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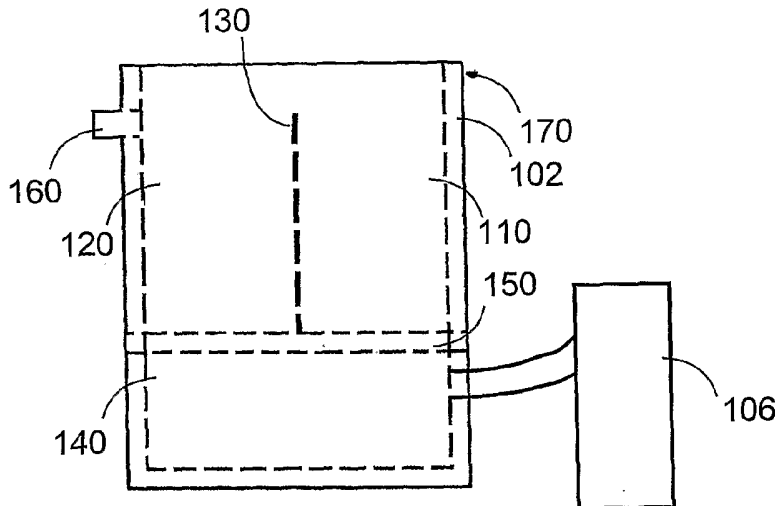
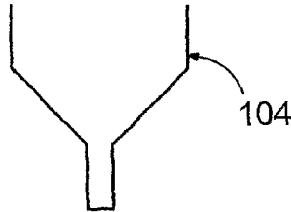
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[Continued on next page]

(54) Title: METHOD AND DEVICE FOR DETERMINING A SET OF OPERATING PARAMETERS FOR A FLUIDIZED BED MINERAL SEPARATOR



(57) Abstract: A method and device for determining operating parameters for a fluidized bed mineral separator includes a feedstock input hopper containing an input material. The input material is a mixture of gangue and a seed material in the form of the desired material to be extracted from the gangue, or a material having a density substantially similar to the density of the desired material. Optionally, the device includes an electrostatic charge generator charging the input material. A chamber enclosed by an outer wall having an exit port and a gas permeable base receives the input material. A fluidized bed is created by delivering pressurized air through the gas permeable base. The outer wall is tilted with respect to the direction of gravity and additional input material is delivered to the chamber until the gangue substantially flows from the exit port while the seed material is retained in the chamber.

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**METHOD AND DEVICE FOR DETERMINING A SET OF OPERATING  
PARAMETERS FOR A FLUIDIZED BED MINERAL SEPARATOR**

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Field of the Invention

The present invention relates to use of fluidized bed mineral separators. Specifically, the present invention is a method and device for determining a set of operating parameters for the operation of a fluidized bed mineral separators so that material of a desired density are delivered from the fluidized bed mineral separator.

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Background of the Invention

Dry placer mining, particularly for mining gold and silver from gravel deposits, has been known for many years. For example, U.S. Pat. No. 5,375,721 discloses a machine used to separate minerals from mined material, typically gravel. Specifically, mined material is delivered to the mineral separator and a fluidizing gas stream is generated. Typically this is performed by applying an electrostatic charge to the material and/or a belt on which the material lies and forcing gas, under pressure, through the belt. The gas pressure is increased until the material is agitated and lifted off the surface of the belt. The fluidized bed of materials separates into

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layers as the mass of particles is balanced by the upward force of the gas flow drag on the particles. The floating of particles is based upon the density of the mineral making up the particle rather than upon the size. That is, as size increases, mass also increases, so that the increased weight is countered by the increased force of the gas flow. Within limited size ranges, these factors approximately balance, and the density of the individual component becomes the dominant factor.

The belt is typically mounted on a tilted deck and moved at a predetermined belt rate to allow the material to be removed. The operator can then remove the materials of an undesired density (referred to as "gangue") and retain the materials of desired density.

However, a fluidized bed mineral separator is highly dependent upon a number of operating parameters. For example, the gas flow rate, the angle of the deck, and the belt rate are significant factors in efficient separation.

While the optimization of these operating parameters, could be determined by use of a fluidized bed mineral separator, the device is complicated and the time required to determine the parameters for the desired operation could be costly. Therefore, there is a need in the art for a method and device that can aid in determining a set of operating parameters for a fluidized bed mineral separator.

## Summary of the Invention

The present invention is a method and device for determining a set of operating parameters for a fluidized bed mineral separator to extract a desired material from particulate gangue. The device includes a feedstock input hopper containing an input material. The input material is composed of a mixture of gangue and a seed material. The seed material is the desired material, or a material having a

density substantially equal to the density of the desired material, or a combination thereof. Optionally, the device includes an electrostatic charge generator imparting an electrostatic charge to the input material.

5 The device further includes a chamber enclosed by an outer wall having an exit port and a gas permeable base. The chamber communicates with the feedstock input hopper to receive the input material. Optionally, the chamber is divided into a hopper chamber and a gangue chamber by an inner wall, with both the hopper chamber and gangue chamber in communication with the gas permeable base. In such an optional embodiment, the feedstock input hopper delivers the input material  
10 to the hopper chamber.

The outer wall tilts through a range of angles with respect to the direction of gravity. Optionally, the outer wall and gas permeable base are fixed with respect to one another such that the outer wall is tilted by tilting the chamber.

15 A gas source delivers pressurized gas through the gas permeable base. A controller, optionally a pressure controller, controls the gas source to create a fluidized bed of the input material in the chamber. Optionally, a pressure measuring device measures the pressure of the pressurized gas creating the fluidized bed.

20 A controller communicates with the outer wall to tilt the outer wall to an angle with respect to the direction of gravity such that the input material is substantially retained in the chamber proximate the exit port. Optionally, an angle measuring device measures the angle of the outer wall with respect to the direction of gravity.

25 A feedstock input hopper controller controls the flow rate of the input material from the feedstock input hopper into the chamber such that the gangue substantially flows through the exit port while the seed material is substantially

retained in the chamber. In an optional embodiment in which the chamber is divided, the hopper chamber receives input material from the feedstock input hopper and the gangue substantially flows from the hopper chamber to the gangue chamber and from the gangue chamber through the exit port while the seed material is substantially retained in the hopper chamber. Optionally, a flow measuring device measures the flow of the input material into the chamber.

The present invention also includes a method for creating a fluidized bed to determine a set of operating parameters for a fluidized bed mineral separator extracting a desired material from particulate gangue. According to the present method, a chamber enclosed by an outer wall having an exit port and a gas permeable base is provided. Optionally, the chamber has a hopper chamber separated from a gangue chamber by an inner wall, in which both the hopper chamber and the gangue chamber communicate with the gas permeable base.

An input material comprising a mixture of gangue and a seed material is delivered to the chamber. As above, the seed material is the desired material, or a material having a density substantially equal to the density of the desired material, or a mixture thereof. Optionally, the input material is imparted with an electrostatic charge. In an optional embodiment having a hopper chamber, the input material is delivered to the hopper chamber.

Pressurized gas is delivered through the gas permeable base, with the pressure of the pressurized gas controlled to create a fluidized bed of the input material in the chamber. Optionally, the pressure of the pressurized gas forming the fluidized bed of input material is measured.

The chamber is tilted to an angle with respect to the direction of gravity such that the input material is substantially retained in the chamber. In an optional

embodiment, the chamber is tilted after the fluidized bed of input material is created by the pressurized gas. Optionally, the angle of the chamber with respect to the direction of gravity is measured.

5 The flow rate of the input material into the chamber, optionally the hopper chamber, is controlled such that the gangue substantially flows from chamber while the seed material is substantially retained in the chamber. Optionally, the flow rate is controlled to cause the flow of gangue from the chamber after the chamber is tilted. In an optional embodiment having a hopper chamber and a gangue chamber, the flow rate of the input material is controlled such that the input material  
10 substantially flows from the hopper chamber to the gangue chamber and the gangue substantially flows from the gangue chamber through the exit port while the seed material is substantially retained in the hopper chamber. Optionally, the flow rate of the input material into the hopper chamber is measured.

15 Brief Description of the Drawings

FIG. 1 is a side view of a device according to an embodiment of the present invention;

FIG. 2 is a top view of a chamber according to an embodiment of the present invention;

20 FIG. 3 is a cutaway side view of a chamber according to an embodiment of the present invention taken along section line A—A of FIG. 2;

FIG. 4 is a cutaway side view of the chamber of FIG. 3 in a tilted position;

FIG. 5 is a cutaway side view of the device of FIG. 1 in operation;

FIG. 6 is a flowchart of a method according to the present invention.

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Description

Reference is now made to the figures wherein like parts are referred to by like numerals throughout. Referring generally to FIGS. 1–5, the device of the present invention creates a fluidized bed 100 in a chamber 170. The chamber 170 is enclosed by an outer wall 102 and a gas permeable base 150. The outer wall 102 includes an exit port 160. The chamber 170 itself may take any shape, form, or construction, but in the optional embodiment shown in FIGS. 1–5, the chamber 170 is a rectangular parallelepiped with a rectangular gas permeable base 150.

As discussed in greater detail below, the method and device of the present invention includes an outer wall 102 that is movable with respect to the direction of gravity. In one optional embodiment, the outer wall 102 itself may be movable independent of the gas permeable base 150. In another optional embodiment, the outer wall 102 is fixed with respect to the gas permeable base 150 and the entire chamber 170 is movable. This optional embodiment, illustrated in FIGS. 1–5, has a chamber 170 that can be tilted with respect to the direction of gravity.

In either case, a controller may be provided to control the tilt of the outer wall 102 with respect to the direction of gravity. The controller may include an actuator, such as a motor, pump, lift, jack, or the like, to tilt the outer wall 102 itself or tilt the chamber 170, thereby causing the outer wall 102 to tilt. Optionally, an angle measuring device may be provided so that the angle 108 of the tilted outer wall 102 may be measured.

While the present invention contemplates the use of a single chamber, in optional embodiments, the chamber may have multiple, i.e. two or more, stages, at least one of which is in communication with the gas permeable base 150. For example, in the optional embodiment shown in FIGS. 1–5, the chamber 170 includes

a hopper chamber 110 and a gangue chamber 120 separated by an inner wall 130, both of which are in communication with the gas permeable base 150. Optionally, the inner wall 130 is shorter in vertical height than the outer wall 102 so that material in the hopper chamber 110 can flow to the gangue chamber 120 without overflowing the outer wall 102.

The gas permeable base 150 may take many different forms. In an optional embodiment, the gas permeable base 150 is a gas dispersion plate or membrane. For example, a fabric, woven from natural or synthetic threads, may form a gas dispersion membrane used in the gas permeable base 150. In such an optional embodiment, a gas dispersion membrane may be held by supports. It is also contemplated that the gas dispersion membrane may be formed from layers of materials, such as a foam sandwiched between layers of fabric. In another optional embodiment, a rigid or flexible gas dispersion plate may be used to form a gas permeable base 150. Optionally, the gas permeable base 150 is formed from a non-conductive material to minimize disturbance of the fluidized bed which, in an optional embodiment, is imparted with electrostatic charge.

As discussed in greater detail below, input material is delivered to the chamber 170. In an optional embodiment, the input material is delivered from a feedstock input hopper 104. In an optional embodiment, the feedstock input hopper 104 may be a gravity feed, such as that shown in FIGS. 1 and 5, or may include an active transport, such as a pump, belt, or the like, to move the input material. Additionally, the feedstock input hopper 104 may deliver the input material through closed pipes or, as shown in FIGS. 1 and 5, in the open. The feedstock input hopper 104 includes a controller 106 to control the flow of input material from the feedstock input hopper 104. The controller 106 could take many forms, including a valve,

meter, gate, tap, or other means for varying the flow of the input material. In an optional embodiment in which the chamber 170 is staged, the feedstock input hopper 104 may be directed to deliver input material to a subset of the chambers. For example, in the optional embodiment of FIGS. 1 and 5, the feedstock input hopper 5 104 delivers input material to the hopper chamber 110. Optionally, a flow measuring device may be provided to measure the flow of the input material from the feedstock input hopper 104.

With continued reference to FIGS. 1 and 5, a gas source 106 delivers pressurized gas through the gas permeable base 150. Optionally, the chamber 170 10 includes a gas chamber 140 receiving the pressurized gas before delivering it through the gas permeable base 150. The gas source 106 may deliver any type of gas, although in one optional embodiment, the gas is air. Optionally, a pressure measuring device may be provided to measure the pressure of the pressurized air.

Referring to FIG. 5, the feedstock input hopper 104 carries input material 15 240. As noted above, the purpose of the present method and device is to determine the operating parameters of a fluidized bed mineral separator extracting a desired material from gangue, i.e. unwanted material, optionally in particulate form. The input material 240 is a sample of the gangue seeded with a seed material either in the form of the desired material or in the form of a material having substantially the 20 same density as the desired material. The behavior of the input material 240 in the present device is then used to extrapolate the operating parameters for a fluidized bed mineral separator. For example, in determining the behavior of gangue so that a fluidized bed mineral separator could be configured to separate gold, the present device could be used with input material 240 consisting of gangue seeded with gold,

or gangue seeded with material having a substantially similar density to gold, such as tungsten.

When in operation as illustrated in FIGS. 5 and 6, input material 240 formed by seeding 610 gangue with seed material is delivered 600 to the chamber 170, optionally the hopper chamber 110. In an optional embodiment, the device includes an electrostatic charge generator and the input material is imparted with an electrostatic charge. The electrostatic charge generator could impart an electrostatic charge at any point in the device, including before reaching the feedstock input hopper 104, at the feedstock input hopper 104, as the input material 240 is delivered from the feedstock input hopper 104 to the chamber 170, or in the chamber 170.

Pressurized gas is delivered to the input material in the chamber 170, optionally the hopper chamber 110. The pressure of the gas is controlled to cause the input material to form 620 a fluidized bed 220. As known in the art, a fluidized bed is characterized by particles floating on a column of pressurized air against their mass and is identified by a boiling or simmering appearance. The fluidized bed 220 allows stratification of the input material 240.

In an optional embodiment using a unitary chamber 170, the outer wall 102, or the chamber 170 itself, is tilted 630 such that the upper surface of the fluidized bed 220 of input material reaches the exit port 160 after the fluidized bed is created. After tilting the chamber, additional input material is added 640 to the chamber, with the flow of the input material 240 into the chamber 170 controlled so that the gangue flows through the exit port 160 while the seed material precipitates out of the input material and is retained in the chamber 170.

In an optional embodiment in which the chamber 170 is staged, the method is substantially similar to that described above, with the delivery of pressurized gas to

the input material to create a fluidized bed, then tilting 630 the chamber 170 until, in this embodiment, the fluidized bed of input material reaches the top of the inner wall 130 separating the hopper chamber 110 from the gangue chamber 120. In this optional embodiment, however, the input material is added 640 so that input  
5 material flows from the hopper chamber 110 over the inner wall 130 to the gangue chamber 120 and gangue flows from the gangue chamber 120 out through the exit port 160, while the seed material is retained in the chamber 170, i.e. the hopper chamber 110 and/or the gangue chamber 120.

In either case, it is contemplated that any of the angle of the tilt, the flow rate  
10 of the input material, and/or the pressure of the gas may be altered until the ratio of seed material retained in the chamber reaches a desired level. That is, by manipulating one or more of these factors, it is possible to obtain a desired residence time for the fluidized bed of input material so that the seed material precipitates from the input material and is retained in the chamber while the gangue exits. For  
15 example, if it is desired that the seed material make up at least 30% of the total material retained in the chamber 170, one or more of the tilt angle, input material flow rate, and gas pressure may be adjusted until the desired level is reached.

In an optional embodiment, one or more of the tilt angle, input material flow rate, and gas pressure are measured. Using these measurements, the operating  
20 parameters of a fluidized bed mineral separator may be extrapolated. While the tilt angle, input material flow, and gas pressure measurements obtained using the present method and device may not directly translate to the operating parameters for a fluidized bed mineral separator, it is contemplated that the use of the present method and device may allow the user to empirically correlate certain measurements

obtained in the present device with the operating parameters of the user's fluidized bed mineral separator.

While certain embodiments of the present invention have been shown and described it is to be understood that the present invention is subject to many  
5 modifications and changes without departing from the spirit and scope of the claims presented herein.

I CLAIM:

1. A device for creating a fluidized bed to determine a set of operating parameters for a fluidized bed mineral separator extracting a desired material from particulate gangue comprising:

5 a feedstock input hopper containing an input material comprising a mixture of said gangue and a seed material in the form of said desired material or a material having a density substantially equal to the density of said desired material;

a chamber enclosed by an outer wall having an exit port and a gas permeable base, said outer wall tilting through a range of angles with respect to the direction of gravity, said chamber communicating with said feedstock input hopper to receive  
10 said input material;

a gas source delivering pressurized gas through said gas permeable base, said gas source controlled to create a fluidized bed of said input material in said chamber;

15 a controller communicating with said outer wall to tilt said outer wall to an angle with respect to the direction of gravity such that said input material is substantially retained in said chamber proximate said exit port; and

a feedstock input hopper controller controlling the flow rate of said input material from said feedstock input hopper into said chamber such that said gangue  
20 substantially flows through said exit port while said seed material is substantially retained in said chamber.

2. The device of claim 1 wherein said outer wall is fixed with respect to said gas permeable base, such that said outer wall is tilted by tilting said chamber.

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3. The device of claim 1 wherein said chamber includes a hopper chamber and a gangue chamber separated by an inner wall with both said hopper chamber and said gangue chamber in communication with said gas permeable base, said hopper chamber receiving input material from said feedstock input hopper and said exit port located on said outer wall proximate said gangue chamber such that such that said input material substantially flows from said hopper chamber to said gangue chamber and said gangue substantially flows from said gangue chamber through said exit port while said seed material is substantially retained in said chamber.
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- 10 4. The device of claim 1 further comprising an electrostatic charge generator communicating with said input material such that said input material is imparted an electrostatic charge.
- 15 5. The device of claim 1 further comprising a pressure measuring device measuring the pressure of said pressurized gas.
6. The device of claim 1 further comprising an angle measuring device measuring the angle of said outer wall with respect to the direction of gravity.
- 20 7. The device of claim 1 further comprising a flow measuring device measuring the flow rate of said input material into said chamber.
- 25 8. A device for creating a fluidized bed to determine a set of operating parameters for a fluidized bed mineral separator extracting a desired material from particulate gangue comprising:

a feedstock input hopper containing an input material comprising a mixture of said gangue and a seed material in the form of said desired material or a material having a density substantially equal to the density of said desired material;

5 a chamber enclosed by an outer wall having an exit port and a gas permeable base, said chamber tilting through a range of angles with respect to the direction of gravity, said chamber communicating with said feedstock input hopper to receive said input material;

10 a gas source delivering pressurized gas through said gas permeable base, said gas source controlled to create a fluidized bed of said input material in said chamber;

a controller communicating with said chamber to tilt said chamber to an angle with respect to the direction of gravity such that said input material is substantially retained in said chamber proximate said exit port; and

15 a feedstock input hopper controller controlling the flow rate of said input material from said feedstock input hopper into said chamber such that said gangue substantially flows through said exit port while said seed material is substantially retained in said chamber.

9. The device of claim 8 wherein said chamber includes a hopper chamber and  
20 a gangue chamber separated by an inner wall with both said hopper chamber and said gangue chamber in communication with said gas permeable base, said hopper chamber receiving input material from said feedstock input hopper and said exit port located on said outer wall proximate said gangue chamber such that such that said input material substantially flows from said hopper chamber to said gangue chamber

and said gangue substantially flows from said gangue chamber through said exit port while said seed material is substantially retained in said chamber.

10. The device of claim 8 further comprising an electrostatic charge generator  
5 communicating with said input material such that said input material is imparted an electrostatic charge.

11. The device of claim 8 further comprising a pressure measuring device  
10 measuring the pressure of said pressurized gas.

12. The device of claim 8 further comprising an angle measuring device  
measuring the angle of said outer wall with respect to the direction of gravity.

13. The device of claim 8 further comprising a flow measuring device measuring  
15 the flow rate of said input material into said chamber.

14. A device for creating a fluidized bed to determine a set of operating  
parameters for a fluidized bed mineral separator extracting a desired material from  
particulate gangue comprising:

20 a feedstock input hopper containing an input material comprising a mixture  
of said gangue and a seed material in the form of said desired material or a material  
having a density substantially equal to the density of said desired material;

a chamber having a hopper chamber separated from a gangue chamber by an  
inner wall, said chamber enclosed by an outer wall having an exit port and a gas  
25 permeable base communicating with both said hopper chamber and said gangue

chamber, said chamber tilting through a range of angles with respect to the direction of gravity, said hopper chamber communicating with said feedstock input hopper to receive said input material;

5 a gas source delivering pressurized gas through said gas permeable base, said gas source controlled to create a fluidized bed of said input material in said chamber;

a controller communicating with said chamber to tilt said chamber to an angle with respect to the direction of gravity such that said input material is substantially retained in said hopper chamber proximate said inner wall; and

10 a feedstock input hopper controller controlling the flow rate of said input material from said feedstock input hopper into said hopper chamber such that said input material substantially flows from said hopper chamber to said gangue chamber and said gangue substantially flows from said gangue chamber through said exit port while said seed material is substantially retained in said chamber.

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15. The device of claim 14 further comprising an electrostatic charge generator communicating with said input material such that said input material is imparted an electrostatic charge.

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16. The device of claim 14 further comprising a pressure measuring device measuring the pressure of said pressurized gas.

17. The device of claim 14 further comprising an angle measuring device measuring the angle of said outer wall with respect to the direction of gravity.

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18. The device of claim 14 further comprising a flow measuring device measuring the flow rate of said input material into said chamber.

19. A method for creating a fluidized bed to determine a set of operating parameters for a fluidized bed mineral separator extracting a desired material from particulate gangue comprising:

providing a chamber having a hopper chamber separated from a gangue chamber by an inner wall, said chamber enclosed by an outer wall having an exit port and a gas permeable base communicating with both said hopper chamber and said gangue chamber;

delivering an input material comprising a mixture of said gangue and a seed material in the form of said desired material or a material having a density substantially equal to the density of said desired material to said hopper chamber;

delivering pressurized gas through said gas permeable base, the pressure of said pressurized gas controlled to create a fluidized bed of said input material in said chamber;

after creating a fluidized bed of input material, tilting said chamber to an angle with respect to the direction of gravity such that said input material is substantially retained in said hopper chamber proximate said inner wall; and

after tilting said chamber, controlling the flow rate of said input material into said hopper chamber such that said input material substantially flows from said hopper chamber to said gangue chamber and said gangue substantially flows from said gangue chamber through said exit port while said seed material is substantially retained in said chamber.

20. The method of claim 19 further comprising imparting an electrostatic charge to said input material.
21. The method of claim 19 further comprising measuring the pressure of said  
5 pressurized gas.
22. The method of claim 19 further comprising measuring the angle of said chamber with respect to the direction of gravity.
- 10 23. The method of claim 19 further comprising measuring the flow rate of said input material into said hopper chamber.

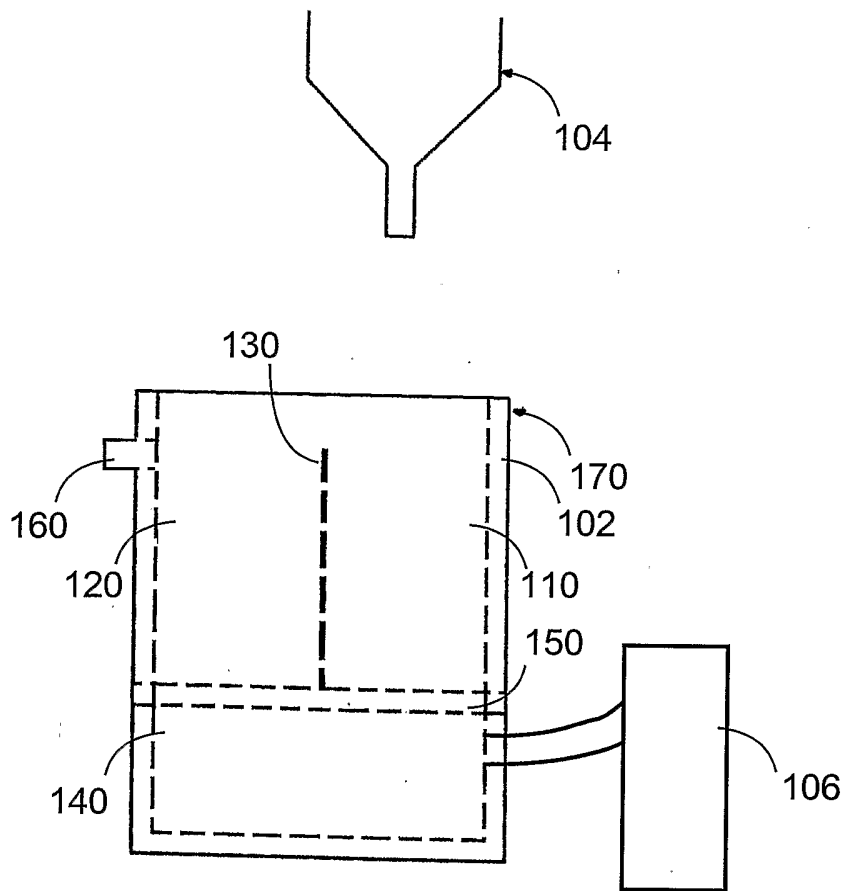
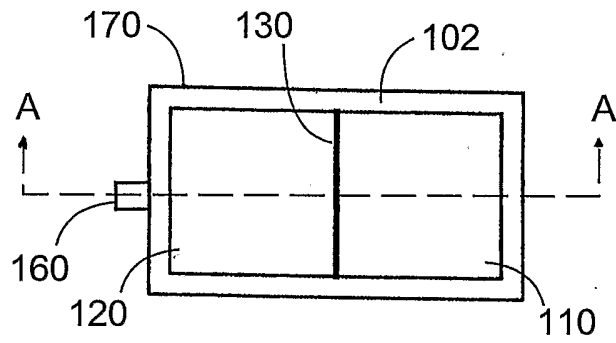
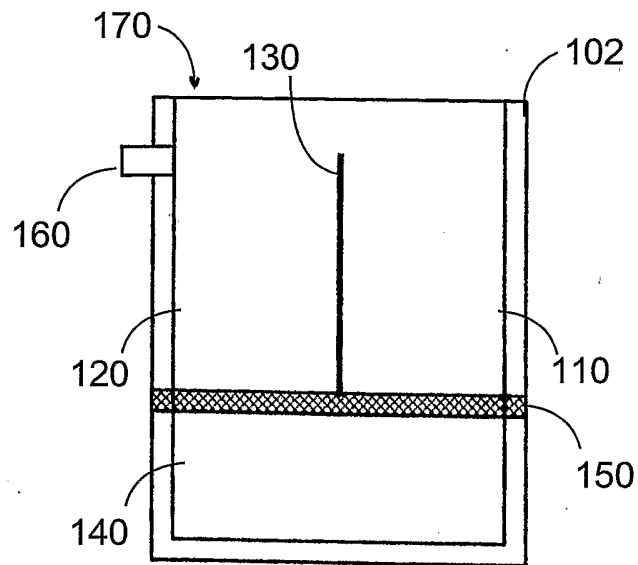


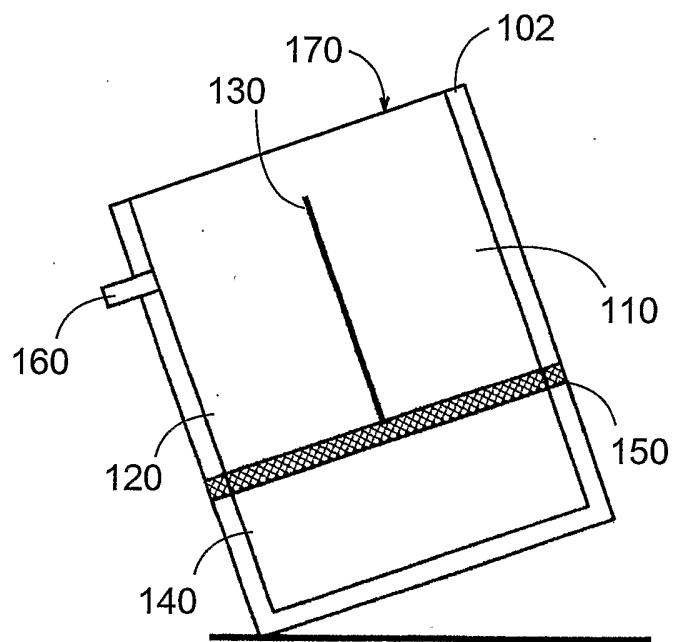
FIG. 1



**FIG. 2**



**FIG. 3**



**FIG. 4**

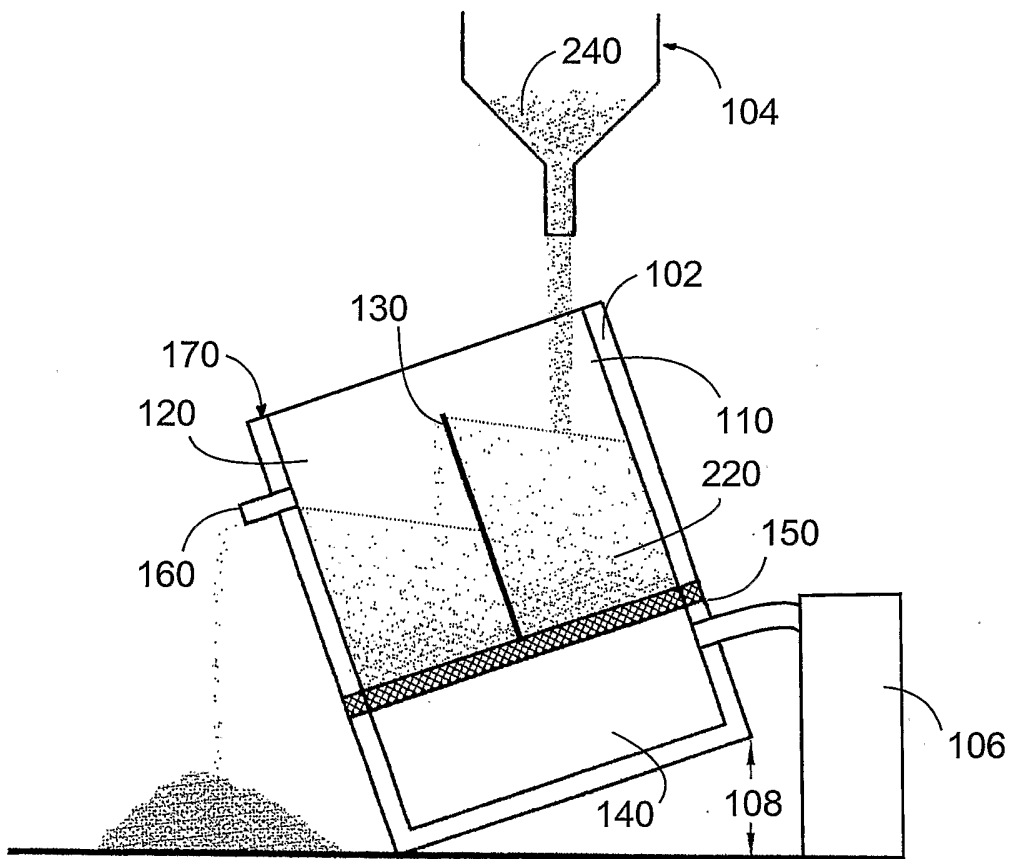
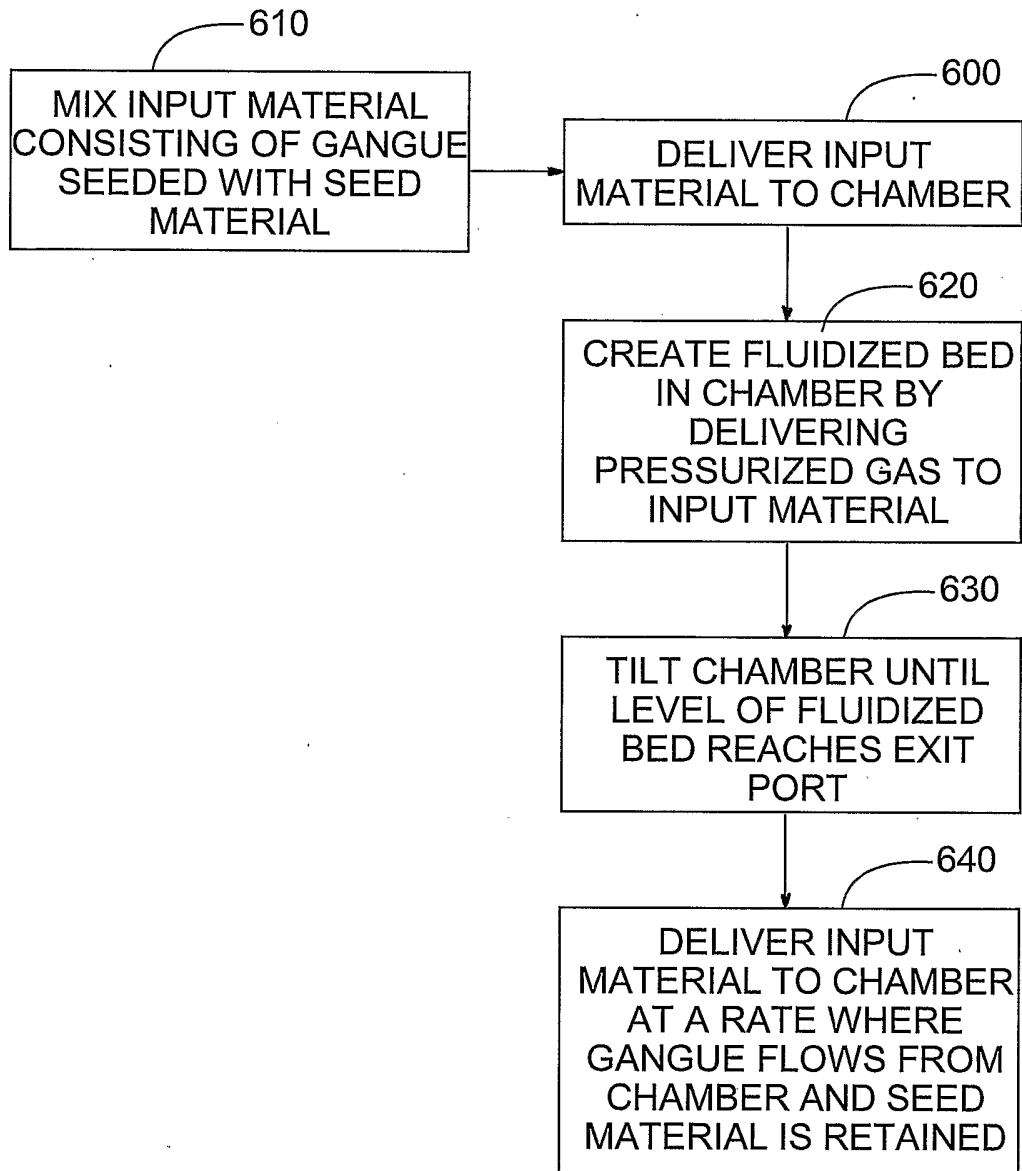


FIG. 5

**FIG. 6**