

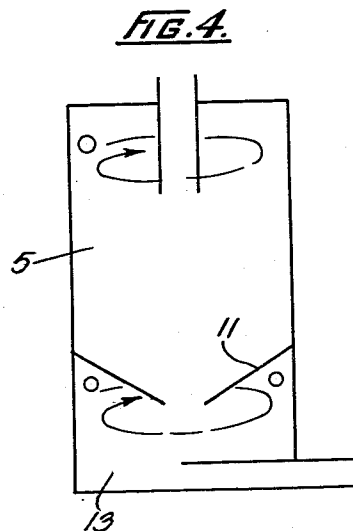
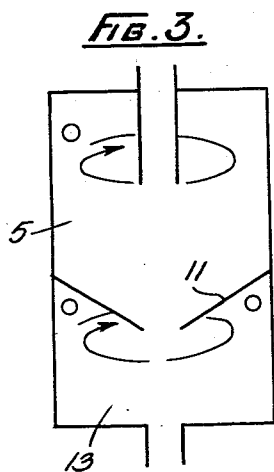
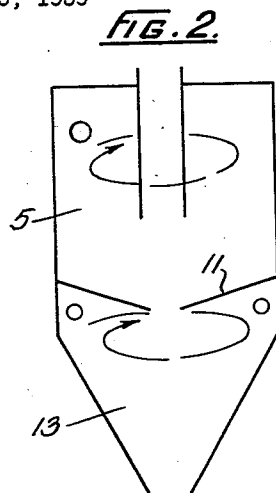
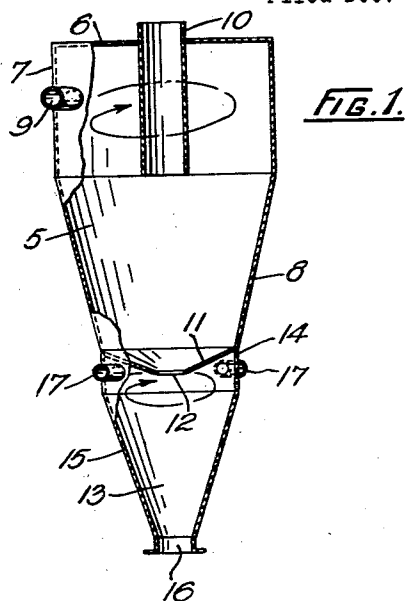
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HYDRO-CYCLONES

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HYDRO-CYCLONES

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1 Claim. (Cl. 210—512)

This invention relates to hydro-cyclones such as are used for the classification of metallurgical pulps.

In a hydro-cyclone pulp is introduced tangentially at the feed end of a container. Axially at the same end there is a vortex finder through which fine particles, and a proportion of the conveying liquid are discharged. At the point axially opposed to the vortex finder there is a discharge of dense pulp. The object is that the coarse particles should find their way into the dense pulp, and that the fine particles should be discharged through the vortex finder. The container may have a wide variety of shapes, all of which are well-known in the art.

With known hydro-cyclones it has been found that the coarse or faster-settling particles in the underflow carry fine particles in the voids among them. The presence of such fine, or slower settling particles in the underflow is undesirable as it lowers the overall efficiency of the classification. There have been proposals for increasing the efficiency of classification by adding hydraulic liquid near the underflow aperture to wash entrained slimes from it. These proposals have not been proved to be very practicable.

An object of the invention is to improve efficiency of classification by decreasing the proportion of fine particles in the underflow pulp of a hydro-cyclone.

According to the invention the underflow is discharged into a cyclonic chamber where clear liquid is introduced tangentially in the same direction as in the main cyclone, and pulp withdrawn axially in the normal way. In other words, the pulp from the main hydro-cyclone is discharged through the vortex finder of this cyclonic chamber. In practice it is found that the cyclonic action in the second chamber washes fine particles from between the voids of the pulp entering it, or that a barrier is set up in the chamber through which fine particles cannot pass. As a result of the relatively low volume of clear liquid required to wash out fine particles the pulp densities of both cyclone products may not be significantly affected.

In the preferred form of the invention the main cyclone and cyclonic chamber have a party wall which may be a surface which, in the direction of the discharge, is concave or convex to the interior of the cyclone, and the peripheral diameter of which coincides with the internal diameter of the main cyclone at a certain position or positions. This party wall has been termed the "cone piece" and is usually a truncated right circular conical shell. The discharge from the main cyclone is thus an aperture in the cone piece and this aperture also constitutes the vortex finder of the cyclonic chamber.

It should be noted (as said above) that the direction of entry of the clear liquid into the cyclonic chamber is such that liquid in that chamber conforms in its direction of swirl with the direction of swirl imposed by the feed of the main cyclone.

The invention is further discussed with reference to the accompanying drawings, in which:

FIGURE 1 is a section through a hydrocyclone according to the invention,

FIGURE 2 is a diagrammatic view of a further type of hydro-cyclone,

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FIGURE 3 is a diagrammatic view of another type, and

FIGURE 4 is a diagrammatic view of a fourth type.

The cyclone illustrated in FIGURE 1 firstly has the conventional cyclonic chamber 5 defined by an end wall 6, a cylindrical shell 7, and a truncated conical shell 8. The side walls of the frustoconical portion 8 slope downwardly in such a manner that the apparent apex of this frustoconical portion has an acute inclined angle in vertical section substantially less than 90°. In the normal way the cylindrical shell 7 is provided with one or more feed ducts 9. A vortex finder 10 pierces the end wall 6 in the normal way.

As against standard practice the conical shell 7 terminates at a relatively wide diameter where it intersects a symmetrically tapered right circular shell or cone piece 11 with an aperture 12 that constitutes the underflow aperture of the chamber 5. The cone piece or frustoconical party wall 11 tapers in the direction of the underflow in such a manner that the apparent apex has an obtuse included angle in vertical section substantially greater than 90°.

To the other side of the cone piece 11 there is a further cyclonic chamber 13, that has a cylindrical shell 14, and a terminal portion 15 constituted by a truncated conical shell. The opening 15 in the portion 15 constitutes the discharge from the apparatus. The shell 14 is provided with a series of inlet ducts 17. The direction of the ducts 17 is such that liquid forced in under pressure through them causes a swirling flow in the chamber 13 which has the same rotational sense as the swirling flow caused by liquid entering the ducts 9 into the chamber 5.

In use pulp enters the ducts 9 in the normal way. The slimes fraction leaves the chamber 5 via the vortex finder 10 and the thickened pulp having fines entrained among the voids therein leaves the chamber through the discharge aperture 12. Before leaving the chamber, however, the pulp which is descending along the sloping walls of the conical shell 8 abruptly changes its direction of movement so that it travels inwardly toward the axis of the chamber. The pulp now descending at a materially slower rate due to the abrupt change in the direction of its travel enters the chamber 13 where it encounters a cyclone of clear liquid fed in through the ducts 17. In passing through the chamber 13 the thickened pulp gets denuded of fine particles contained between the voids of coarse particles and the percentage of fine particles reporting in the discharge from the opening 16 is significantly decreased.

The most important operating features are as follows:

(1) The underflow aperture 16 of the cyclone must be large enough to accommodate the feed rate to the cyclone of solid particles whose separation into the underflow is desired and should be situated a suitable distance from clear liquid inlet 17 such that as thick an underflow as is desired is in fact obtained.

(2) The rate of injection of clear liquid into the cyclonic chamber 13 must be sufficient to displace the desired proportion of entrained slimes from between the voids of the faster settling particles.

(3) The cone piece aperture 16 must be large enough to accommodate the feed rate to the cyclone of solid particles whose separation to the underflow is required, having regard to the back pressure which is exerted by clear liquid injected into the cyclonic chamber 13 and passing back into the main cyclone chamber 5.

(4) The feed rate must not be such as to overload the cyclone, that is, the cyclone should not be fed solid particles to be classified at such a rate that the efficiency of classification is poor and the quality of the overflow or underflow product, or of both products, is seriously impaired.

(5) The feed and overflow apertures are not affected and are adjusted according to conventional practice.

In a rest run figures in the following table were obtained:

Characteristic of the separation	Normal cyclone apparatus	Cyclone modified to incorporate the apparatus of the present invention
Feed head (ft. of water) -----	12	12
Volume flow rate to the cyclone feed (litres/min.) -----	16.5	17.1
Solids feed rate (kg./min.) -----	15.2	12.6
Pulp density of feed, percent solids w./w. -----	33.2	27.7
Flow rate of injected water, l./min. -----		3.5
Percentage of total water added reporting in the underflow stream -----	33.0	27.8
Percentage of the minus 10 μ particles in the feed reporting in the underflow stream -----	43.0	11.5
Injection water flow rate as a percentage of water flow rate to the underflow stream -----		68.1
Pulp density of the underflow stream, percent w./w. solids -----	58.7	49.9
Pulp density of the overflow stream, percent w./w. solids -----	4.2	4.2
Percentage of particles larger than 25 microns in the solids which report in the overflow stream -----	3.6	2.7
Percentage of particles smaller than 25 microns in the solids which report to the underflow stream -----	7.2	3.0

The figures speak for themselves. In other tests on a variety of cyclones incorporating the present invention, no difficulty has been experienced in obtaining a thick underflow.

Conventional hydro-cyclones are easily adapted for the purposes of the invention. Thus the cone piece could be inserted in the interior of any conventional hydro-cyclone, thus dividing it into a main hydro-cyclone and a cyclonic chamber. Of course, tangential feed ports should be formed in the cyclonic chamber. Alternatively, the chamber could be added on to a conventional hydro-cyclone. Where a tapering hydro-cyclone has to be modified, the narrow end is usually cut off and a continuing cyclonic chamber is added on. The latter may have first a cylindrical section and then also a tapering section as in a normal cyclone. The adaption of known cyclones for the purposes of the invention offers no difficulties.

In FIGURES 2 to 4 further adaptations of known types of hydro-cyclones have been illustrated diagrammatically. These figures require no elaboration excepting to point out that the main cyclonic chambers have been marked 5, the cone pieces 11 and the additional cyclonic chambers 13 as was the case in the embodiment of FIGURE 1. Many more variations on the same theme are possible.

We claim:

Apparatus of the hydro-cyclone type for separating

finer from coarse particles contained in a liquid feed, comprising: a main vertically disposed cyclonic chamber circular in section, at least a portion of said chamber being frustoconical in configuration with the walls converging toward the lower end of said chamber, the apparent apex of said frustoconical portion having an acute included angle in vertical section substantially less than 90°; means including a feed duct communicating with said chamber near its upper end for introducing said liquid feed and for imparting cyclonic movement to material within the chamber to cause said coarse particles to move outwardly to form an underflow traveling downwardly in said chamber, a portion of said fines being entrained in the voids among said coarse particles; a second duct extending into the chamber at said upper end, the lower open end of said second duct being substantially aligned with the axis of the chamber, the duct serving as a vortex finder to provide an outlet for an overflow comprising said liquid and the non-entrained fines; a party wall substantially frustoconical in configuration with its concave side facing said main chamber and with its perimeter contacting the lower end of the frustoconical portion of said main chamber to form the lower end wall of said main chamber, said party wall having a central opening forming an outlet for said underflow from said main chamber, the apparent apex of said frustoconical party wall having an obtuse included angle in vertical section substantially greater than 90° to cause an abrupt change in the direction of movement of said underflow so that it travels inwardly toward the axis of said chamber to materially slow its descent prior to passing through said central opening; a second vertically disposed cyclonic separating chamber on the convex side of said party wall, said second chamber being circular in section with its axis coincident with the axis of the main chamber, said party wall forming the upper end wall of the second chamber, said second chamber having an opening in its lower end forming an underflow outlet; and means for introducing a wash liquid into the second chamber near its upper end in the region of said party wall in a tangential direction that is the same as the direction of cyclonic movement of material in the main chamber, said wash liquid removing the fines from the coarse particles and passing back into said main chamber.

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