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2,931,503

CONDITIONING PAPER-MAKING STOCK

Filed April 21, 1953

2 Sheets-Sheet 1

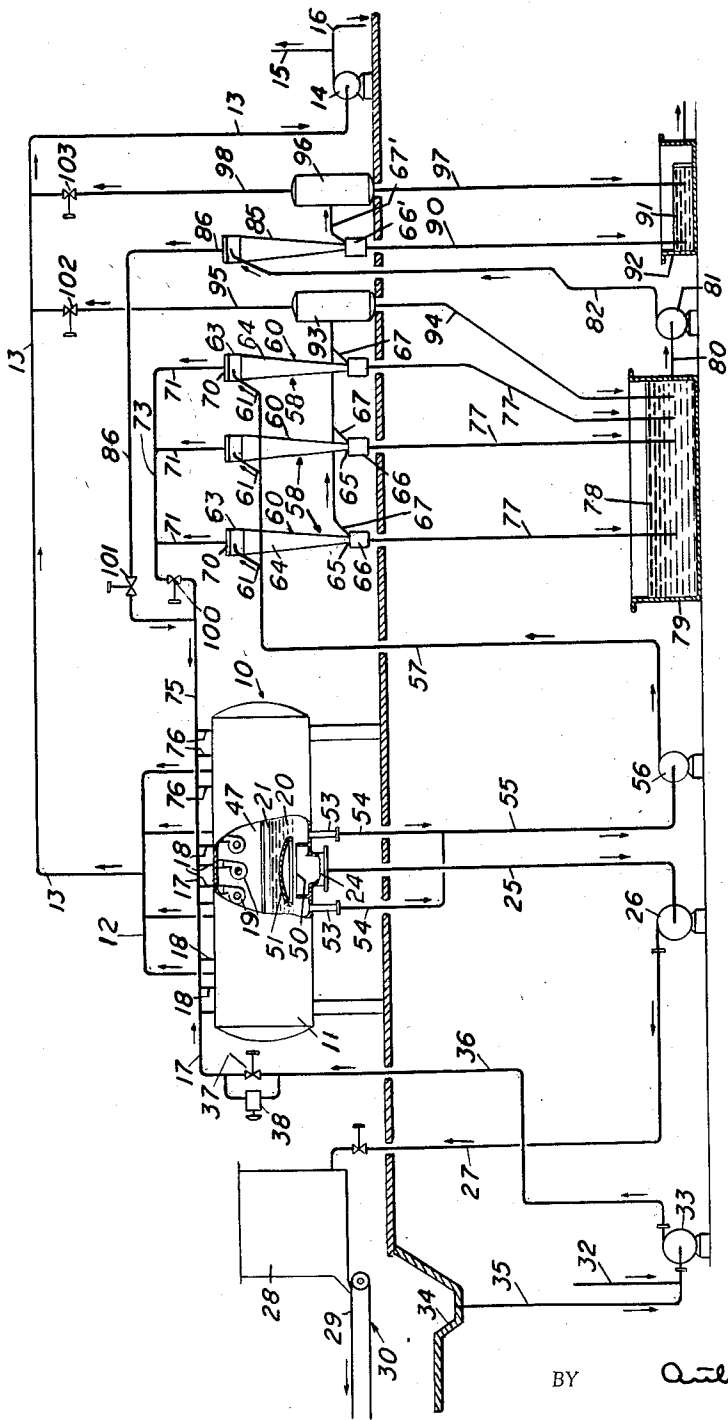


Fig. 1.

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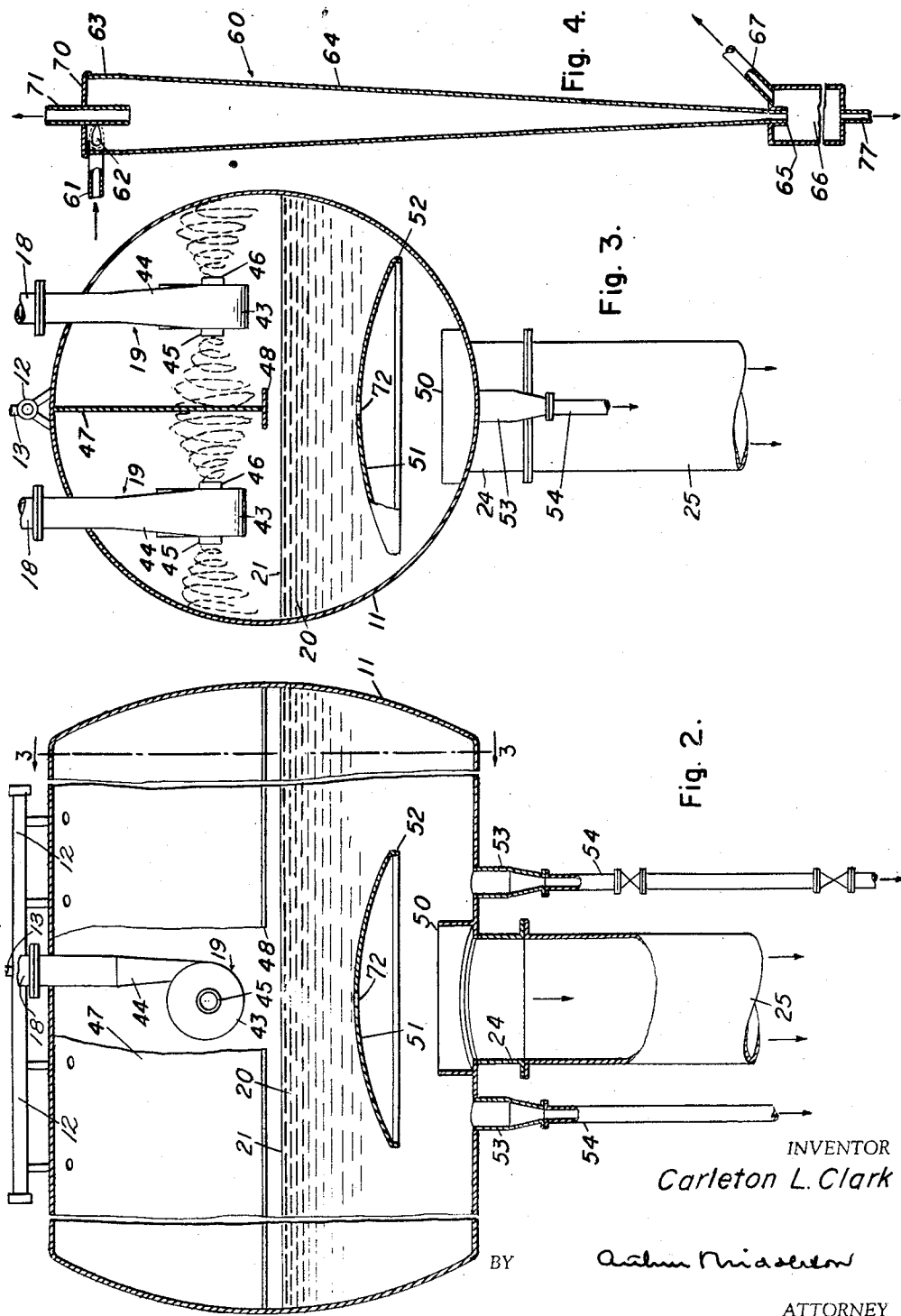
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CONDITIONING PAPER-MAKING STOCK

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12 Claims. (Cl. 209—211)

This invention relates to the preparing of paper-making stock to ready it for the paper-making machine and to improve its condition to be handled by that machine. It has heretofore been proposed to improve its handleability by de-aerating it, sometimes referred to as degasifying it. This is accomplished by atomizing the pumpably fluid stock while subject to the effect of substantial vacuum, collecting a pond of de-aerated stock while still under the effect of vacuum and then conducting it to the paper-making machine. Such a proposal has been patented in the patent to DeCew—No. 2,571,219 dated October 16, 1951. It has also been proposed to clean or to de-dirt the stock prior to supplying it to the papermaking machine. This proposal has been carried out by treating the stock in a hydrocyclone to divide the stock into two fractions of which one is acceptable substantially dirt-free and thus clean stock, while the other has the dirt concentrated in it and is called rejected stock. One such proposal has been patented in the patent to Samson, et al.—No. 2,377,524, dated June 5, 1945, while another such proposal has been patented in the patent to Freeman—No. 2,312,706, dated March 2, 1943.

Such centrifugal separating devices are characterized in that as a result of pressure on a tangential feed thereinto, vortices are said to be set up therein. The liquid body in the centrifugal separator is given a vortically spinning movement with inner and outer layers, in which outer layers are segregated coarser or faster settling solids, while in the inner layers are segregated the fine or slower settling solids. The devices of these two patents both comprise a hydrocyclone characterized in that two vortices are said to be set up therein. One vortex discharges through the apex of the conical part of the cyclone and is called underflow, while the other vortex discharges through a vortex finder in the base of the hydrocyclone and is called overflow. The dirt-free acceptable fraction is discharged as overflow while the dirt-rich and rejected fraction is discharged as underflow. In such a dirt-extracting hydrocyclone with its oppositely-directed axial discharges, an air-core is formed that passes completely through the hydrocyclone, and this air-core seems to aerate to an appreciable extent the stock while it is being cleaned. Since the centrifugal forces set up in such a hydrocyclone are considerable, the infeed pressures that have to be used are high. This means that a large amount of power is consumed in forcing through the de-dirting hydrocyclones the very large volumes of stock needed to be treated.

So it is an object of this invention to put these two types of treatment stations together while modifying each to conjointly co-operate with the other to improve the results including reducing the costs of installation and of operation. The hydrocyclones normally inject air into the stock while cleaning it so it is another object of the invention to devise ways and means for eliminating this function that is undesirable when producing a de-gassed and de-dirted stock. Another object is to devise ways and means whereby the de-dirted stock discharging from

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the hydrocyclone is maintained under the effect of vacuum so it can be returned advantageously to the de-aerating station. And another object is to make it possible to pass less than the full volume of the stock to the paper machine through the de-dirting hydrocyclone and thus reduce the power requirements.

Some of the features of this invention contributing to the realization of these objects comprise the means whereby the effect of vacuum is maintained on the stock both while it is treated in the hydrocyclone station and after it is discharged therefrom, so it continues in well-de-aerated condition; the means for the concentration of settled dirt in a portion of the stock in the de-aerating station so that a minor flow can be drawn therefrom that is dirt-rich, while the major flow drawn therefrom is dirt-poor—but with both flows being well de-aerated; and the means for continuously recycling the acceptable de-dirted de-aerated stock from the hydrocyclone station back to the de-aerating station whereby the acceptability of the stock in the major flow from that station is progressively improved until a maximum is reached.

The objects of this invention, and perhaps others that appear as this specification proceeds, are realizable in an embodiment of this invention having an enclosed tank provided with means for subjecting the tank to vacuum-induced significantly reduced pressure into the atmosphere of which tank pumpable papermaking stock is atomized and then falls to join a pond of so-treated stock collected in the bottom of the tank on which a constant liquid-level is maintained. De-aerated or de-gassed stock then flows down a major flow discharge pipe having a barometric leg to a pump. The entrance to that pipe is surrounded by a submerged weir-edge that holds back settled solids that have settled from the stock before it reaches the weir-edge to overflow it. The discharge pipe and the weir-edge is preferably shielded from settling solids in the stock. From that part of the tank outside of and below the weir-edge there is drawn a minor flow of stock in which settled solids such as sand and other fast-settling dirt is concentrated, is drawn off and forcibly fed to hydrocyclones in a hydrocyclone station, the interior of which hydrocyclones are maintained under the effect of vacuum so that the stock being treated therein does not become substantially re-aerated. Underflowed stock from the hydrocyclones being dirt-rich is discarded, while overflowed stock from the hydrocyclones being both de-aerated and dirt-poor is recycled to the de-aerating station.

The best embodiment of the invention now known to me is illustrated in the accompanying drawings. This has been selected for illustrative and not for limiting purposes. In the drawings, Figure 1 shows a flow-sheet type of diagram illustrating the papermaking environment of the invention as well as the features of the invention. Figure 2 shows a vertical longitudinal sectional view through the de-aerating station or tank. Fig. 3 shows a transverse sectional view taken along the line 3—3 in Fig. 2. Fig. 4 shows a vertical sectional view through a hydrocyclone usable in practicing this invention.

Since the foundation of this invention is based on the paper-stock de-aerating or de-gassing station 10, that will be described first. In it there is an enclosed zone, such as a cylindrical tank or stock receiver and de-aerator 11, to the top of which is connected a vacuum header 12 connected by a line or conduit 13 to a vacuum pump station 14 having an air-discharge 15 and a water-discharge 16. A suspension of paper-making stock to be treated comes into the tank 11 through a primary stock header 17, from whence it passes through a plurality of inlet pipes numbered similarly as 18, each leading to an atomizing spray nozzle 19, hereinafter described in more detail, for atomizing the stock into the vacuum-

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induced significantly reduced pressure in the atmosphere of the tank 11. The stock, so subdivided into tiny or miniscule droplets, is de-aerated and de-gassed by the vacuum, and falls as mist or fog to collect as liquid in the bottom of the tank as a pond 20 thereof, having a maintained liquid-level 21 at an elevation substantially just below the axial line or middle of the tank. Vacuum-treated stock then flows from the bottom of the tank through main flow stock discharge outlet 24 and down a barometric drop leg 25 (shown reduced in diameter in Fig. 1 and thus being merely illustrative) to a centrifugal or fan pump 26 and then through a valved pipe 27 to the head box 28 and then onto the wire 29 of a paper-making machine 30.

The tank 11 is supplied with stock to be treated, as follows: New stock comes into the system through a pipe 32 and is mixed ahead of a fan or centrifugal pump 33 with white water drawn from the wire pit 34 through a pipe 35. The white water is used to dilute the stock coming in through pipe 32 because the vacuum treatment operates more effectively if the stock is diluted and thus subject to intense atomization. The diluted stock from the stock pump 33 is forced through pipe 36 to pass selectively either through the hand-operated valve 37 or through the automatically controlled valve 38 to primary stock header 17. Operation is usually through the latter because it is important to control the constancy of the liquid-level 21 in the tank 11, and this is accomplished by the automatic valve. This also provides an assured constant delivery of stock from the tank 11 through the main delivery pipe 25 to the paper-making machine 30.

The preferred construction of the atomizing nozzles 19 and their cooperating elements, is shown in patent application Ser. No. 259,248 filed November 30, 1951, by Clark et al., now Patent No. 2,642,950.

Briefly stated, each nozzle has a cylindrical body 43 to which stock is fed tangentially through feed-pipe 44. The stock is swirled around in the cylindrical body of the nozzle at great speed, and then issues or is ejected from each of two oppositely directed nozzles 45 and 46 respectively as an intensely swirling spray of minutely atomized stock, ejected with sufficient force to impinge upon adjacent deflecting surfaces. One such surface is provided by vertical baffle or impingement plate 47 that is reinforced by its bottom marginal flange 48. Another such surface is the interior face of the tank 11 against which the oppositely directed nozzles impinge ejected atomized stock. Such forced impingement aids in the further atomization of the stock. To effect substantially complete de-aeration of the stock, the vacuum-induced reduced pressure in the tank must be the result of a very high vacuum, preferably as set forth in the patents and applications mentioned herein. But if less complete de-aeration will do, much less vacuum is needed.

Surrounding the entrance to the main stock discharge outlet pipe 24 is an endless upstanding weir presenting a weir-edge 50, and thereabove, but well below the liquid-level 21 in the tank is a shield or baffle 51, preferably dome-shaped or umbrella-like and having a depending peripheral flange 52 preferably having a vent 72 in the top thereof for inducing flow therethrough. The baffle has extent considerably greater than that of the weir-edge 50, as can be seen from the drawings. In the bottom of the tank, adjacent the main discharge pipe 24, but on the opposite side of the weir-edge 50 therefrom and also beneath the shield 51, are a plurality of minor flow stock outlet pipes 53, similarly referenced, leading to pipes 54 merging into a barometric leg drop pipe 55 for conducting stock to a fan or centrifugal pump 56. These minor flow outlet pipes 53 are for drawing off dirt-enriched stock in advance of the weir-edge 50 since that contains some settled or sedimented contaminant solids such as sand, grit, and so on. Such contaminant solids tend to settle and thus are deterred from over-

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flowing the weir-edge into the main flow outlet pipe 24. These pipes may be valved as shown, if desired.

These minor flows of stock in which contaminants are more or less concentrated and while still under the effect of vacuum and thus de-aerated, are drawn to the fan or centrifugal pump 56 and from there forced through pipe 57 to a de-dirting or hydrocyclone station indicated collectively at 58. A primary station of this kind is made up of a plurality of similar hydrocyclones each numbered 60, to each of which stock from the pipe 57 is forcibly supplied tangentially to the hydrocyclone through pipes 61. The hydrocyclones of the de-dirting station 58 are merely representative of a number of such devices operating on the principle of centrifugal and centripetal action that results in the separation of one type of liquid-suspended solids from another. For the purpose of illustration, there has been chosen that type of hydrocyclone shown in the patent to Samson et al., No. 2,377,524, but other types can be used although this is the preferred type. Such a type is shown in Fig. 4 in vertical sectional view. In that showing, the hydrocyclone has a cylindrical portion 63 from which depends a conical portion 64 that terminates in an apex discharge outlet 65 leading to a spray-receiving expansion chamber 66 into which the apex discharge is whirlingly sprayed from the hydrocyclone. Chamber 66 has an outflow pipe 67 for tapping off of gas or air pressure along with some liquid while the main flow of the apex discharge stock falls down pipe 77. The cylindrical portion 63 has a base closure 70 through which extends a base discharge outlet pipe 71, sometimes called a vortex-finder. The overflow through pipe 71 could also be treated in an expansion chamber 66, if desired.

In such a hydrocyclone, the pump 56 impels its forced feed tangentially into the cylindrical portion 63 where it sets up centrifugal forces many times more powerful than gravity which in turn set up reaction centripetal forces. The result is that two similar directed spinning vortices are thus established and maintained in the hydrocyclone by the pumped feed and more rapidly settling liquid-suspended solids are segregated and discharged as underflow through the apex discharge 65, while the slower settling suspended solids are segregated and discharged as overflow through the vortex-finder 71 at the base of the generally conical device. These devices are made use of in this invention to de-dirt or clean the de-aerated dilute paper-making stock fed to it, namely to substantially rid that stock of sand, grit, specks, and other contaminants; the dirt-rich and unacceptable fraction going out through the apex discharge while the dirt-poor and clean fraction going out through the base discharge or vortex-finder 71. The primary accepted stock from hydrocyclone station 58 is flowed through pipe 73 to a secondary stock header 75, and from thence through pipes 76 and associated nozzles 19 to be recycled and re-atomized into the de-aerating tank 11. Under some conditions, the nozzles 19 need not be used on this recycled stock. Rejected or unacceptable stock from the apex discharge of the hydrocyclones is conducted through barometric drop legs 77 to be delivered in submergence into a pond 78 of such stock, forming primary rejected stock or rejects, held in a seal basin 79. By having the effect of vacuum maintained within the hydrocyclone, less than normal inlet pressure is required on the stock being fed to the hydrocyclone through pipe 57 from pump 56—and this results in a saving in power. Similarly, since the overflow 71 from the hydrocyclone is forwarded by its residual impetus imparted by pump 56 and it flows back into the de-aeration tank 11 while the latter is also under the effect of vacuum, there is a saving in power here too.

In order to reclaim some of the fibers of this primary rejected stock, such stock is drawn off from the basin 79 through pipe 80 by fan pump 81, and forced through pipe 82 to a secondary hydrocyclone station illustrated

only by single hydrocyclone 85, that is in all respects like the other hydrocyclone heretofore described, so the details thereof will be given the same reference numerals but primed. Here in hydrocyclone 85, the primary rejected stock is re-cleaned to reclaim some of its fibers. The stock that becomes re-cleaned and dirt-poor is acceptable as secondary accepted stock and conducted as overflow through pipe 86 to join the primary accepted stock in pipe 75 for re-introduction and re-aerization in the de-aerating tank 11. Rejected or stock that is still dirt-rich is sprayingly discharged as underflow through the apex discharge into spray-receiving expansion chamber 66 leading to barometric drop leg 90 terminating in submergence in a pond 91 of similar stock held in a seal basin 92.

Returning now, for a moment, to hydrocyclone station 58, and particularly to the expansion chamber 66 on the apex discharge of each hydrocyclone: its purpose is to permit the drawing off near its top through pipe 67, of any air or gas entrained in the stock being sprayed into that chamber. The pipe 67 conducting gas and some liquid, leads to a gas separation tank 93 which it joins at substantially the middle elevation thereof, that also has a barometric leg 94 whose end is submerged in the pond 78 in seal basin 79 and that also has a gas-outflow pipe 95 in its top that leads to the pipe 13 connected with the vacuum pump 14. The purpose of this separating tank, that is much larger than the expansion chamber 66, and is located between the expansion chambers 66 on the apex discharges of the hydrocyclone 60 and the vacuum lines 95 and 13, is to further separate air or gas from the stock suspension, so as to minimize the carrying of such suspension into the vacuum system. The second hydrocyclone station has a similar but secondary gas separation tank 96 for a similar purpose, with a barometric drop leg 97 leading to the pond 91 in the seal basin 92 from which its secondary rejects flow to discard, and a pipe 98 from its top leading to the vacuum line 13.

The degree of vacuum operating on the primary hydrocyclones 60 is controlled by valve 100 in pipe 73 through which primary accepted stock flows to the de-aeration tank 11, while valve 101 in pipe 86 controls the vacuum operating on the secondary hydrocyclones 85. Control is important because the accepted stock from the hydrocyclone is drawn to the tank 11 by means of the high vacuum maintained therein, and these valves regulate the sucking power of that vacuum. Valve 102 in pipe 95 from the separator 93, and valve 103 in pipe 98 from the separator 96 similarly regulate the effect of vacuum in line 13 in its operation of those separators. All pipes are valved to give ample controls.

Operation

Diluted paper-making stock is pumped through pump 33 and pipe 36 in quantity controlled by automatic valve 38 through primary stock header 17 and the plurality of inlet pipes 18, each connected to an atomizing nozzle element 19 that swirlingly sprays atomized stock into the de-aerating tank 11 against either the impingement baffle plate 47 or the interior periphery of the tank, as the case may be, from whence the atomized stock in the form of fog or mist descends to and is collected in a pond 20 thereof in the bottom of the tank that has a controlled liquid-level 21. The interior of the de-aerating tank is under the effect of a high vacuum effected by vacuum pump 14 through vacuum line 13 that is connected with vacuum header 12 with the interior of the tank. The atomized stock impinged against the impingement surfaces while under high vacuum, is de-aerated or degassed substantially completely, but it still has a certain content of dirt or other such solid contaminants.

A major flow of the de-aerated stock in the pond thereof 20 overflows the endless weir-edge 50 surrounding the main flow stock discharge pipe 24 and passes through 25 to a pump 26 for delivery to the head-box 28 of a paper-

making machine. But between the weir-edge 50 and the ends of the tank 11, there is sedimentation taking place in the pond of stock of certain faster settling contaminants such as sand, grit, and so on. In other words, there is a substantially high concentration of settled contaminants outside the weir-edge, so that stock overflowing the weir-edge and passing through the main flow discharge 24 is acceptable cleaned and de-aerated stock.

The fraction of stock that is dirt-enriched or in which dirt has settled outside the weir-edge 50 is tapped off, so that a minor flow of stock from the pond thereof, by passing through two or more draw-off minor flow or auxiliary pipes 53 and conducted through pipes 54 to a pump 56 for delivery through pipe 57 to a primary de-dirting or hydrocyclone station 58, while still under the effect of vacuum so that a minimum of air gets back into the stock being so transported. This exclusion of air must continue during treatment of the dirty minor flow of stock in the de-dirting hydrocyclone station. This station is made up of a plurality of hydrocyclones of which the one shown in Fig. 4, is an example. The dirty stock is forcibly and tangentially fed to the cylindrical part 63 of the hydrocyclone with sufficient force to swirl the stock in the hydrocyclone by centrifugal action that is much greater than gravity. This forms an outer vortex or spinning layers, and reaction as centripetal force, establishes a second and inner vortex or spinning layers, both outer and inner layers operating in the same direction. This causes faster settling suspended solids to move to the periphery of the conical portion 64 of the hydrocyclone while the slower settling suspended solids move into the inner vortex to issue from the base of the hydrocyclone through the vortex finder 71. The faster settling solids issue from the hydrocyclone through the apex discharge 65, so we have here a fractionation of the stock into a dirt-poor or clean fraction of acceptable stock overflowing through the vortex-finder and a dirt-rich or concentrated dirty fraction of rejected stock underflowing through the apex discharge.

But in the normal operation of such a hydrocyclone open to the atmosphere, an air core is formed extending between the axially aligned outlets of the hydrocyclone. This results in aeration of the suspension being treated. However, aeration of the stock must be avoided because the object of this invention is to produce stock that is both de-aerated and de-dirted. So the formation of the usual air core must be prevented. This is accomplished by keeping both discharges from the hydrocyclone under the effect of vacuum, namely, by making the apex discharge pass through a barometric drop leg 77, and maintaining the base or overflow discharge 71 and its pipe 86 also under the effect of vacuum through pipe 73 to the tank 11. Accepted cleaned and de-aerated stock from pipes 71 is recycled to the de-aeration tank 11 through header 75, for re-treatment therein to rid it of air that may have inadvertently gotten into it since it left that tank for its de-dirting treatment.

Rejected dirty stock that flows down the barometric legs 77 is caught in the pond 78 in the seal tank 79. This dirty stock is again treated to further de-dirt it by sending it to a secondary hydrocyclone station 85 wherein it is again treated just as it was in the primary hydrocyclone station 58. Secondary accepted stock flows through pipe 86 to header 75 for re-treatment in the de-aerating tank 11, meanwhile having air excluded therefrom by being maintained under the effect of vacuum during its hydrocyclone de-dirting treatment. Secondary rejects from the secondary hydrocyclone station 85 pass through another barometric leg 90 to a seal tank 92 from which they go to discard.

But there is a tendency for the de-dirted stock to pick up air in spite of major precautions. So as a refinement, it is endeavored to get rid of this progressively by having the apex discharge of the primary hydrocyclones 58 pass first into an expansion chamber 66, from which such air

is extracted by pipe 67 through which it is drawn to gas-separation tank 93 from which such air is sucked through pipe 95 to the vacuum line 13 and any stock therein flows downwardly through a barometric leg 94 to the seal tank 79. This same refinement treatment is added to the secondary hydrocyclone station 85. The degree of vacuum operating on the hydrocyclone stations is controlled by the valves 100 and 101 respectively. The degree of vacuum operating on the de-aeration tank 11 is controlled by the character and operation of the vacuum pump station 14. In the de-aeration tank 11, there is provided a shield 51 over the weir-edge 50 to prevent settling solids from settling into the main flow discharge by deflecting them into another part of the tank. Vent 72 is for inducing some flow of stock through the shield to prevent hang-up of stock on the underside of the shield.

From 10% to 20% of the total flow passing through the de-aerating tank 11 is removed through the minor flow or auxiliary stock outlets. However, because of the settling out and accumulation of the stock-contaminating solids, this 10% to 20% of the total flow contains 50% or even more of the total amount of solid contaminants in the entire flow. Thus 50% or more of the solid contaminants or dirt of the stock is removed by pumping only 10% to 20% of the total flow through the hydrocyclones. This means a significant saving in power over pumping all of the very large volumes of stock flow through the de-dirting hydrocyclones. It is surprising how the contaminant solids tend to settle or sediment in the area of the bottom of the de-aeration tank outside the weir-edge 56. For example, in a de-aerating tank 6' in diameter wherein the liquid-level is maintained at above the center of the tank, the velocities of the suspension moving horizontally toward the main flow discharge outlet 24, increase from the order of 0.15 feet per second at either end of the tank to velocities of the order of 4 to 5 feet per second at the main outlet. Because of these low velocities and relative quiescence, there is a significant settling to the bottom of the tank of the solid contaminants that are heavier and thus faster settling than the paper-making fibers themselves. So the intercepting of them in a minor flow from the tank and de-dirting that minor flow in a hydrocyclone station while maintained under the effect of vacuum is a major feature of this invention.

Technical effects inherent in the apparatus when in operation and realizable by the practice of this invention comprise (1) maintaining a constant sub-atmospheric pressure on the apex end of the hydrocyclone in order to produce a constant rate of rejectable fraction discharge and hence a constant cleaning efficiency; (2) maintaining a constant suction head and liquid submergence on the secondary hydrocyclone supply pump 81 which is handling the diluted rejectable fraction to the secondary hydrocyclone station 85 in order to maintain a constant feed pressure and volume to that secondary hydrocyclone station; (3) maintaining a constant rejectable fraction discharge rate and pressure as well as a constant feed pressure to the secondary hydrocyclone station whereby there is eliminated possible fluctuations in the basic weight of the paper made from the primary hydrocyclone station acceptable fraction, which basic weight might otherwise vary due to varying pressures; (4) preventing atmospheric air from entering in at the apex end of the hydrocyclones; and (5) removing whatever portion of the free air that is discharged through the apex end of the hydrocyclone along with rejectable fraction.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined in the appended claims rather than by the description preceding them, and all changes that fall within the metes and bounds of the claims or that form their

functional as well as conjointly cooperative equivalents, are therefore intended to be embraced by those claims.

I claim:

1. The continuous process of de-gassing and de-dirting paper-making stock, which comprises establishing and maintaining a confined zone under vacuum-induced significantly reduced pressure, atomizing pumpable paper stock thereto to encounter the de-gassing effect of the reduced pressure while in atomized condition, collecting a pond of so de-gassed stock, maintaining a substantially constant liquid-level thereon, withdrawing a major flow of the stock from the pond over an endless weir-edge, maintaining stock in the pond beyond the weir-edge sufficiently quiescent to effect sedimentation of suspended dirt therein, withdrawing a minor flow of such sedimented stock from an elevation lower than the weir-edge and from a point ahead of the weir-edge, forcibly supplying tangentially to a de-dirting hydrocyclone such minor flow of de-gassed but dirty stock while still under the effect of vacuum, dischargingly underflowing dirt-enriched stock from the hydrocyclone, dischargingly overflowing de-dirted stock from the hydrocyclone while still de-gassed, and returning at least some of the latter to the confined zone, the stock supplied to the hydrocyclone being under pressure while both discharges from the hydrocyclone are maintained under the effect of vacuum for minimizing entrainment of air into the stock being treated in the hydrocyclone.

2. The process according to claim 1, with the addition of shielding the point of discharge of the major flow from suspended solids descending in the pond.

3. The process according to claim 1, with the addition that at least one discharge from the hydrocyclone is delivered into an expansion zone connected with a source of vacuum.

4. The process according to claim 1, with the addition that the underflow discharge from the hydrocyclone is treated by passing it through an expansion zone from which entrained gas is removed by vacuum and stock is passed to the atmosphere through a barometric leg.

5. The process according to claim 4, with the addition that stock from the barometric leg is re-subjected to fractionating treatment in a second hydrocyclone, and the overflow from that second hydrocyclone re-introduced into the enclosing reduced pressure zone.

6. Apparatus for de-gassing and de-dirting a suspension of paper-making stock, which comprises an enclosed tank, means for subjecting the tank to vacuum-induced significantly reduced pressure, means for atomizing pumpable paper stock into the tank, means for maintaining a substantially constant level pond of stock in the tank, a stock-discharge pipe in the bottom of the tank through which a major flow of treated stock passes, an endless weir-edge encircling the entrance to the discharge pipe, conduit means for withdrawing a minor flow of stock from the pond at an elevation lower than the weir-edge and from a point ahead of the weir-edge, a plurality of de-dirting hydrocyclones having an overflow of de-gassed de-dirted stock, means for forcibly supplying tangentially to the hydrocyclones such minor flow stock, and a conduit for returning such overflowed stock to the tank, whereby stock so overflowed is drawn back into the tank by the vacuum therein.

7. Apparatus according to claim 6, with the addition of shielding means in the tank for deflecting solids settling in the pond away from the discharge pipe.

8. Apparatus according to claim 6, with means for maintaining the effect of vacuum on both the overflow and the underflow of the hydrocyclones.

9. Apparatus according to claim 6, with an expansion chamber through which is passed at least one of the overflow and the underflow from the hydrocyclones, and means connecting that chamber with a source of vacuum.

10. Apparatus according to claim 9, with a barometric leg connected to the expansion chamber, and means for

re-passing stock from the barometric leg to and through a hydrocyclone.

11. The continuous process involving de-dirting of a liquid suspension of paper-making constituents en route to a paper-making apparatus, which comprises establishing and maintaining a primary de-dirting station made up of a plurality of hydrocyclones operating in parallel and each with a base discharge outlet and an apex discharge outlet, feeding the suspension tangentially into each hydrocyclone, spinning the suspension in each hydrocyclone with sufficient force to segregate the suspension into two fractions of which one is an acceptable fraction that is emitted through the base outlet while the other is a rejectable dirt-rich fraction, emitting as a spray the dirt-rich fraction through the apex outlet of each of said hydrocyclones into a non-submerged spray-receiving area of an expansion zone, establishing and maintaining in a single closed gas-separation tank a collected body of liquid, establishing and maintaining continuous communication between each of said spray-receiving areas and said single gas-separation tank above the level of the body of liquid therein, continuously applying from an exterior power-operated vacuum-producer vacuum induced suction to the gas-separation tank above the level of the liquid therein and through the communication between the tank and the spray-receiving areas to the spray-receiving areas and thence to the interior of each of the hydrocyclones to constantly suck air from the core of the hydrocyclones, through the spray-receiving areas into and from the gas-separation tank, establishing and maintaining a secondary de-dirting station made up of at least one hydrocyclone having a base discharge outlet and an apex discharge outlet, pumping liquid discharged from said spray-receiving areas and from the collected body in the gas-separation tank from a level below that of the body to the secondary de-dirting station to ensure delivery of the liquid to the secondary de-dirting station at constant pressure and volume, feeding the last-mentioned liquid tangentially into the secondary hydrocyclone and spinning it with sufficient force to segregate the suspension into two fractions of which one is an acceptable dirt-poor fraction that is emitted through the base outlet while the other is a rejectable dirt-rich fraction that is emitted through the apex outlet, and conveying the acceptable fraction from the base outlet portion of each of said hydrocyclones to a place of its use.

12. Apparatus for de-dirting paper-making stock, which comprises a primary cleaning station having a

plurality of hydrocyclones connected in parallel, each of said hydrocyclones having a base discharge outlet and an apex discharge outlet, means for feeding liquid suspension of paper-making constituents into each hydrocyclone, pump means in said feeding means for spinning such suspension in each hydrocyclone with sufficient force to segregate two fractions in the hydrocyclone and to discharge a rejectable dirt-rich fraction from the apex outlet thereof and an acceptable dirt-poor fraction from the base outlet thereof, expansion chamber means associated with the apex outlet of each of said hydrocyclones, a single closed gas-separation tank having a body of collected liquid disposed therein during operation, means providing communication between said expansion chamber means and the interior of said gas-separation tank above the liquid level therein, power-operated vacuum-producing means, means connecting said vacuum-producing means with said gas-separation tank above the level of the collected liquid therein for continuously applying suction to the tank and to said expansion chamber means and said hydrocyclones for drawing air from the hydrocyclones, the expansion chamber means and said gas-separation tank, a secondary hydrocyclone station having at least one hydrocyclone with a base discharge outlet and an apex discharge outlet as well as a feed inlet, a pump means disposed at an elevation below said gas-separation tank, means connecting the lower portion of said tank and said expansion chamber means with said pump means, and means connecting said pump means to the feed inlet of said last-mentioned hydrocyclone, whereby constant pressure and constant volume delivery of liquid to said last-mentioned hydrocyclone is ensured.

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