

[54] **CENTRIFUGAL FORCE SEPARATOR
OR CLASSIFIER**
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209/144, 211

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[57] **ABSTRACT**

A method and apparatus for simultaneously separating the solid from the liquid phase and coarse solids from finer solids in a suspension by feeding the suspension tangentially to the top of a centrifugal separator and water under pressure radially inwardly to a lower portion by the separator whereby the combined action of the centrifugal force generated and the turbulence thresholds created by the entry of the water causes the finer solid particles to move upwardly along the axis of rotation to a discharge outlet and the coarse particles to move downwardly along the wall of the separator to a discharge outlet at the lower end thereof.

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12 Claims, 4 Drawing Figures

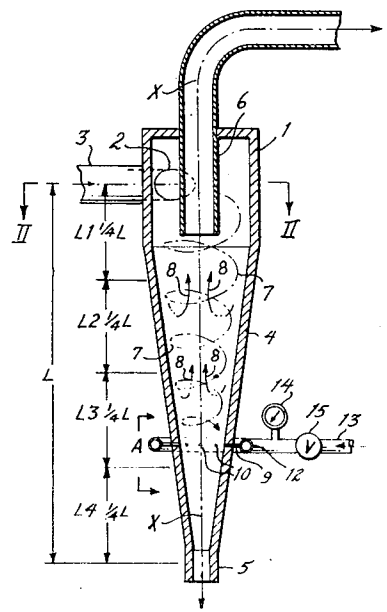


Fig. 1.

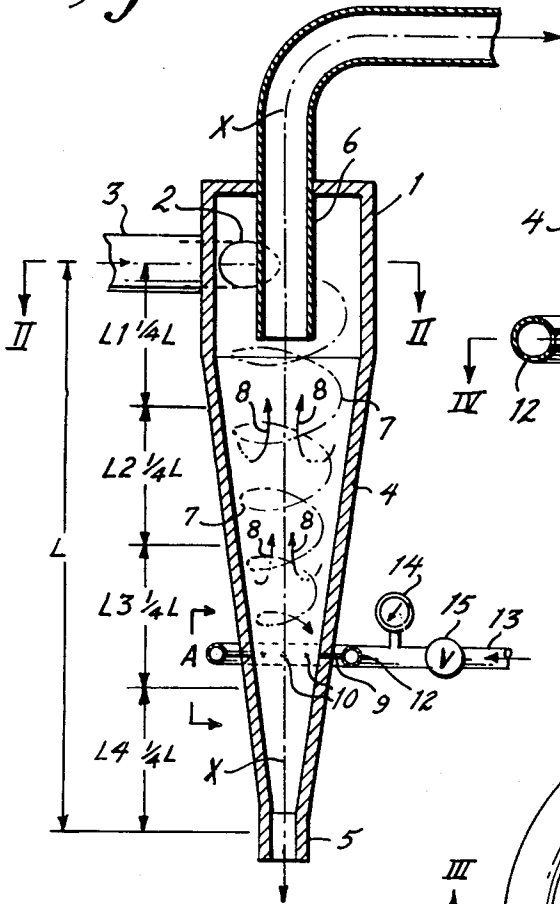
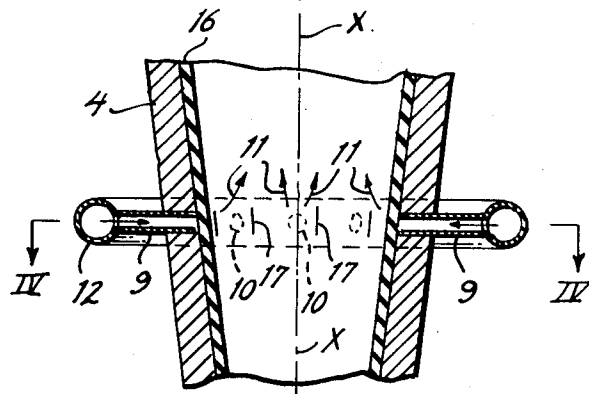


Fig. 3.

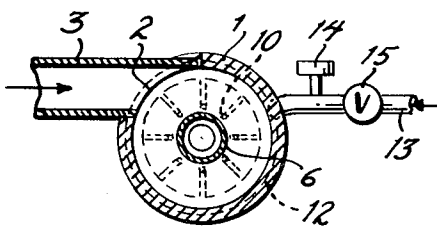


Fig. 2.

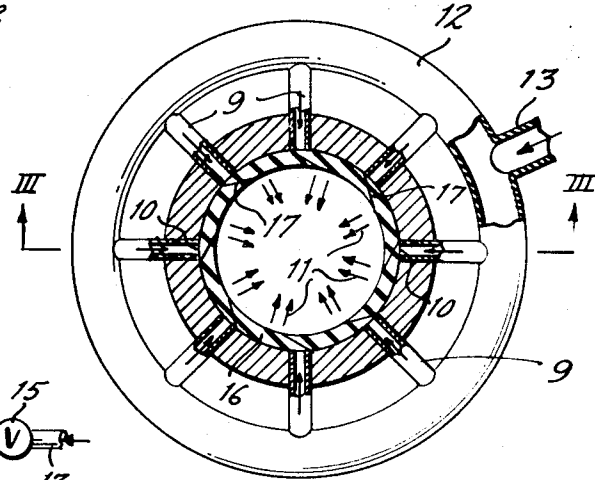


Fig. 4.

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CENTRIFUGAL FORCE SEPARATOR OR CLASSIFIER

This invention pertains to a centrifugal force classifier for the separation of a mixture of granular material of varying particle sizes, suspended in a liquid medium, or, in a turbidity mass, into a coarse grain portion and a fine grain portion.

Classifying devices are known in which the suspensions or turbid masses to be classified or separated are subject to the combined influence of centrifugal force and additionally produced currents therein. In these devices, however, the material is fed into the top of the device without pressure, as a free falling mass, coaxially or substantially coaxially, with the device and is then subjected to the influence of centrifugal force and to mechanical agitation produced by simultaneously introducing water at various levels into the lower part of the device. With such centrifugal force classifiers and the like, the selectivity and separation of the larger or coarse particles from the finer particles could not be increased to a desired degree because, on the one hand, the finer solid particles could be pulled along by the centrifugal force into the outer layer of the turbid mass, if they adhered to the large size particles, or formed large size agglomerates with one another and, on the other hand, coarse or large size particles could be conveyed into the inner layer of the finer particles and incorporated therewith if substantially no room existed in the outer layer. In the first case, a more or less sizeable amount of the fine grain material is removed along with the coarse grain material through the lower part of the device as a part of the faulty granulation. In the second case, a more or less sizeable portion of the coarse grain material flows away with the finer grain or good material through the overflow. Thus, the selectivity or separation is considerably impaired.

It is the primary object of this invention to provide a centrifugal separator or classifier which overcomes the disadvantages of the conventional classifiers noted above by increasing the degree of selectivity of the classifier.

Another object of the invention is to provide a method of centrifugally classifying or separating coarse from finer solid particles or a suspension of the solid matter in a liquid or in a turbid mass thereof.

According to the invention, the suspension or turbid mass is introduced by means of a pump from a high-level tank to the centrifugal classifier at a certain minimum speed tangentially through an inlet or loading aperture, the suspension moving towards an outlet at a lower position. In so doing the centrifugal force generated therein increasingly causes separation of the liquid phase from the solid phase. The heavier or coarser granules of the solid particles, suspended in the turbid mass, are subject to a stronger effect of the centrifugal force than the lighter or finer granulations, thereby causing the coarse granules in the turbid mass which is spirally flowing toward the outlet below, to gradually appear in the outer portion of the mass while the solid particles with progressively smaller grain size are contained in those portions of the mass which are increasingly closer to the axis of rotation of the mass in the classifier.

A feature of the invention is to provide an outlet orifice in the lower portion of the classifier with a

discharge range smaller than the loading or inlet aperture which permits, within a certain period of time, the drainage of only one portion of the suspension or turbid mass, namely that which flows along the wall of the chamber of the centrifugal force classifier and which contains particles above a certain grain size. The radial inner portion of the turbid mass which contains the finer solid particles, below the separating grain size, is deflected toward the axis of the centrifugal force classifier in the form of a partially spiral-like current which moves axially towards an overflow through which the portion of the turbid mass containing the fine grain runs down.

An important aspect of the invention is the production of supplementary currents in the lower area of the centrifugal classifier while tangentially introducing the suspension or turbid mass above that area to effect separation of the coarser from the finer solid particles. Thus there is a sector in the centrifugal force classifier which is situated in the zone between the loading or inlet aperture for the suspension or turbid mass and a lower course serving for the removal of the coarse grain solid material in which a separation of the solid from the liquid phases has already occurred caused by the centrifugal force. Into this sector water is introduced to flow in a course across the axis of rotation of the mass in the centrifugal force classifier. The water flowing through their inlets into the classifier causes upcurrent-turbulence thresholds in the zone of the inflow. In these turbulence thresholds, because of the centripetal current of the water, the fine grain particles, having arrived at the layer flowing along the wall of the chamber of the classifier where mutual relative motions of the solid particles are not possible or possible only to an insignificant extent due to the high density of the mass in this zone, are separated from the granules of a larger size to which they adhere or by which they have been pulled into the outer layer. The particles thus separated are transferred into a zone of lesser density which is radially further inward with the result that the faulty granules are reduced in the coarse grain portion escaping through the lower course as well as in the fine grain portion draining off through the overflow. The reduction is so great that the selectivity is increased up to 30 percent in comparison to the known centrifugal force classifiers.

Another feature of the invention is the attainment of a particularly favorable effect of the centripetal current-turbulence thresholds by arranging the water supplies so that they enter the second or third quarter, preferably in the third quarter, of the zone between the loading or inlet aperture and the lower course, the water being directed preferably in a radial manner toward the inside of the chamber and spaced evenly in an annular circumferential zone.

Yet another feature of the invention is the provision of a coating at the inner face of the wall of the chamber of the centrifugal force classifier, at least at the inlet orifices of the water supplies, which coating consists of an elastic material, such for example as plastic or rubber with notches therein over the inlet orifices to prevent penetration of solid particles into the water supplies, and thereby impede inflow of water. With a centrifugal force classifier of the character described, it is important that the water supply be opened before the

start of the operation of the classifier, and during the operation, the water pressure in the supply line must be regulated to be higher than the back pressure of the turbid mass caused by the centrifugal force.

These and other objects of the invention will become more apparent as the following description proceeds in conjunction with the accompanying drawings, wherein:

FIG. 1 is an axial section of a centrifugal force classifier shown as a cyclone separator and embodying the invention;

FIG. 2 is a cross section taken on the line II—II of FIG. 1;

FIG. 3 is an enlarged sectional view of that part of the centrifugal force classifier of FIG. 1 taken at the area A and taken on the line III—III of FIG. 4; and

FIG. 4 is a cross section taken on the line IV—IV of FIG. 3.

Specific reference is now made to the drawings in which similar reference characters are used for corresponding elements throughout.

The centrifugal force classifier shown in the drawings is a stationary hollow member which is rotationally about its axis X—X and includes an upper cylindrical portion or head-piece 1 in whose side wall is provided an inlet or loading aperture 2 for the supply into the chamber of the headpiece of the granular mixture to be classified, contained in a liquid or a turbid mass. A supply line 3 opens tangentially into the headpiece 1 and communicates with the loading aperture 2. To the cylindrical headpiece 1 a conically downwardly tapered or constricted member 4 is connected therebelow leading to a lower course or discharge outlet 5. Into the headpiece 1 extends an overflow pipe 6 which is arranged coaxially therewith.

The suspension or turbid mass is introduced tangentially at a predetermined minimum velocity through the loading aperture 2 into the headpiece 1 via the supply line 3 and is thus transposed into a rotary motion, whereby it diffuses downwardly towards the lower course or discharge 5 in a spiral-type flow 7 (primary turbulence) along the inner surface of the conical wall of the constricted member 4. This lower course 5 has a limited transmission range through which the concentrated coarse grain is discharged. The main portion of the turbid mass is deflected radially inwardly toward the interior of the separator in the direction of the axis X—X thereof and is ultimately conveyed to the overflow 6 in a current 8, which is still partially spiral yet is directed upwardly (secondary turbulence); and is then conveyed out through the overflow 6.

As the turbid mass moves downwardly in the separator, each solid particle suspended in it is subject to a centrifugal force which acts with greater force on the heavier or larger masses and hence urges them farther radially outwardly away from the axis X and toward the wall of the separator. Consequently, the heavier granules, i.e. normally above a certain limiting size, known as the grain separating size, arrive at the outlet for the coarse grain portion of the flow 7 of the turbid mass. The outlet 5 is positioned so that the coarse grains spiral downward along the wall of the tapered or conical member 4, while the granules of a particle size below that of the grain separating size remain in that portion of the turbid mass that is deflected radially inwardly and is directed toward the secondary turbulence

8, which, in part, is still spiral and oriented upwardly to the overflow 6.

To minimize the possibility of part of the fine grains being carried away through the lower or discharge outlet 5, and part of the coarse grains being carried away through the upper overflow outlet 6, water supply conduits 9 are positioned to open into the separator in a sector situated in the zone L between the loading aperture 2 and the lower or discharge outlet 5. As shown in the drawings, these water supply conduits are preferably confined to the third quarter L3 of this zone L, where a separation of the solid from the liquid phases, caused by the centrifugal force, is already occurring. The water supplied through the conduits 9 runs across or diametrically of axis X—X of the centrifugal force classifier and is suitably directed radially inward, the inlet orifices 10 in the classifier at the inner ends of the water supply pipes being distributed circumferentially of an annular or ring zone.

Centripetal flow turbulence thresholds are created by the water 11 passing into the chamber of the classifier through the orifices 10 whereby, in the manner described hereinbefore, the faulty grain portion of the coarse grain material and the fine grain material is considerably reduced and the selectivity is markedly increased.

The water supply conduits 9 are joined to a ring conduit 12 to which a main water supply 13 is connected which is equipped with a pressure meter 14 and a regulating valve 15.

The chamber of the centrifugal force classifier is supplied at the innerface of the wall of the constricted or conical member 4 with a protective cover 16 which consists of a wear-resistant elastic material; the protective cover including notches 17 at the water inlet orifices 10. The notches open up inwardly due to an excess pressure of the water running in and act in the manner of sealing non-return valves. By this construction the possibility that the solid particles entering the water supply conduits 9 is prevented and the erosion and wear at the orifices 10 of the water supply conduits 9 by the solid particles is substantially avoided.

While preferred embodiments have here been shown and described, it is to be understood that skilled artisans may make variations without departing from the spirit of the invention.

What is claimed is:

1. A centrifugal separator for suspensions of solid particles in a liquid phase to simultaneously separate the liquid from the solid phase and the coarse from the fine solid particles comprising a hollow member including an upper portion and a lower downwardly tapered portion terminating in a lower discharge outlet for coarse solid particles, an upper discharge pipe for fine solid particles extending axially into said upper portion, means to deliver the suspension tangentially into said upper portion, and means to deliver water around and radially into said lower tapered portion between said upper and lower solid particles discharge outlets, so that turbulence thresholds are created at the water inlets which coact with the generated centrifugal force to cause the coarse particles to move along the walls of the member downwardly towards the lower discharge outlet and the finer particles and the bulk of the liquid to move inwardly adjacent the axis of the member upwardly towards the upper discharge outlet.

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2. The separator of claim 1 characterized in that said means to deliver water delivers said water at a pressure higher than the back pressure of the suspension at the water inlets.

3. The separator of claim 1 wherein said upper portion of said member is substantially cylindrical and said means to deliver the suspension therein includes an aperture in the wall of said upper portion above said upper discharge pipe and a pipe communicating with said aperture extending tangentially of said upper portion.

4. The separator of claim 3 characterized in that said lower discharge outlet is smaller than the aperture in the wall of the upper portion.

5. The separator of claim 1 wherein said means to deliver water into said lower portion of said member includes radially extending, circumferentially spaced conduits opening into said member above said lower discharge outlet.

6. The separator of claim 3 further comprising a ring conduit surrounding the lower portion of said member, said water supply conduits being connected to said ring conduit to derive their water supply therefrom, and a water supply pipe also connected to said ring conduit to supply water thereto.

7. The separator of claim 5 wherein said water supply conduits open into said member at the third quarter of the space between the entry of the suspension into the member at its upper end and the lower discharge outlet.

8. The separator of claim 5 further comprising a protective layer of elastic material on the inner face of said member at the entry of said water supply conduits, said

protective layer including notch means opposite said conduits which act as one-way valves for the passage of water into the member and block passage of solid particles into said water supply conduits.

9. The separator of claim 5 characterized in that said supply conduits open into said member within the lower third quarter of the space between the entry of the suspension into the member at its upper end and the lower discharge outlet.

10. A process of separating coarse from finer solid particles suspended in a liquid and simultaneously separating the liquid from the solid phases comprised of providing a rotary zone having an upper portion and a downwardly tapering lower portion, feeding the suspension tangentially into the upper portion and feeding water around and radially into the tapering lower portion so that the turbulence thresholds of water are created which coact with the generated centrifugal force to cause the finer particles and the bulk of the liquid to move upwardly along the axis of the zone to a discharge outlet in the upper portion thereof and the coarser particles to move downwardly along the outer sides of the zone to a discharge outlet at the lower end of the zone.

11. The process of claim 10 wherein the feeding of water into the lower portion of the zone commences before commencing to feed the suspension into the upper portion of the zone.

12. The process of claim 10 wherein the feeding of water under pressure is to the lower third quarter of the zone radially inward thereof at circumferentially spaced points.

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