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METHOD AND APPARATUS SEPARATING DIRT FROM AQUEOUS SUSPENSIONS OF PULP FIBRES

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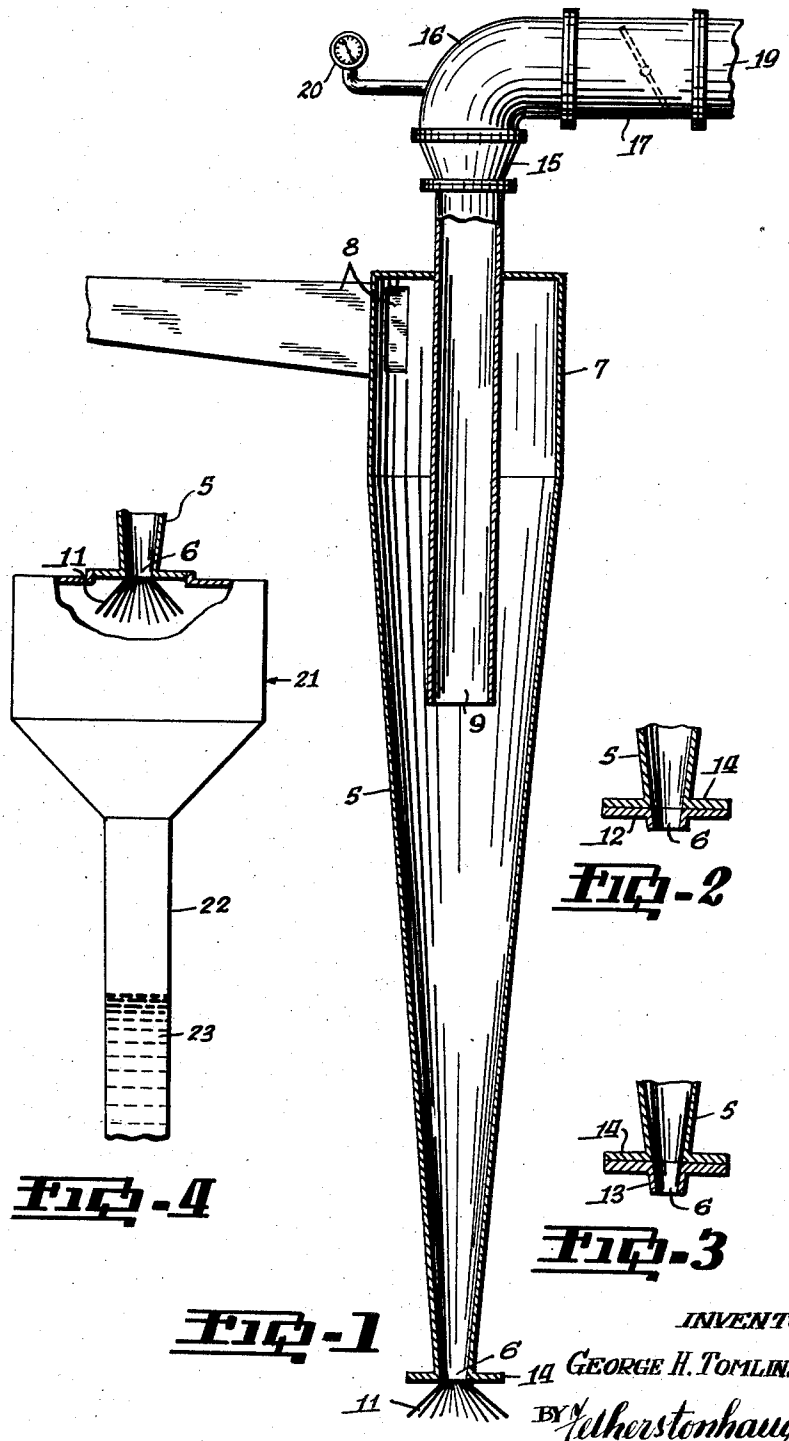


FIG-4

FIG-2

FIG-3

FIG-1

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METHOD AND APPARATUS SEPARATING DIRT FROM AQUEOUS SUSPENSIONS OF PULP FIBRES

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Continuation of application Serial No. 363,277, June 22, 1953, and application Serial No. 205,655, January 12, 1951. This application November 1, 1957, Serial No. 694,479

6 Claims. (Cl. 209—211)

The present invention relates to an apparatus for cleaning an aqueous suspension of pulp or paper making fibres to remove dirt therefrom by centrifugal action wherein vacuum means are provided for removing entrained air.

This application is a continuation of application Serial No. 363,277, filed June 22, 1953, and application Serial No. 205,655, filed January 12, 1951, the latter being abandoned.

Hydrocyclones for use in separating solid particles in pulp suspensions are well known in the prior art. The Samson Patent 2,377,524 discloses an apparatus of the general type to which the present invention relates. Such hydrocyclones generally comprise a separating chamber having a conical portion and a tangential inlet adjacent one end of the chamber for the introduction of the suspension containing cellulose fibres and dirt particles. There is provided an outlet at the apex of the conical portion and an outlet at the other end of the separating chamber. The suspension is whirled about a central axis to produce a vortex having a central liquid-free core and a portion of the suspension containing a major proportion of dirt particles is ejected at the apex outlet whereas that portion of the suspension containing a major proportion of cellulose fibres leaves the separating chamber through the central outlet opposite the apex outlet. Such prior art hydrocyclones have proven effective in separating dirt particles from the cellulose fibres but difficulties have been encountered in connection with air entrained with the suspension. Such entrained air produces bubbles of froth and causes excessive accumulation of the fibres which brings about consequent disadvantages in the paper forming steps.

The present invention provides a means for removing this entrained air through the utilization of a vacuum chamber. The vacuum chamber is located adjacent the apex outlet of the separating chamber and the dirt rich portion of the suspension is sprayed through this outlet into the vacuum chamber. The outlet pipe from the vacuum chamber has a liquid seal which is maintained by a pump or a barometric leg. Thus the space within the vacuum chamber is maintained under sub-atmospheric pressure so that a suction is created within the liquid free central portion of the hydrocyclones thereby drawing off the air within the core and preventing its entrainment with the accepted stock.

An object of the present invention is to provide in a hydrocyclone which will separate dirt particles from an aqueous suspension of pulp fibres a means to prevent substantial entrainment of air with the accepted stock.

A further object of the present invention is to provide a vacuum chamber on the apex outlet of a hydrocyclone whereby air within the hydrocyclone is drawn off with that portion of the suspension sprayed from the apex outlet.

Other objects and many of the attendant advantages of the present invention will become apparent upon consideration of the following detailed specification in connection with the accompanying drawing wherein:

Fig. 1 is a view partly in section showing a typical hydrocyclone to which the present invention is applied;

Figs. 2 and 3 are sectional views showing the application of conical fittings to vary the effective diameter of the dirt discharge aperture; and

Fig. 4 is a fragmentary sectional view of the vacuum constituting the present invention.

The separator shown in Fig. 1 comprises a relatively large diameter hollow truncated cone section 5 of a length considerably greater than its maximum diameter. It is important that cone section 5 be free of internal obstructions likely to impede uninterrupted flow of the pulp suspension from the larger to the smaller end of the cone. The upper or larger end of cone section 5 is joined to a cylindrical head section 7 provided with a tangential stock inlet 8, preferably of rectangular cross section, elongated in the direction of the axis of the unit. A clean stock outlet pipe 9 extends below the level of the tangential stock inlet 8 in axial alignment with rejects discharge aperture 6, situated at the truncated apex of the cone, to provide a stock outlet of greater diameter than said rejects discharge aperture.

The clean stock is delivered through outlet pipe 9, pipe renducer 15 and elbow 16 to a throttling valve 17 and thence, through suitable pipe connections 19, to any suitable point of delivery such, for example, as a flow box from which the stock is passed on to the next process stage. A pressure gauge 20 is provided immediately ahead of throttling valve 17 and, in the present instance, is shown connected to elbow 16.

The included cone angle of cone section 5 may be relatively sharp, say of the order of 10° to 18°. When the area of stock inlet 8 in approximately 12.5 square inches and the inside diameter of cylindrical head section 7 is 12 inches, the inside diameter of cone section 5 at aperture 6 should be approximately 2 inches. For certain purposes, a smaller diameter at aperture 6 may be desirable. In this event, separately formed flanged conical fittings 12 and 13 may be provided and selectively secured to flange 14 of cone section 5, as shown in Figs. 2 and 3. These fittings 12 and 13 are machined on the inside to the same angle as the cone section 5, with the larger diameter of the cone of each fitting matching the internal diameter of conical section 5 at rejects discharge aperture 6. The minimum internal diameter of the cones of conical fittings 12 and 13 can be 1.75 inches and 1.5 inches respectively. Thus, by securing either fitting 12 or fitting 13 to the main cone section 5, a rejects outlet of a diameter of 1.75 inches or 1.5 inches may be provided, while maintaining the angle of the cone down to the smaller diameter. In like manner, a rejects outlet diameter of 1.25 inches or any other desired size may be obtained by the use of additional fittings similar to the fittings 12 and 13. The stock outlet pipe 9 is shown extending into cone section 5 to a point where the cone diameter is approximately ¾ that of the cylindrical head section 7. The internal cross section of outlet pipe 9 may be approximately equal to the cross section of inlet 8, this corresponding in the present instance to a diameter of approximately 4 inches.

The stock entering under pressure at the tangential inlet initiates a swirling motion, the liquid simultaneously spiralling inward and downward at increasing velocity. An upflowing helical stream, having a maximum diameter equal to that of the accepted stock outlet pipe develops about the central axis, with a liquid flow transferring from the downward spiral flow to the upward helical flow, which is void of liquid at the axis. It is this central air column which permits the use of a relatively large diameter rejects outlet. Solids in suspension in the incoming liquid are subjected to the centrifugal force increasingly developed as the liquid spirals inward and downward thus

causing a concentration of solids at the outer shell. Since the centrifugal force tends to drive the solids away from the central axis, it might be expected that they would accumulate in the cylindrical section. The fact that they carry to the rejects outlet is explained by the fact that they are entrained by the downward fluid spiral in the conical portion of the apparatus, and does not result from a settling towards the rejects outlet by a simple gravity effect, since the unit will also work "upside down." It can be seen from the above that the cone section accelerates the swirl and facilitates removal of the solids.

A short cylindrical section at the point of entry of the stock somewhat simplifies the construction of the unit and also allows the accepted stock discharge pipe to extend well below the level of stock entry without extending so far into the cone that the resultant narrow annulus would restrict stock flows. By extending this outlet pipe somewhat below the stock entry pipe, additional time is available for the centrifugal action to effect separation before any of the stock passes from the downward spiral to the upward helix and thence out of the unit as accepted stock.

While a separator as described above has proven highly satisfactory in effecting the separation of the dirt particles from the cellulose fibres, it has been found that air entrained with the accepted stock has caused many difficulties in connection with subsequent paper making operations. Hence the present invention is concerned primarily with providing means for eliminating a substantial portion of this entrained air. In Fig. 4 there is disclosed a vacuum chamber provided by a casing **21** disposed immediately below the dirt discharge opening **6**. A drain pipe **22** provides means for continuously withdrawing the solid and liquid components from casing **21**. A liquid seal **23** is maintained so that the casing provides a liquid free space into which the rejects are sprayed as shown at **11** in Figs. 1 and 4. The liquid-free space is maintained under sub-atmospheric pressures so that a suction is created therein which extends along the axis of cone section **5** within the upwardly spiralling stream of clean stock passing to outlet **9**. The liquid seal **23** may be maintained by means of a barometric leg from which the rejected stock will drain or by means of a pump fitted with a level control on the suction side. It has been found that with a vacuum chamber such as described herein on a hydrocyclone the rate of flow through the rejects discharge aperture **6** is greater than when discharged into atmosphere. This results from a decreased diameter of the liquid-free axial core due to its decreased pressure and the diameter of the aperture **6** can be adjusted to give the desired rate of rejection when operating under these conditions. Entrainment of air with the accepted stock is thus prevented.

Having thus described the principles of the invention, it will be understood that various modifications may be resorted to within the scope and spirit of the invention as defined by the appended claims.

I claim:

1. An apparatus of the class described comprising a separating chamber, a tangential inlet adjacent a first end of said separating chamber for introducing a suspension thereto, the suspension being whirled within the separating chamber to form a vortex with a central liquid-free core, a first outlet at said first end of said chamber, a second outlet at a second end of said chamber, a vacuum chamber in communication with said second outlet, and means connected with said chamber for maintaining a partial vacuum in said chamber whereby a portion of the suspension including a major proportion of dirt particles to be separated is sprayed through said second outlet into the vacuum chamber and the cleaned suspension passes out of the separating chamber through the first outlet.

2. An apparatus for de-aerating an aqueous suspension of cellulose fibres and separating dirt particles therefrom comprising a separating chamber in which the suspension is whirled about a central axis to produce a vortex having a central liquid-free core, a tangential inlet at one end of the chamber through which the pulp suspension is fed to establish and maintain the vortex, an axial outlet at the other end of the chamber, a vacuum chamber in communication with said axial outlet providing a liquid-free space into which air entering the liquid-free core is discharged together with a stream of the suspension containing a major proportion of dirt particles, means connected with said chamber for maintaining a partial vacuum in said chamber, and a second outlet located at said one end of the chamber in axial alignment with said first-mentioned outlet and through which is discharged a second steam of suspension containing a major proportion of the cellulose fibres.

3. An apparatus according to claim 2 wherein said vacuum maintaining means comprises a barometric leg connected with said vacuum chamber.

4. An apparatus according to claim 2 wherein said vacuum maintaining means comprises a pump.

5. Apparatus for de-aerating an aqueous suspension of cellulose fibres and separating "dirt" particles therefrom, comprising a conical separating chamber in which the suspension is whirled about a central axis to produce a vortex of conical form having a central liquid-free core, a tangential inlet through which the pulp suspension is continuously fed into the larger end of said chamber to establish and maintain said vortex, an outlet at the apex end of said chamber, a vacuum chamber in communication with said apex outlet affording a liquid-free space into which air entering said liquid-free core is discharged together with a stream of the suspension containing "dirt" particles and a minor proportion of the cellulose fibres, means connected with said chamber for maintaining a partial vacuum in said chamber, and a second outlet located at the larger end of said separating chamber in axial alignment with said first-mentioned outlet and through which is discharged a second stream of the suspension containing a major proportion of the cellulose fibres.

6. Apparatus for separating, from an aqueous suspension of cellulose fibres, dirt particles of varying size, comprising a conical separating chamber in which the suspension is whirled about a central axis to produce a vortex of conical form having a central liquid-free core, a tangential inlet through which the pulp suspension is continuously fed into the larger end of said chamber to establish and maintain said vortex, an outlet at the apex end of said chamber, a vacuum chamber having air-tight connection with the apex end of said separating chamber and affording a liquid-free space which is sealed off from the atmosphere and into which a stream of the suspension containing "dirt" particles and a minor proportion of the cellulose fibres is directly discharged through said outlet, means connected with said chamber for maintaining a partial vacuum in said chamber, and a second outlet located at the larger end of said separating chamber in axial alignment with said first mentioned outlet and through which a second stream of the suspension containing a major proportion of the cellulose fibres is discharged.

References Cited in the file of this patent

UNITED STATES PATENTS

2,377,524	Samson	June 5, 1945
2,571,219	De Cew	Oct. 16, 1951