63047/86

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 9-7-90

Form 1
Regulation 9

601698

COMMONWEALTH OF AUSTRALIA

Patents Act 1952

CONVENTION APPLICATION FOR A STANDARD PATENT

WE, THE STANDARD OIL COMPANY a United States Company of 200 Public Square, 36-F-3454, Cleveland, Ohio, 44114, United States of America, hereby apply for the grant of a standard patent for an invention entitled APPARATUS AND METHOD FOR FROTH FLOTATION which is described in the accompanying complete specification.

The actual inventors of the said invention are:

ALEX SZENTLASZLOI
FRANCIS J. MCDONNELL
JAMES V. DUTTERA

Details of Basic Application:-

Number of Basic Application:	803.099
Convention Country in which Basic Application was filed:	United States of America
ISO Code:	US
Date of Basic Application:	27 November 1985

OUR address for service is SMITH SHELSTON BEADLE, 207 Riversdale Road, (P O Box 410), Hawthorn, 3122, Victoria, Australia (Attorney Code SA).

DATED THIS 29 June 1990

SMITH SHELSTON BEADLE
Patent Attorneys for the Applicant

AUSTRALIAN PATENT OFFICE

TO: The Commissioner of Patents
Our Ref: #223 BC:AM STANDAPP

PATENT DECLARATION FORM
(CONVENTION OR NON-CONVENTION)

DECLARATION IN SUPPORT OF APPLICATION FOR A PATENT

Insert name of applicant.

In support of the application made by THE STANDARD OIL COMPANY

Insert title of invention.

for a patent for an invention entitled: Apparatus and Method For Froth Flotation

Insert full name(s) and address(es) of person(s) making declaration. If applicant a company person must be authorised to make declaration.

I/We Larry William Evans, Manager, 200 Prospect Avenue, Cleveland, Ohio 44115, United States of America

do solemnly and sincerely declare as follows:

* ~~(a) I am/we are the applicant(s) for the patent.~~

* OR (b) I am authorized by the abovementioned applicant to make this declaration on its behalf.

* ~~(a) I am/we are the actual inventor(s) of the invention.~~

* OR (b) Alex Szentlaszloi, RD1, Box 353, Hockessin, Delaware, 19707, U.S.A., Francis J. McDonnell, 2743 Harmil Road, Broomall, Pennsylvania, 19008, U.S.A., and James V. Duttera, 1006 Polk Drive, Springfield, Pennsylvania, 19064, U.S.A.

* Delete alternatives which do not apply

Insert name(s) and address(es) of actual inventor(s).

is/are the actual inventor(s) of the invention and the facts upon which the applicant(s) is/are entitled to make the application are as follows:—

Insert details of entitlement to apply, e.g. Applicant is assignee of inventor(s)

Applicant is assignee of inventors

3. The basic application(s) as defined by Section 141 of the Act was/were made in the following country or countries on the following date(s) by the following applicant(s)

in USA on November 27 19 85

by Alex Szentlaszloi, Francis J. McDonnell, James V. Duttera

in ____ on ____ 19____

by ____

in ____ on ____ 19____

by ____

in ____ on ____ 19____

by ____

Delete 3 and 4 if application non-convention. Otherwise insert details of basic application(s).

4. The basic application(s) referred to in paragraph 3 of this Declaration was/were the first application(s) made in a Convention country in respect of the invention the subject of the application.

Place and date of Signature.

Declared at Cleveland, OHIO this 26 day of September 19 86

THE STANDARD OIL COMPANY

NO ATTESTATION OR SEAL

By _____

Larry William Evans, Manager
Patent & License Division

Signature(s) of declarant(s).

To: The Commissioner of Patents, Australia

SANDERCOCK, SMITH & BEADLE, P.O. Box 410, Hawthorn, 3122, Australia

(12) PATENT ABRIDGMENT (11) Document No. AU-B-63047/86
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(54) Title
FROTH FLOTATION APPARATUS

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(74) Attorney or Agent
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(56) Prior Art Documents
US 4347127
US 3351199

(57) Claim

1. Apparatus for froth flotation separation of the components of a slurry having particulate matter therein which is to be separated, said apparatus comprising:

(i) a flotation tank comprised of at least two individual flotation cells separated by a partition and having a commuting common sloped bottom for withdrawing tailings from each of said flotation cells, wherein said sloped bottom is sloped downwardly towards the feed input end of said flotation tank;

(ii) primary means for feeding slurry into said flotation cells, said means for feeding slurry positioned above said flotation cells; and

(iii) means for withdrawing a floating fraction from said individual flotation cells.

601698

Form 10

PATENTS ACT 1952

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

Short Title:

Int. Cl:

Application Number: 63047/86
Lodged:

This document contains the amendments made under Section 49 and is correct for printing.

Complete Specification—Lodged:
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Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: THE STANDARD OIL COMPANY

Address of Applicant: 200 Prospect Avenue, Cleveland, Ohio, 44115, United States of America

Actual Inventor: ALEX SZENTLASZLOI, FRANCIS J. MCDONNELL, and JAMES V. DUTTERA

Address for Service: SANDERCOCK, SMITH & BEADLE, Patent Attorneys, 207 Riversdale Road, Hawthorn, Victoria, 3122 Australia

Complete Specification for the invention entitled: APPARATUS AND METHOD FOR FROTH FLOTATION

The following statement is a full description of this invention, including the best method of performing it known to me:—*

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* Note: The description is to be typed in double spacing, pica type face, in an area not exceeding 250 mm in depth and 160 mm in width, on tough white paper of good quality and it is to be inserted inside this form.

This invention relates to a method and apparatus for flotation separation and more particularly to a method and apparatus for beneficiating carbonaceous matter by flotation separation.

Coal is an extremely valuable natural resource in the United States because of its relative abundant supplies in this nation. It has been estimated that the United States has more energy available in the form of coal than in the combined natural resources of petroleum, natural gas, oil shale, and tar sands. Recent energy shortages, together with the availability of abundant coal reserves and the continuing uncertainties regarding the availability of crude oil, have made it imperative that methods for converting coal into a more useful energy source be developed.

Some known prior art processes for froth flotation separation of a slurry of particulate matter are based on constructions wherein air is introduced into the liquid slurry of the particulate matter as, e.g., through a porous cell bottom or a hollow impeller shaft, thereby producing a surface froth. These prior art methods are relatively inefficient approaches especially when large concentrations of particulate matter are being processed. Generally, these techniques are inefficient in providing sufficient contact area between the particulate matter and frothing air. As a result, large amounts of energy can be expended in frothing. In addition, froth flotation techniques which permit bubbles to rise in the slurry can tend to trap and carry impurities,

such as ash in the froth slurry, and accordingly the resultant beneficiated particulate product can have more impurities therein than necessary.

With more particularity to the prior art, U.S. Patent No. 3,351,199 discloses an apparatus for froth flotation comprising a flotation cell divided in its upper part into compartments by partition walls. The flotation cell is described as being a rectangular or trapeziform elongated trough the bottom of which slopes away from the point at which the feed is introduced. The froth is removed by rotating paddles located at the top of the flotation cell.

U.S. Patent No. 2,350,943 discloses a counter-current froth flow flotation system where the froth is caused to flow from the tailing end of the flotation apparatus towards the feed end. Concomitantly, the tailings are caused to flow counter to the flow of the froth and are discharged at the opposite end of the pulp body. The apparatus is comprised of a plurality of individual flotation cells arranged together in series to form a multiple cell unit in which free communication among the constituent cells, as well as a common pulp level are maintained, while at the same time the cells are operatively distinct one from another.

U.S. Patent No. 2,184,115 discloses an apparatus for flotation concentration of ores comprising a plurality of cells interconnected to permit the flow of concentrates from one cell to another and the counterflow of middlings and tailings from one cell to another. The middlings and tailings pass through pipes connecting the various cells.

Other patents which disclose froth flotation apparatus comprising pluralities of cells include U.S. Patent Nos. 4,399,028, 953,746, 2,073,148, 4,045,243, 3,491,880, 2,423,456, 2,765,081, 4,184,967, 2,983,377, U.S. 2,687,213 and 2,416,066.

Other methods have been suggested and are being explored in the beneficiation of coal, i.e., the cleaning of coal of impurities such as ash and sulfur, either prior to burning the coal or after its combustion. In one recently developed technique for beneficiation disclosed in U.S. Patent No. 4,304,573 and U.S. Patent No. 4,412,843, raw coal is pulverized to a fine mesh size and is then chemically treated. According to this technique the chemically treated coal is then separated from ash and sulfur, and a beneficiated or cleaned coal product is recovered therefrom.

In further detail, in the heretofore mentioned chemical surface treating technique, coal is first cleaned of rock and the like, and is then pulverized to a fine size of about 48 to 300 mesh. The extended surfaces of the ground coal particles are then rendered hydrophobic and oleophilic by a polymerization reaction. The sulfur and mineral ash impurities present in the coal remain hydrophilic and are separated from the treated coal product in a water washing step. This step utilizes oil and water separation techniques, and the coal particles made hydrophobic can float in recovery on a water phase which contains hydrophilic impurities.

In the multi-stage cleaning mode of operation, such as disclosed in U.S. Patent Nos. 4,304,573 and 4,412,843 several independent flotation tanks are used in a

series for the beneficiation circuit. For a three stage beneficiation, as disclosed in these patents, three flotation tanks are used, and one scavenger tank. The floating fraction of the slurry containing the coal particles is reintroduced into successive flotation tanks for stage cleaning. The tailing fraction of the slurry, containing some ash laden coal is withdrawn from the bottom of the tanks into a scavenger for the recovery of coal from the counterflow stream. The rate of withdrawal of tailings is regulated by pumps, controlled from level sensors of the tanks to prevent settlement of solids in the piping between each individual tank unit.

An improved apparatus for carrying out the aforedescribed chemical beneficiation technique is disclosed in U.S. Patent No. 4,347,127. This patent discloses a flotation apparatus wherein a primary spray nozzle is positioned above the flotation tank for spraying input slurry and a recycle spray nozzle is positioned above the tank for respraying particulate matter collected in a collecting trough positioned in the tank for collecting sinking material.

While the aforedescribed chemical surface treating beneficiation flotation systems have provided excellent end product results, improved systems are desirable which will provide for a simpler, less expensive arrangement and reduce the complexity of the overall control required to operate the system.

Accordingly, it is a primary object of the present invention to provide an improved apparatus and method for froth flotation separation of a slurry of particulate matter.

Another object of this invention is to provide an improved method and apparatus for beneficiating coal by a froth flotation separation of particulate coal from impurities associated therewith such as ash and sulfur.

Still another object of the present invention is to provide a method and apparatus for froth flotation separation of a slurry of particulate matter which is simpler, less expensive, more efficient and moreover provides improved yields of clean product.

Thus in accordance with the objectives in one aspect the invention thus provides an apparatus for froth flotation separation of the components of a slurry having particulate matter therein which is to be separated, said apparatus comprising:

(i) a flotation tank comprised of at least two individual flotation cells separated by a partition and having a commuting common sloped bottom for withdrawing tailings from each of said flotation cells, wherein said sloped bottom is sloped downwardly towards the feed input end of said flotation tank;

(ii) primary means for feeding slurry into said flotation cells, said means for feeding slurry positioned above said flotation cells; and

(iii) means for withdrawing a floating fraction from said individual flotation cells.

In another aspect of the invention there is provided a

method for froth flotation separation of the components of a slurry having particulate matter therein which is to be separated, said method taking place in a flotation tank having a number of flotation cells partitioned from each other in a continuous liquid bath and comprising the steps of:

(i) feeding an input slurry of particulate matter to the liquid bath in a first flotation cell to create a froth on the surface of said liquid having a substantial quantity of particulate matter floating therein, while other components of the slurry and a minor quantity of particulate matter sink in the liquid;

(ii) feeding the froth created on the liquid surface in said first flotation cell to a liquid bath in a second flotation cell to create a froth on the surface of said liquid in said second flotation cell having a substantial quantity of particulate matter floating therein, while other components of the slurry and a minor quantity of particulate matter sink in the liquid; and

(iii) withdrawing a tailings fraction from said first flotation cell and a tailings fraction from said second flotation cell in a counterflow stream in a common communicating bottom beneath said first and second flotation cells, said common communicating bottom sloped downwardly in the direction wherein said input slurry of step (i) is being fed.

The apparatus and method of the present invention are adapted to the separation of a wide variety of solid-fluid streams by the creation of a solids containing froth phase and is suitable for the separation of many types of particulate

matter. U.S. Patent Nos. 4,304,573 and 4,412,843, incorporated herein by reference may be referred to for further details on the chemical treating processes which are particularly useful in conjunction with the present invention.

As illustrated in Figures 1 - 3, the flotation tanks, called cells herein, are not independent from each other but combined into one large tank having a hydraulically commuting inclined common bottom for the slurry at each cell. In this arrangement, the collection and transportation of coal laden tailings in the counterflow stream into the scavenger tank is more efficient than in previous methods. Instead of using discrete piping and pumps between each tank, a common sloped bottom extends under all of the beneficiation compartments or cells, as shown in Figs. 1 and 3. The common bottom which extends under all the beneficiation cells is sloped downwardly towards the point at which the input slurry enters the tank. Fluid input at the upper end of the sloped bottom provides a counterflow stream of tailings. This method of collection of tailings, including some coal laden particles for recycling into the scavenger tank, as shown in Fig. 1, results in both improved yield and reduction of ash in the final clean coal product. Further, this arrangement results in a simpler, less expensive construction of the beneficiation tank in that only one liquid level sensor is used for all cells in the tank.

In order to better understand the method and apparatus disclosed herein, the present invention is described with reference to the coal beneficiating process as disclosed for example in said U.S. Patent Nos. 4,304,573 and 4,412,843. Thus, referring to the drawings herein in greater detail, Fig. 1 schematically illustrates a preferred embodiment of the present invention having a flotation tank 5 comprised of three cells filled with water to a level 6. Flotation tank 5 is generally trapezoidal in shape having a bottom which slopes toward the end of the tank where the input slurry is fed. In operation, a slurry of finely ground coal particles, associated impurities, and additives and reagents, if desired, such as monomeric compounds, chemical initiators, catalysts and fluid hydrocarbon carriers, are initially fed, e.g., from a ball mill, to a coal slurry feed tank 7 and then sprayed into flotation tank 5 through at least one primary spray nozzle 8 positioned at a spaced apart distance above the water level 6 in tank 5. In alternative embodiments, two or more primary nozzles can be used to spray slurry and/or any other desired ingredients into the cells of flotation tank 5. Preferred types of spray nozzles utilized herein are, for example, the spiral or helix open flow spray nozzles disclosed in U.S. Patent No. 4,514,291 incorporated by reference herein or the full jet spray nozzles for example as disclosed in U.S. Patent No. 4,347,126, or U.S. Patent No. 4,347,127 also incorporated by reference herein.

The stream of treated coal is pumped under pressure to the primary spray nozzle 8 wherein the resultant shearing forces spray the coal flocculent slurry as fine

droplets such that they are forcefully jetted into the mass of continuous water bath in cell No. 1 creating a froth 2 on the liquid surface having a substantial quantity of particulate matter floating therein, while other components of the slurry and a minor quantity of particulate matter sink in the liquid bath.

The froth produced in cell No. 1 is discharged by skimmer paddle 16 into collection tank 17, as illustrated in Fig. 2 which is a section of the apparatus of Fig. 1 taken along lines A-A. While Fig. 2 is a sectional view taken through cell No. 1, Fig. 2 is also representative of the same sectional view taken through cell No. 2 and cell No. 3. As shown in Fig. 2, an upwardly inclined and curved surface 18 extends from the water surface at skimmer 16 to collection chute 21 in the cell for the draining of excess (and laden) water from the froth before it is discharged into froth collect tank 17. The froth which is discharged from the first cell into froth collect tank 17 is generally diluted and mixed with water from spray nozzle 40 before being pumped and sprayed through primary nozzle 19 into the liquid surface of cell No. 2 for additional cleaning. Cell No. 2 (as well as cell No. 3) is like cell No. 1 and the operation in cell No. 2 (as well as cell No. 3) is similar to that which occurs in cell No. 1. After treatment in Cell No. 2, the froth from cell No. 2, collected in a froth collect tank like tank 17, is then pumped and sprayed through primary nozzle 20 into the liquid surface of cell No. 3 after which the clean coal froth produced is removed from a further froth collect tank like tank 17 for drying and final fuel blending. As is evident from the drawings, the tailings from each cell are removed in a counterflow stream 10 at the hydraulically communicating sloped

common bottom 11 of the flotation tank 5 as shown in Figs. 1-3. Water is introduced at inlet 25, shown in Fig. 1, to sloped common bottom 11 to maintain a controlled hydraulic flow therein.

Flotation tank 5 is divided in its upper part into the various cells by partitions 30 and 31. The partitions 30 and 31 extend vertically into the tank but as shown do not extend completely to the bottom thereby providing the common communicating bottom 11.

In order to illustrate further details of one embodiment of the present invention, a typical beneficiation cell in accordance with the present invention is shown in Fig. 2. As stated before, Fig. 2 is a section taken from Fig. 1 along the line A-A through cell No. 1, as indicated. In this embodiment, the primary spray nozzle 8, positioned above the liquid bath in the cell, sprays an input slurry of particulate matter through an aeration zone into the liquid surface. The spraying operation creates a froth 2 on the liquid surface having a substantial quantity of particulate matter floating therein, while other components of the slurry and a minor quantity of particulate matter sink in the liquid bath. A collector trough 33 is positioned in the cell below the primary spray nozzle 8 for collecting the sinking materials. The collected materials are then recycled to at least one recycle spray nozzle 4 positioned in proximity to the primary spray nozzle(s) 8 of the cell. A verticle baffle 15 is positioned between the primary and recycle nozzles to provide separation for materials sinking from the sprays of the respective nozzles. The froth 2, produced in the cell, is discharged by skimmer paddle 16 through chute 21 and into the froth

collection tank 17. The primary and recycle spray nozzles, 8 and 4, are preferably inclined from a vertical in the direction in which the skimmer paddle 16 operates to direct the flow of froth in that direction along the liquid surface.

The froth which is discharged from the first cell into tank 17, is diluted and mixed with water before being pumped and sprayed into the liquid surface of the second cell for additional cleaning. In the same manner, the final (third) stage cleaning of the froth is accomplished in the cell No. 3, after which the clean coal froth product is transferred for drying and fuel blending. The tailings are removed in a counterflow stream 10, flowing in opposite direction of the froth, at the hydraulically communicating common bottom 11 of the tank as shown in Figs. 1-3.

Referring to Fig. 2, materials which tend to settle from the recycle spray in the pulp are withdrawn along the sloped bottom of the cell 12, by counterflow stream 10, flowing through common bottom 11. Similarly, settling materials in the pulp from the primary spray, which are not collected in trough 33, are withdrawn along cell bottom 14 by the counterflow stream 10, as also shown in Fig. 2. The angle of the slope used for the cell bottoms 12 and 14 is about forty-five degrees, in one embodiment. The angle of the slope of common bottom 11, as shown in Figs. 1 and 3 is about fifteen degrees in the same embodiment. This geometry of the tank bottom is given herein only as an example, and is not intended to be as a restriction of using different slopes for other size tanks.

The use of one level sensor control with communication between cells, as shown in Fig. 1, results in a simpler and less expensive system than the system with individual level control for each tank as in prior art arrangements. The rate of flow of water added to the system at location 25 as shown in Fig. 1 must be controlled so as to prevent any back-flow of the pulp from cell No. 1 to cell No. 2, and from cell No. 2 to cell No. 3, that is, to exchange liquid in the direction of the counterflow stream as shown, so that the greater ash content of pulp in cell No. 1 does not contaminate the pulp in cell No. 2, and the pulp in cell No. 2 does not contaminate the pulp in cell No. 3. Further, the velocity of the counterflow at the bottom of the tank must be sufficient to prevent settling of the tailings in conduit 11.

Thus, in accordance with the present invention, a froth flotation apparatus utilizing at least two and preferably three beneficiation cells are used side by side with a hydraulically communicating common bottom of liquid under all the cells. The arrangement permits the use of one tank level control, which is common for all of the cells. Further, controlled flow of water is introduced to the system to produce a counterflow stream pattern under the cells by which the greater ash content of pulp in the first cell cannot contaminate the pulp in the second cell. In the same manner, the higher ash content of pulp in the second cell cannot contaminate the same in the third cell. The counterflow stream is sufficient to prevent any settling of the tailings at the tank bottom. With this improved method of collection, transportation of the tailings for recycling from a scavenger tank as shown in Fig. 1 is more efficient than in previous methods.

While several embodiments and variations of a method and apparatus for froth flotation separation of the components of a slurry have been described in detail herein, it should be apparent that the teachings and disclosure of the present invention will suggest many other embodiments and variations to those skilled in the art. For example, while the drawings illustrate the use of three beneficiation cells, fewer or more cells can be employed depending upon specific requirements.

The claims form part of the disclosure of this specification.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Apparatus for froth flotation separation of the components of a slurry having particulate matter therein which is to be separated, said apparatus comprising:

(i) a flotation tank comprised of at least two individual flotation cells separated by a partition and having a commuting common sloped bottom for withdrawing tailings from each of said flotation cells, wherein said sloped bottom is sloped downwardly towards the feed input end of said flotation tank;

(ii) primary means for feeding slurry into said flotation cells, said means for feeding slurry positioned above said flotation cells; and

(iii) means for withdrawing a floating fraction from said individual flotation cells.

2. The apparatus of claim 1 wherein at least one of said flotation cells contains a collector means positioned in said cell below said slurry feeding means for collecting sinking material.

3. The apparatus of claim 1 wherein at least one recycle feeding means for re-feeding sinking material is positioned above at least one of said flotation cells and in proximity to said primary means for feeding slurry.

4. The apparatus of claim 1 wherein said means for withdrawing said floating fraction includes at least one skimmer paddle.

5. The apparatus of claim 1 wherein said flotation tank is comprised of at least three individual flotation cells separated from each other by a partition and having a

commuting common sloped bottom for withdrawing tailings from each of said flotation cells.

6. Apparatus for froth flotation separation of the components of a slurry having particulate matter therein which is to be separated, said apparatus comprising:

(i) a flotation tank comprised of at least three individual flotation cells separated from each other by a partition and having a commuting common sloped bottom for withdrawing tailings from each of said flotation cells, wherein said sloped bottom is sloped downwardly towards the feed input of said flotation tank and wherein said sloped bottom is provided with an inlet means for introducing liquid at the upper end of said sloped bottom;

(ii) primary means for feeding slurry into said flotation cells, said primary means for feeding slurry positioned above said flotation cells;

(iii) recycle feeding means for re-feeding sinking material, said recycle feeding means positioned above said flotation cells and in proximity to said primary means for feeding slurry; and

(iv) means for withdrawing a floating fraction from said flotation cells.

7. A method for froth flotation separation of the components of a slurry having particulate matter therein which is to be separated, said method taking place in a flotation tank having a number of flotation cells partitioned from each other in a continuous liquid bath and comprising the steps of:

(i) feeding an input slurry of particulate matter to the liquid bath in a first flotation cell to create

a froth on the surface of said liquid having a substantial quantity of particulate matter floating therein, while other components of the slurry and a minor quantity of particulate matter sink in the liquid;

(ii) feeding the froth created on the liquid surface in said first flotation cell to a liquid bath in a second flotation cell to create a froth on the surface of said liquid in said second flotation cell having a substantial quantity of particulate matter floating therein, while other components of the slurry and a minor quantity of particulate matter sink in the liquid; and

(iii) withdrawing a tailings fraction from said first flotation cell and a tailings fraction from said second flotation cell in a counterflow stream in a common communicating bottom beneath said first and second flotation cells, said common communicating bottom sloped downwardly in the direction wherein said input slurry of step (i) is being fed.

8. The method of claim 7 wherein at least a portion of the sinking materials in said first flotation cell are collected in a collector means and recycled to the liquid bath in said first flotation cell whereby at least a portion of the recycled materials floats as froth on the liquid surface.

9. The method of claim 7 wherein the sinking materials in said second flotation cell are collected in a collector means and recycled to the liquid bath in said second flotation cell whereby a portion of the recycled materials floats as froth on the liquid surface.

10. The method of claim 7 wherein froth created on

the liquid surface in said second flotation cell is fed to a third flotation cell containing a liquid bath to create a froth on the surface of said liquid bath having a substantial quantity of particulate matter floating therein.

11. The method of claim 10 further comprising the step of withdrawing a tailings fraction from said third flotation cell in a counterflow stream in a common communicating bottom beneath said first, second and third flotation cells, said common communicating bottom sloped downwardly in the direction wherein said input slurry of step (i) is being fed.

12. The method of claim 11 wherein a fluid is fed into the upper end of the common communicating sloped bottom to provide a controlled counterflow stream of tailings.

13. The method of claim 10 wherein the froth on the surface of said liquid in said third flotation cell is collected.

14. A froth flotation apparatus substantially as described with reference to the accompanying drawings.

15. A froth flotation method substantially as described with reference to the accompanying drawings.

DATED this 29 June 1990

SMITH SHELSTON BEADLE

Fellows Institute of Patent Attorneys of Australia

Patent Attorneys for the Applicant:

THE STANDARD OIL COMPANY

amspe.004/stand 90 6 29

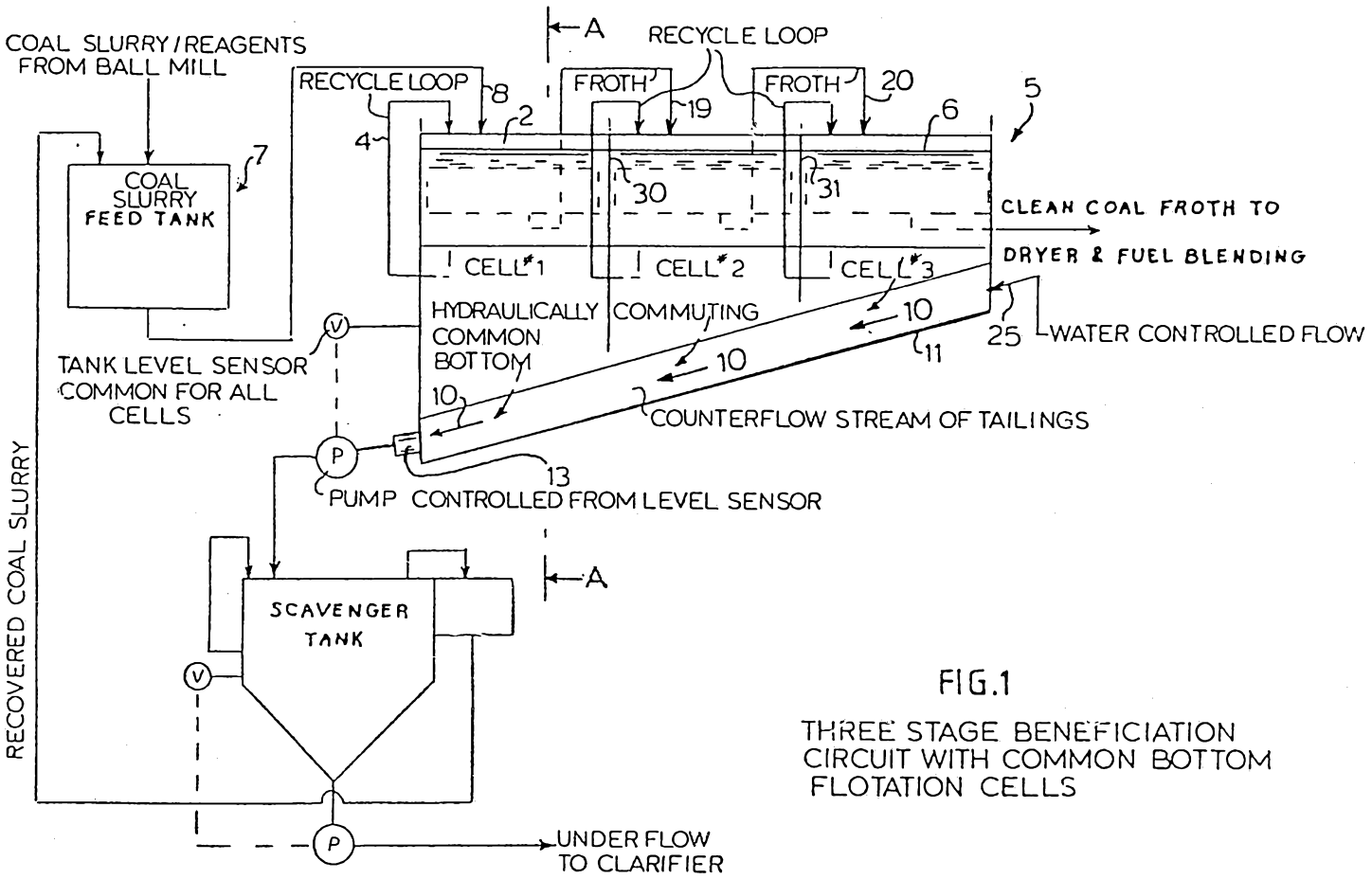

FIG.1

THREE STAGE BENEFICIATION CIRCUIT WITH COMMON BOTTOM FLOTATION CELLS

98/L4059

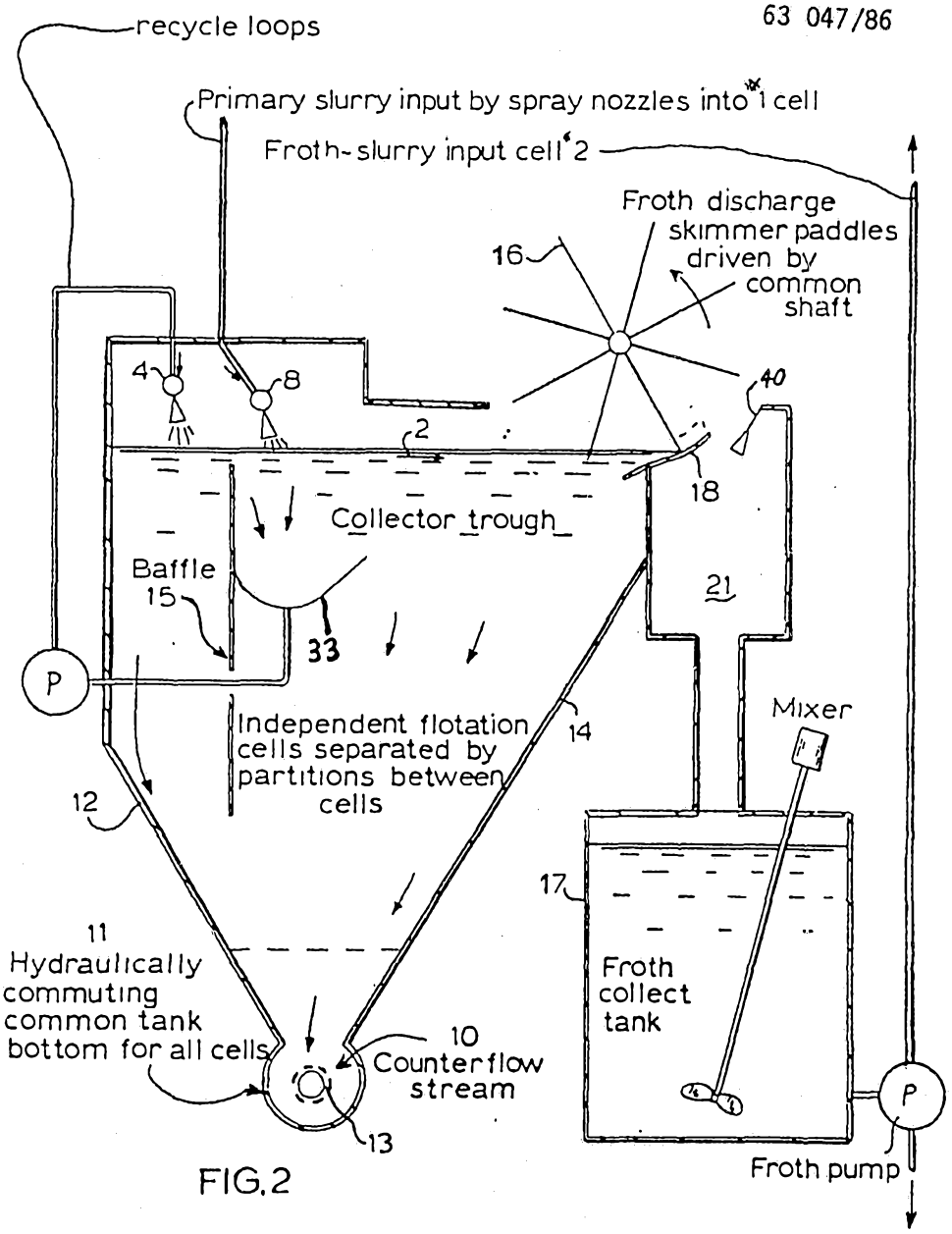
recycle loops
Primary slurry input by spray nozzles into 1 cell
Froth-slurry input cell 2
Froth discharge skimmer paddles driven by common shaft
16
4
8
40
2
18
Collector trough
Baffle 15
33
21
P
Independent flotation cells separated by partitions between cells
14
Mixer
12
17
11
Hydraulically commuting common tank bottom for all cells
10
Counterflow stream
13
Froth collect tank
P
Froth pump

FIG. 2

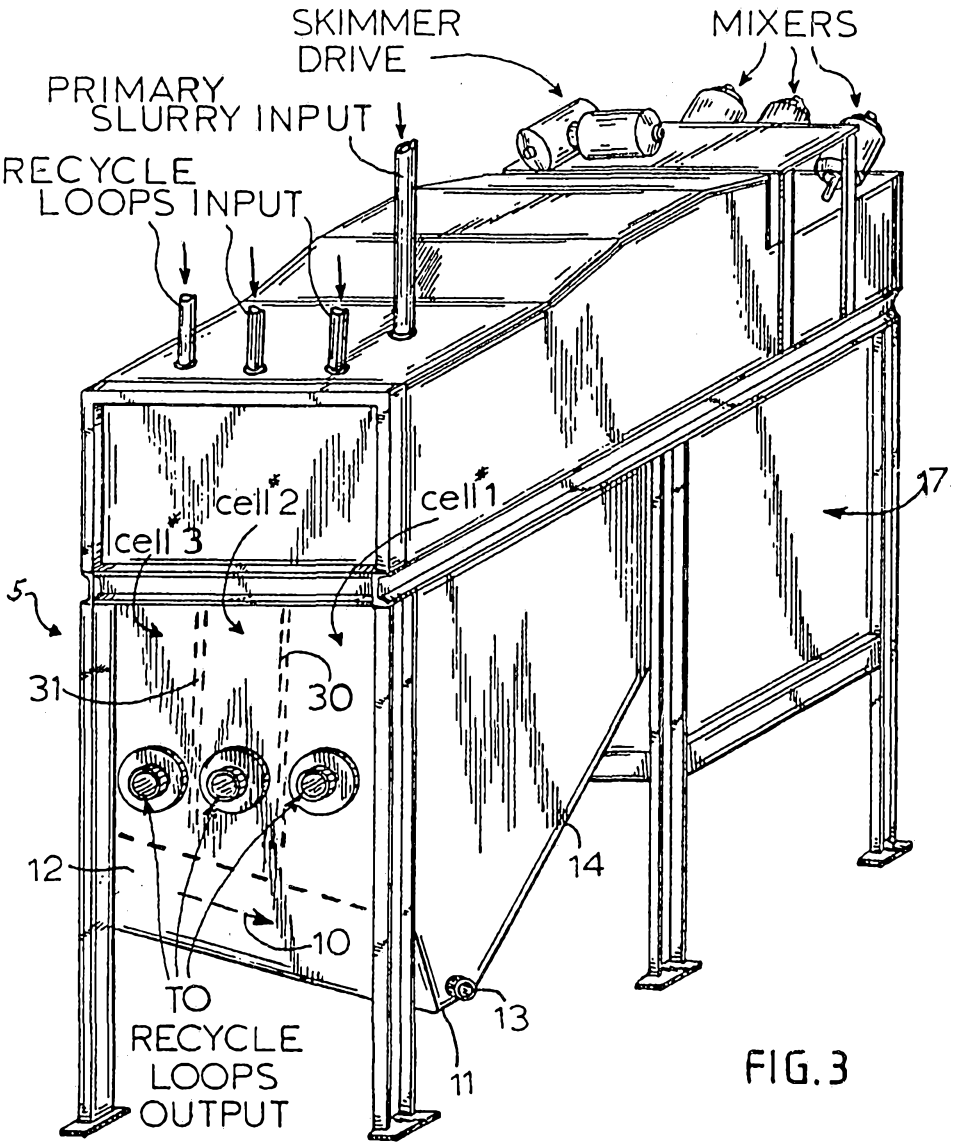
SKIMMER
DRIVE
MIXERS
PRIMARY
SLURRY INPUT
RECYCLE
LOOPS INPUT
cell 2
cell 1
cell 3
17
5
31
30
12
14
10
13
TO
RECYCLE
LOOPS
OUTPUT
11

FIG. 3