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1,452,815

C. J. REED

PROCESS OF AND APPARATUS FOR GRADING SOLID MATERIALS

Filed April 25, 1919

2 Sheets-Sheet 1

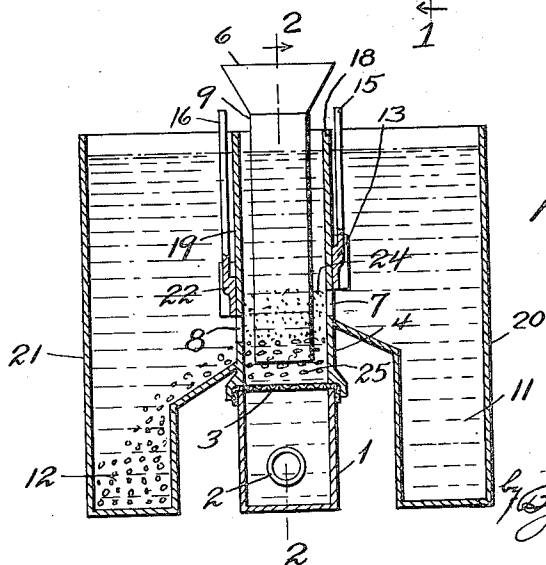
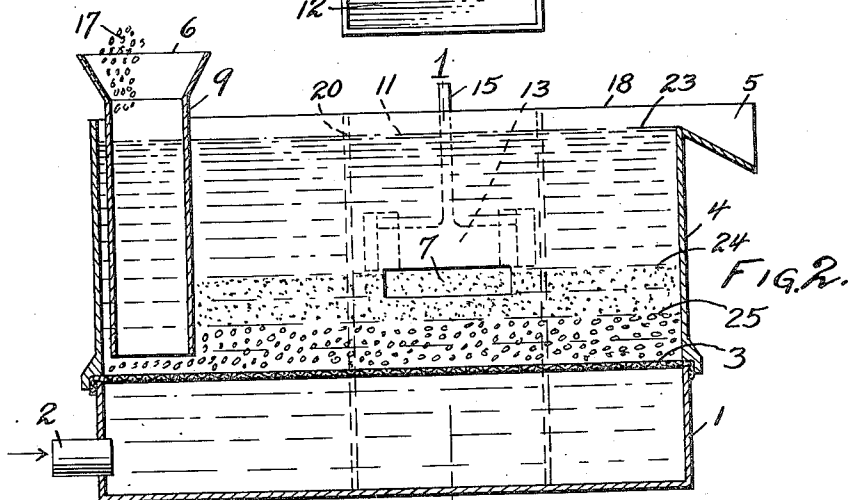
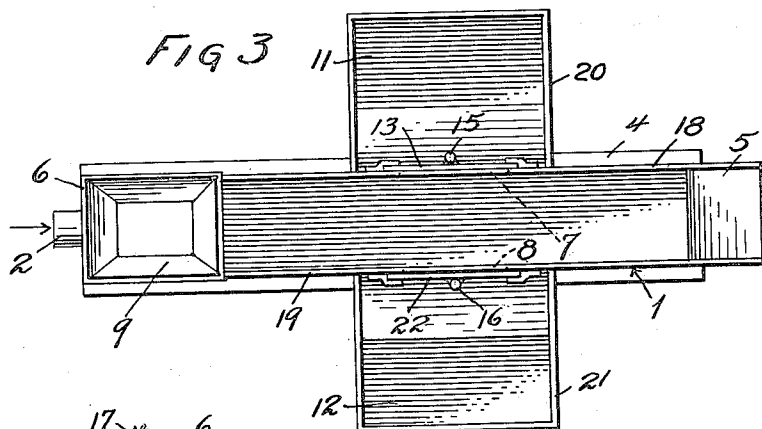


FIG. 1.

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FIG. 6.

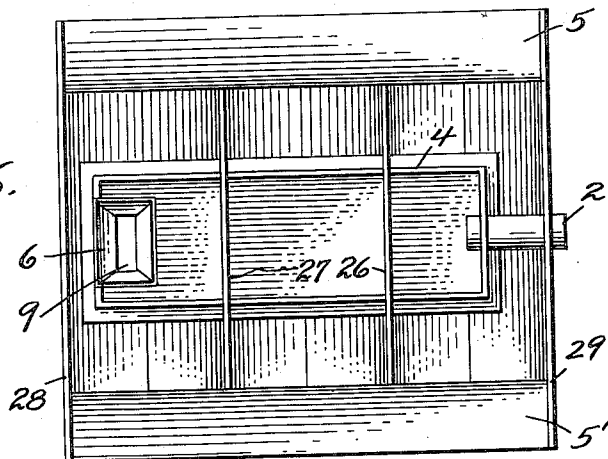


FIG. 5.

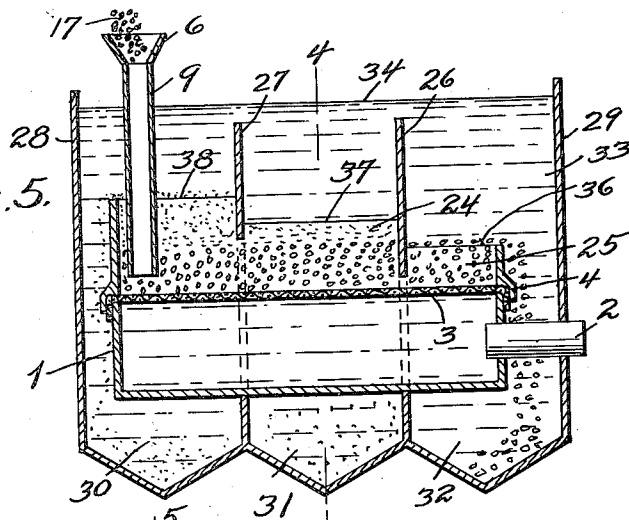
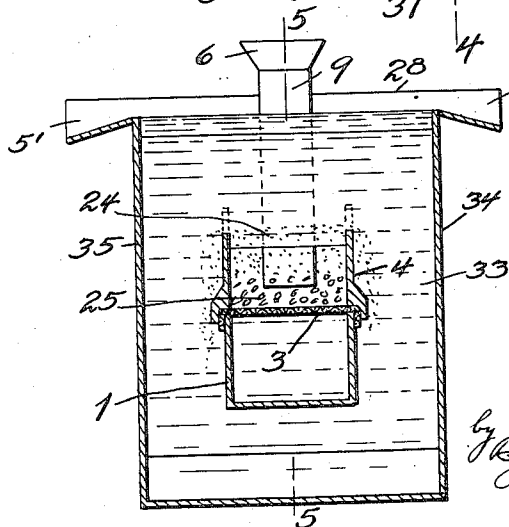


FIG. 4.



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UNITED STATES PATENT OFFICE.

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PROCESS OF AND APPARATUS FOR GRADING SOLID MATERIALS.

Application filed April 25, 1919. Serial No. 292,718.

To all whom it may concern:

Be it known that I, CHARLES J. REED, a citizen of the United States, residing at Glenside, county of Montgomery, and State of Pennsylvania, (whose post-office address is 507 Brannan Street, San Francisco, California), have invented certain new and useful Improvements in Processes of and Apparatus for Grading Solid Materials, of which the following is a specification.

In Letters Patent of the United States No. 1,291,137 I have described a method of and apparatus for causing a mass of solid particles, under the influence of an upwardly flowing medium of uniform distribution, to acquire a condition of liquid mobility in which there is an automatic stratification of the solid particles into horizontal layers and a separation of those having similar properties as to size and densities, these layers maintaining a certain relative position depending on their properties and at the same time maintaining their liquid mobility.

In the Letters Patent above referred to I have described and claimed a method of and means for removing separately these stratified products by causing them to flow out of the apparatus in an initially upward direction in order not to produce horizontal currents in the flowing medium, which horizontal currents, and all irregular currents, tend to interfere with and destroy the stratification and separation of the solid particles.

The method described by me in the above named Letters Patent of producing permanent liquid mobility and permanent stratification of the solid particles by means of an upwardly flowing medium of uniform distribution is highly efficient and practically instantaneous in operation. But a practical final separation of the particles of the several strata requires a means of removing these strata from the apparatus without interfering with this stratification. Owing to the extreme mobility of this mass any influence tending in any way to interrupt or disturb either the uniformity of distribution or the upward direction of the flowing medium instantly destroys or impairs the stratification. In the Letters Patent referred to I have shown a means of accomplishing this with good results by causing solid particles to be carried out along with the stream of upwardly flowing medium and to be drawn

initially upward through tubes or pipes acting as siphons or through suction. While this arrangement accomplishes the purpose in an efficient manner, it is subject to limitation owing to the fact that the motion of the mass, that is of the solid particles and the moving medium, towards the exit tubes causes some disturbance of the flowing medium or irregularity in the current and, consequently, destroys to some extent the stratification, even though the tubes may be numerous and uniformly distributed. This seems to be an inherent defect in any method of removing the solid particles which requires also the simultaneous removal of part of the flowing medium.

In the method and apparatus herein described I accomplish the continuous removal of the solid particles after stratification through a suitable outlet without the removal of any part of the flowing medium and without in any way disturbing the same.

I accomplish this object by the method and the mechanism illustrated in the accompanying drawing, in which—

Fig. 1 is a vertical section of one form of the apparatus taken on line AA' of Fig. 2. Fig. 2 is a vertical section of the same on line BB' of Fig. 1. Fig. 3 is a top view of the same. Fig. 4 is a vertical section of the modified form of the apparatus taken on line CC' of Fig. 5. Fig. 5 is a vertical section on line DD' of Fig. 4, and Fig. 6 is a top view of the same after removal of the hopper.

Similar numerals refer to similar parts throughout the several views.

Referring to Figs. 1, 2 and 3, 1 is a rectangular receptacle of suitable material for sustaining pressure closed on all sides except the top, which is closed by a sheet of felt 3 or other porous, uniformly resisting material. Above this felt, resting on its periphery and holding it in place is a rectangular frame, 4, preferably of metal, which, with the felt acting as a bottom, constitutes the separating pan. 2 represents an inlet tube—for the injection under suitable pressure of a flowing medium, which, for illustration, may be water. 6 represents a hopper and 9 a vertical tube for the introduction of the granular material into the separating pan 4 near the bottom. 5 is an outlet spout at the top of the pan for the exit of the flowing medium after it has passed to a considerable

height above the level of the solid material. 11 and 12 are receptacles outside of the pan, but connected with it through openings 7 and 8 respectively in the side walls 18 and 19 respectively. These receptacles are closed on all sides except the top and may also be closed at the top. But those shown in the drawing are not closed at the top, the walls 20 and 21 respectively extending to the level of the walls 18 and 19. These outside receptacles are adapted to be filled with the flowing medium and to retain it to the same level as that in the pan 4 and to hold the same level, and must have no outlet through which the flowing medium may escape. Under these conditions when the apparatus is filled with the flowing medium to the level at which it overflows through 5 a constant level will be maintained in all the receptacles 4, 11 and 12, and while there will be free communication between them all through the openings 7 and 8, there will be no further actual flow of the medium through these openings and they may be opened or closed by sliding doors 13 and 22 or partly closed without any of the flowing medium passing through in either direction. It is through these openings and under these conditions that I remove the solid particles from the various strata without removing the flowing medium. 15 and 16 are vertical rods attached to the doors 13 and 22 respectively and extending to a considerable height above the walls to be used in manipulating the doors. It is evident that the rods may be arranged to operate or be held or adjusted either by hand, as shown, or by any suitable controlling mechanism not shown in the drawing.

In the operation of this mechanism the flowing medium, water, for example, is forced under pressure into 1 through 2 and it passes upwardly through the felt 3 by which it is uniformly distributed. When it reaches the height indicated by the line 23 it begins to flow out through the spout 5 and the constant level 23 is thereafter maintained. The granular material 17 is then introduced in a steady stream through 6 and 9. In the bottom of 4 this material acquires liquid mobility and flows out horizontally and forms the layers 24 and 25 which are held in a condition of mobile suspension. When the layer 25 acquires a height above the level of the opening 8 the door 22 is raised and the particles in the layer 25 are allowed to flow out through the opening 8 into the receptacle 12. When the layer 24 acquires a height above the level of the opening 7 the door 13 is raised and the particles in the layer 24 pass out through the opening 7 into their receptacle 11. The doors may be thus manipulated to allow the exit of only the desired material into its receptacle. There is evidently no limit to the number of open-

ings and receptacles that may be used, though for the purpose of illustration I have shown only two.

It is also evident that instead of the open receptacles 11 and 12 I may use, as heretofore stated, receptacles entirely closed and filled with the flowing medium. In that case the receptacle would be a blind pocket and need not be of any particular height, but in that case the doors 13 and 22 must be operated by a different device, or the rods 15 and 16 might be placed inside of the pan 4.

Figs. 4, 5 and 6 show respectively a vertical transverse, a vertical longitudinal and a top view of a modified form of the apparatus. In Fig. 6 the hopper 6 is removed. In this form of apparatus the entire mechanism is submerged in a receptacle 33 having walls 28 and 29 filled with the flowing medium. This receptacle is divided by partitions 26 and 27 into compartments or pockets 30, 31 and 32. These partitions extend down into the pan nearly to the felt. The separating pan is mounted within the receptacle 33 and extends through the partitions 26 and 27. The walls 4 are cut down as shown, the three portions 36, 37, 38 being of different heights in the different compartments. The openings 7 and 8 and their doors are dispensed with. The inlet pipe 2 extends through the wall 29 of the receptacle 33.

In the operation of this modified form the apparatus is allowed to fill with water through 2 until it overflows from the spouts 5, 5' at the top of the receptacle 33. The granular materials introduced through 6 and 9 and stratified and flows under the partition 26 and 27 until the densest layer 25 in all three compartments rises to the level of 36, when it will flow over the walls into the pocket 32. When the next layer 24 reaches the height of 37 it will flow over into the pocket 31 and when the third layer reaches the height 38 it will flow over into the pocket 30. From these pockets the material may be removed by any suitable means, not shown either continuously or by interrupting the operation when the pockets are filled. Evidently I am not limited to a particular number of partitions, pockets or products.

Whatever may be the form of apparatus or the nature of the mobile medium, the essential and sufficient conditions are that the stratified particles shall pass out from the moving portion of the medium to a portion of the same medium at rest without transferring the medium. These conditions require that the medium at rest shall be a fixed volume confined in a receptacle from which it cannot escape or undergo change of volume. By being at rest I do not mean that there is absolutely no motion at and adjacent to the opening between the two receptacles where the flowing portion and the

portion at rest are in contact. There will be some irregular, eddying motion at that point, but that does not prevent the solid particles from passing through the opening into the volume of medium at rest without transporting any of the medium with them.

When I speak of the moving or transporting the solid particles without removing the flowing medium I do not mean that a few atoms or molecules of the medium in actual intimate contact with the solid particles may not be removed, but I mean that no measurable and, hence, no detrimental quantity is removed. On the contrary, instead of conveying the medium with it, when a solid particle passes out of the upwardly flowing current through the opening into a receptacle of fixed volume filled with the medium, a volume of the medium equal to the volume of the solid particle passes in the opposite direction through the opening to make room for the entering solid particle. In this way every particle which passes out of the flowing current leaves no disturbance behind it because an equal volume of the medium takes its place from the receptacle into which it passes.

I claim:

1. The process of grading solid particles, which consists in holding a mixture of the solid particles in a suspension zone of a suspension medium in a condition of stratified suspension and withdrawing particles from different strata out of the suspension zone into separate zones of relative quiet in the suspension medium.

2. The process of grading solid particles, which consists in subjecting a mixture of the solid particles in a suspension medium to forces causing stratification and withdrawing particles from different strata laterally into separate zones of relatively quiet in the suspension medium.

3. The process of grading solid particles, which consists in subjecting a mixture of solid particles in a suspension medium to the buoyant action of a fluid medium causing stratification and withdrawing particles from different strata laterally into separate zones of relative quiet in the suspension medium.

4. The process of grading solid particles, which consists in subjecting a mixture of the solid particles in a suspension medium to forces holding it in a condition of stratified suspension by the action of an upwardly flowing mobile medium and allowing particles to pass laterally out of different strata into separate zones of relative quiet in the suspension medium.

5. A separator for grading solid particles, comprising a vessel containing a suspension medium, means for holding a mixture of the particles in the medium in a condition of stratified suspension, means for

restraining lateral movement of the particles out of the suspension zone and means for allowing particles to pass laterally out of different strata into separate zones of relative quiet in the suspension medium.

6. A separator for grading solid particles, comprising a vessel containing a suspension medium, means operative within a limited zone in the medium to hold a mixture of the particles in a condition of stratified suspension and means for allowing particles from different strata to pass laterally out of different strata into separate zones of relative quiet in the suspension medium.

7. An apparatus for grading solid particles, comprising the pan or receptacle having peripheral walls and a porous bottom, means for introducing the solid particles, means for introducing a medium of suspension into the pan through the porous bottom, a receptacle inclosing the pan and divided into compartments by partitions, a portion of the pan extending into each compartment and portions of the wall of the pan in different compartments extending to different heights, the enclosing receptacle being adapted to retain the medium of suspension above the walls of the pan and at the same level in two or more compartments.

8. In a separator for grading solid particles a pan having a peripheral wall and porous bottom, means for introducing a medium of suspension into the pan through the porous bottom, a receptacle outside of and inclosing the pan, and having walls extending to a higher level than the walls of the pan, said receptacle adapted to retain the medium at a height above the wall of the pan.

9. A separator for grading solid material, comprising a container having a transverse porous wall, a second container adjacent the said first container, a medium of suspension in said containers, means for introducing material to be graded into the first container, means operative through the said porous wall for maintaining the material in the first container in a state of mobile suspension and stratification, means permitting the material forming a stratum to float out of the first container into the second container, and means operative to maintain the medium of suspension under substantially the same pressure in both containers at the level of said stratum.

10. A separator for grading solid material, comprising a container having a transverse porous wall, a plurality of additional containers adjacent the said first container, a medium of suspension in said containers, means for introducing material to be graded into the first container, means operative through the said porous wall for maintaining the material in the first container in a state of mobile suspension and stratification,

means permitting the material forming different strata to float out of the first container, each into a different additional container, and means operative to maintain substantially equal pressure between the medium in each additional container and the medium in the first container at the levels of the respective strata.

11. A separator for grading solid material, comprising a container having a transverse porous wall, a second container adjacent the said first container, a medium of suspension in said containers, means for introducing material to be graded into the first container, means operative through the said porous wall for maintaining the material in the first container in a state of mobile suspension and stratification, means permitting the material forming a stratum to float out of the first container into the second container, and means for maintaining the medium in the first and the medium in the second container at substantially equal levels.

12. A separator for grading solid material, comprising a container having a transverse porous wall, a plurality of additional containers adjacent the said first container, a medium of suspension in said containers, means for introducing material to be graded

into the first container, means operative through the said porous wall for maintaining the material in the first container in a state of mobile suspension and stratification, means permitting the material forming different strata to float out of the first container, each into a different additional container and means for maintaining the medium in each of the additional containers and the medium in the first container at substantially equal levels.

13. A separator for grading solid material, comprising a container having a transverse porous wall, a second container adjacent the said first container, a medium of suspension in said containers, means for introducing material to be graded into the first container, means for introducing a stream of suspension medium through the porous wall to maintain the material in the first container in a state of mobile suspension and stratification, means permitting the material forming a stratum to float out of the first container into the second container and means operative to maintain the medium of suspension under substantially the same pressure in both containers at the level of said stratum.

CHARLES JOHN REED.