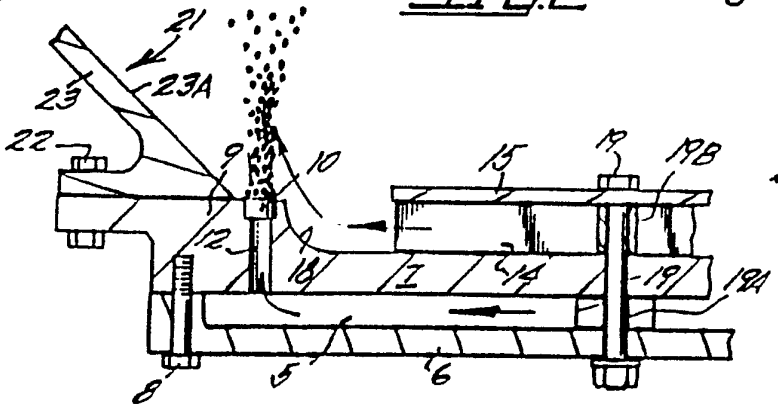

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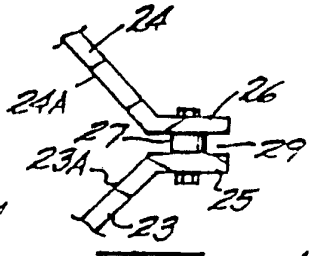

ФИГ.4

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 90/01234

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B03D1/14 ; B03D1/22

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B03D ; B04B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	FR,A,2539772 (MARVEJOULS) 27 July 1984 see page 1, lines 4 - 10 see page 2, line 4 - page 3, line 8 see page 4, line 6 - page 6, line 29 see page 7, line 19 - page 8, line 32 see page 9, lines 11 - 13; figures	1, 2, 8, 10-13
A	DE,A,3634323 (LESCHONSKI) 21 April 1988 see column 3, line 54 - column 4, line 17 see column 5, lines 23 - 29; figure	1-4, 12, 13
A	FR,A,539535 (SAMAIN) 27 June 1922 see page 1, lines 1 - 5 see page 1, line 51 - page 2, line 34 see page 2, lines 82 - 98; figures	1-4, 7-11

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IV. CERTIFICATION

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,4186096 (AREAUX ET AL) 29 January 1980 see column 2, line 66 - column 3, line 3 see column 3, lines 30 - 43 see column 3, lines 53 - 65 see column 4, lines 3 - 9 see column 4, line 66 - column 5, line 24; figures 1, 2	1-3, 7, 8, 10
A	US,A,4247391 (LLOYD) 27 January 1981 see column 1, lines 49 - 58; figure	1, 12

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/US90/01234

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A-2539772	27-07-84	None	
DE-A-3634323	21-04-88	None	
FR-A-539535		None	
US-A-4186096	29-01-80	None	
US-A-4247391	27-01-81	None	