Oct. 16, 1951 J. A. DE CEW 2,571,219

DEAERATION OF PAPER MAKING FIBERS

Original Filed April 27, 1946 2 Sheets-Sheet 1

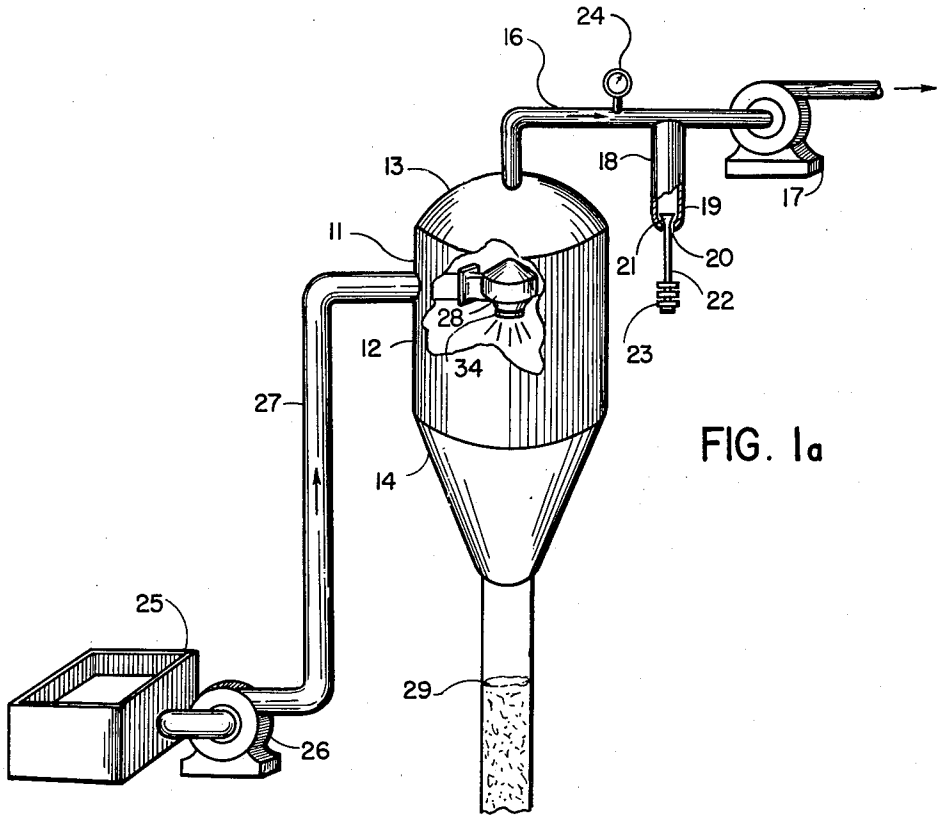


FIG. 1a

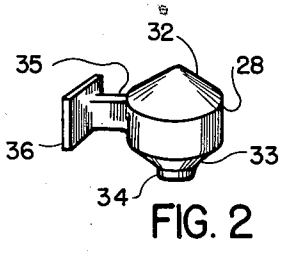


FIG. 2

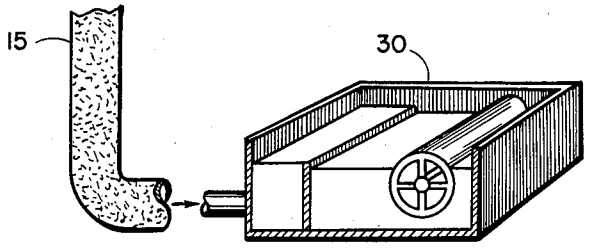


FIG. 1b

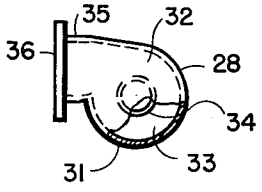


FIG. 3

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DEAERATION OF PAPER MAKING FIBERS

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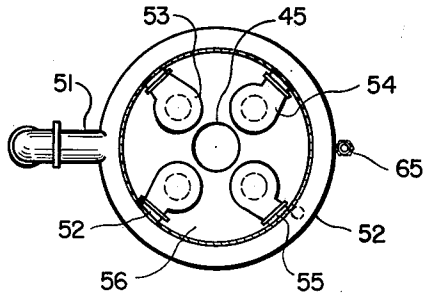


FIG. 5

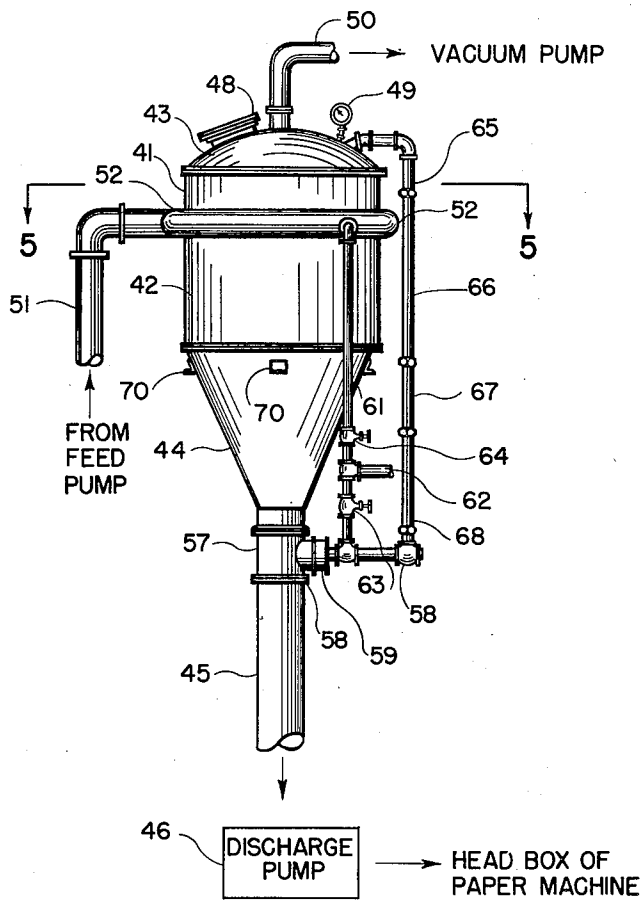


FIG. 4.

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DEAERATION OF PAPER MAKING FIBERS

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Continuation of application Serial No. 665,408, April 27, 1946. This application May 17, 1950, Serial No. 162,542

5 Claims. (Cl. 183—2.5)

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This invention relates to the treatment of conditioning of paper-making stock as it is diluted or rendered into a suspension to be ready for the paper-making machine. With the ever-increasing demand for more and more speed and capacity for paper-making machines, it is necessary to remove huge quantities of water from the stock while on the paper machine, so one of the objects of this invention is to facilitate that removal. Frothing of the paper stock as it goes onto the paper machine is another problem, so another object of this invention is to minimize such froth formation. Another problem is to minimize flocculation of the fibers of the paper stock since that tends to slow down the rate of water removal. So it is still further an object of this invention to prevent or at least deter such flocculation. I have found that a significant cause of these troubles is the presence not only of entrained air or gas in the paper stock, but more particularly the presence of air or gas that is dissolved in the water carrying such stock. So an important object of this invention is the removal of such air or gas from the stock at a point just ahead of the paper-making machine.

In normal paper-making operations, the diluted paper stock is pumped, under pressure, to the screens or head-box and while under such pressure, a part of the entrained air becomes dissolved. When this pressure is released to atmospheric pressure, a large portion of the dissolved air comes out of solution and in changing phase, forms into a myriad of microscopic bubbles. These bubbles form on and adhere to the fibers of the paper-stock and, in addition, air or gas is adsorbed by the surfaces of the fibers. This seems to cause the fibers to be attracted to each other, apparently due to static electricity, so that the fibers form into flocs. As a result both of this adhesion of bubbles and this flocculation, the fibers, if given the opportunity, will float to the surface and form a frothy mass of fibers. Fiber flocculation is a well recognized phenomenon that always takes place in ordinary paper-making operations and is the cause of the non-uniform or heterogeneous concentration of the fibers in many papers. This condition shows itself when a piece of such paper is held between the viewer and the light, whereupon the irregular concentrations of fibers appear as clouds. If attempt is made by ordinary means to remove substantially all air from the stock, it has been found that such air or gas in its various phases is removed in the following order: first, free or entrained air or gas will escape quickly; second,

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dissolved air or gas will begin to come out of solution and that which does not become attached to the fibers will escape slowly; and third, the air or gas adsorbed or attached to the fibers is very slowly removed. In commercial operations in paper making, there is no time for the removal of such air or gas in these three stages or steps.

All of these disadvantages can be palliated, if not obviated, by the practice of this invention. The invention revolves about the method and means embodied in a suitably supported closed tank having an unobstructed interior, and which is subjected to suction. The tank has a body portion with a depending leg portion. Stock is pumped to the upper section of the body portion of the tank and released thereinto by means of a specially constructed spray or atomizing nozzle or nozzles. The stock so released in the form of a very fine spray encounters the vacuum-induced suction in the tank, whereupon air or gas of the stock, both entrained and dissolved, is sucked out of the droplets and fibers of the stock and from the tank through the vacuum pump (or other suction-producing means) to the atmosphere. The de-aerated fibers sink in the tank and fall down into the depending leg, dispersed in the water. The tank is completely smooth inside for such de-aerated stock, or succession of fibers, are actively adherent to anything in the tank to which they may cling. Therefore, there should be a minimum of obstructions, baffles, contact shelves, or other such surfaces in the tank so that this clinging tendency will not have a chance to exert itself. The conditioned and de-aerated fibers in suspension are conducted from the leg to the cylinder-mold vat or to the head box of the paper-making machine, either by gravity or by pump.

Certain features of this embodiment must meet specific requirements. For instance, it takes time for the air to get out. So with the enormous volumes of stock to be treated, it is imperative to cut down the duration of this time interval. In so doing, it is important to take into consideration the following factors: the amount of air to be removed; the size of the tank for the larger the tank the more spray nozzles can be used and the less can be the vacuum used; and the fineness of the spray which is the result of the pressure with which the stock is forced through the emission orifice of each nozzle. The spray nozzle must be of a type that contains no obstructions, ribs, spokes, vanes, or the like, on which fibers can lodge, adhere or collect for they

would quickly clog up the nozzle. In other words, the nozzle has an unobstructed flow-passage therethrough. There must be a constant supply of feed stock passing into the tank for treatment therein, and the treated stock must be removed from the tank at such an assured rate that there is substantially no stock detained in the tank. That is, the treated stock which is in fluid form and presents a liquid level, must be so transited that as far as possible no liquid level thereof is developed in the tank. To that end, the depending leg is provided for the tank to hold an accumulated body of treated stock so that the variation of its liquid level ranges within the leg. The reason for not wanting the liquid level within the vacuum tank is that a slight variation of this level will affect the flow from the tank on the paper machine, which flow must be kept constant, whereas a difference in elevation of the liquid level in the discharge leg will have little or no effect upon this flow. However, if with proper control devices, a fixed liquid level could be maintained, there would be no disadvantage in having the level within the tank. Nevertheless, this would be affected by the design of the tank. In a tank that is wide and shallow, it is difficult to control the liquid level, whereas a tank that is narrow and deep might, under good conditions, be operated with a liquid level within the tank. The prime essential is that the flow to the paper machine is maintained significantly constant.

Further, it is highly important that the suction on the tank be maintained uniform. The main body portion of the tank should have a volume enough to provide ample space for the upflow of the separated-out air passing to and through the vacuum pump while at the same time not interfering with the descent of the falling de-aerated or degassified water and fibers. The vacuum preferred lies in a range of from substantially 14 or 15 inches of mercury upward. The length of the leg used on the tank has a relation to the degree of suction used (if the de-aerated stock is removed from the leg by gravity) in that the leg should be long enough so that it has as minimal requirements, one foot of length for each inch of mercury of the vacuum used. However, if the de-aerated or degassified stock is removed from the leg by means of a suction pump, then the leg needs to be long enough only to collect the de-aerated stock under the following conditions:

The leg, when it has a gravity discharge, must be long enough (1) to minimize air-leakage through it into the tank, and (2) to provide sufficient hydraulic head of stock to cause the stock to flow from the leg to the paper-making machine against any resistance that it may encounter in so doing. The leg, when it has a pump discharge, must have a volumetric or detention capacity sufficient to provide the discharge with an ample reservoir of stock from which to pump, for its rates of discharge must be substantially constant, yet the quantity of stock accumulated in the leg must not have its liquid level reach significantly into the main body of the tank wherein the sprayed stock is being vacuum treated, since, if the main body of the tank is too small to permit the sucked-out air to be removed from the tank substantially as rapidly as it is so removed, the efficiency of this method of treatment falls rapidly. So the hydraulic head exerted by the de-aerated stock in the leg should be fairly constant in order to meet

the requisite of uniform feed of the de-aerated stock to the paper machine, but ordinarily since the vacuum used is uniform and constant, the discharge of stock from the leg can be equally uniform and constant.

The invention is illustrated in the accompanying drawings wherein is shown the best embodiment of this invention now known to me, but it is to be understood that the embodiment is chosen for illustrative purposes only, and is not limiting, for obviously changes of details and of construction can be made so long as they fall within the ambit of the appended claims.

In the drawings, Fig. 1[a] is an isometric view of one embodiment of my invention, shown more or less diagrammatically and with parts in section. Fig. 1[b] is an associated apparatus to which conditioned stock is supplied from the apparatus of Fig. 1[a], but this figure is drawn on a much smaller scale than Fig. 1[a]. Fig. 2 is an isometric side elevation of my preferred form of spray nozzle, while Fig. 3 is a top plan view thereof, with parts in section. Fig. 4 is a vertical elevational view through one form of vacuum tank of this invention, and Fig. 5 is a cross-sectional view thereof on the line 5—5 of Fig. 4.

The vacuum de-aerating tank of this invention shown at 11, has a main body portion 12, a top 13 which is preferably domed, a coned bottom section 14 and a depending leg 15 having certain requirements as to length and volumetric capacity. Suction is applied to the tank through pipe or conduit 16 leading to a vacuum pump 17 or other vacuum-producing means such as a steam jet. Since it is important to assure constant and uniform suction on the tank, there is provided some suction control means 18, such as a vacuum breaker illustrated by way of example as a pipe 19 terminating in a valve seat 20 having a coned valve 21 adapted to seat on it and be held thereon by means of its stem 22 on which adjustable removable and replaceable weights 23 are provided. 24 indicates a suitably located pressure gauge or other device for indicating the degree of suction being applied to the tank 11. The tank is fed with stock to be treated from a source of constant supply, shown symbolically at 25, pumped by pump 26 through pipe or conduit 27 leading into the upper part of the tank 11, where it terminates in a spray nozzle 28 of special construction. Conditioned and de-aerated stock accumulated in the leg 15 to a liquid level such as 29 (below the tank) is led (as shown by the arrows at its end) while minimizing air-leakage into the leg, to a stock-treating apparatus shown by example in Fig. 1[b]. The apparatus illustrated diagrammatically at 30 is a cylinder mold and vat, although a head-box for a paper-making machine can be substituted for it, if so desired.

The preferred construction of the spray nozzle 28 is shown in Figs. 2 and 3. It has a cylindrical body portion 31, a coned top 32, a coned bottom 33 terminating in a depending orificed neck or spout portion 34. The nozzle has a feed portion or section 35 communicating from a flange 36 to the interior of the nozzle in a tangential manner. This feed portion tapers in cross section from the flange 36 to the point where it joins the body portion 31 of the nozzle 28. It will be noticed that this type of nozzle has no interior obstructions of any kind and it breaks up the liquid fed to it by swirling centrifugal action and emits the liquid in the form of a very fine spray.

The operation of this embodiment is as follows: The dilute paper stock for feeding to the vacuum tank is accumulated in the box 25 so that it provides a constant source of supply. It is sucked therefrom by the pump 26 which pumps the stock to the tank and the nozzle 28 wherein the stock is broken up into a very fine spray that is emitted from the orificed neck or spout portion 34 of the nozzle. The suction within the tank is equal to at least substantially 15 inches of mercury due to the action of the vacuum pump 17 since it is controlled by the vacuum breaker 18. If suction becomes greater than that for which the vacuum breaker is set, the valve 21 is sucked off its seat 20 in spite of the weights 23 that tend to hold it on its seat. Upon being unseated, the suction is broken by the inrushing of air through the seat 20 in pipe 19. The weights 23 are adjustable or variable so the vacuum breaker can be made adjustable to give any desired response.

Stock emitted from the neck 34 of the nozzle 28 is de-aerated both of its entrained and its dissolved air. The reason is that complete de-aeration or degassification is a surface phenomenon. And since the stock is atomized into a very fine spray, a maximum amount of surface is exposed to the suction, and de-aeration results in a minimum of time. The de-aerated air tends to eddy and to rise to be sucked out through pipe 16 and out through the vacuum pump 17. The de-aerated stock falls down through the tank which is completely smooth so that there is nothing to which the falling de-aerated stock can adhere. The stock, in more or less fluid condition accumulates in the leg 15 to form a pool of stock therein whose liquid level 29 is controlled so that even though it may fluctuate slightly, it is always below the main body 12 of the tank, due to the volumetric capacity of the leg, and preferably even below the coned bottom 14. The importance of this is to assure that there is ample space in the tank to permit the escape of the de-aerated air or gas for there should be enough space so that the escaping air does not tend to set up an increased pressure in the tank. De-aerated stock flows by gravity from the leg 15 to further treatment such as in the cylinder mold vat of Fig. 1[b], or a paper machine. This delivery of the de-aerated stock, while de-aerated, directly to the place where it is to be made into paper, prevents re-entrainment or readsorption of a fresh or new supply of air. Since the stock is completely conditioned by being de-aerated of both entrained and dissolved air, there is no tendency to foam or to flocculate, which renders such stock amenable to rapid dewatering and better sheet formation.

The nozzle has been described and its essence is that it renders the stock into an atomized or fine spray and yet has no obstruction in it on which fibers of the stock can lodge and thus clog the nozzle.

Proportionate and relative dimensions are important in the functioning of embodiments of this invention, as has been previously indicated. By way of example, it may be stated that the following has been found satisfactory: Main body of tank 12, four feet in diameter and three feet high; the leg 15 is fifteen feet high and twelve inches in diameter; the pipe 27 is six inches in diameter, while the pipe 16 is four inches in diameter; a suction equal to fifteen inches of mercury; the height of the spray nozzle is approximately six inches; its length about thirteen inches; and its orifice three inches. In this tank, one spray nozzle can handle from 800 to 1000 gallons of stock per minute, so if a greater volume is to be treated, more than one spray nozzle can be used in one tank and a larger tank used.

In the practice of this invention, it has been found that the paper-making fibers so treated, are free from occluded, adhering or adsorbed air or gas and the water is free from dissolved air, and the fibers no longer have any attraction for each other. Indeed, they seem to repel each other and thus form a definite dispersion in their aqueous medium or carrier whereupon they settle rapidly since they reassume their true specific gravity. Such fibers do not form a flocculent mass in the head-box of the paper machine or as they pass along on the machine wire. They settle readily and rapidly and quickly form a mat on the wire, retaining more of the fine fibers and filling material than in normal current practice.

The embodiment shown in Figures 4 and 5, differs from the embodiment of Fig. 1[a] in that in the latter, its de-aerated stock flows from the leg 15 by gravity; in the present embodiment such stock is flowed from the leg by means of a suction pump. In Figs. 4 and 5, 41 indicates the de-aerating enclosed tank having a main portion or section 42, a domed top 43, a tapered or conical bottom portion or section 44, and a leg 45, leading to a suction discharge pump 46, which, in turn, is connected to and delivers into the head-box of a paper machine, shown generally in Fig. 1[b]. The domed top 43, if large enough, may have a manhole and cover 48 and a suction indicator 49. Suction from a suction or vacuum-producing pump (such as 17 in Fig. 1[a]) operates through pipe or conduit 50 leading to the interior of the tank 41. Diluted paper-mill stock, from a source of supply, such as tank 25, is pumped by pump such as 26 (both in Figure 1[a]) through pipe or conduit 51 leading to a bustle-pipe 52 that preferably encircles the tank 41 and feeds stock to a plurality of spray nozzles 53, 54, 55 and 56, for example, each of which corresponds to nozzle 28 and is substantially represented by Figs. 2 and 3.

The leg 45 includes a coupling section 57 having a T 58 including a fitting 59 that is provided with a wire cloth screen held between rubber gaskets, for a purpose hereinafter described. This T 58 leads through a pipe 61 which connects with the bustle pipe 52. Pipe 61 is provided with a water inlet pipe 62 leading from a suitable supply of water, and valves 63 and 64 are included in pipe 61 for control purposes. T 58 also leads to a pipe 65 connected with the interior of the tank 41 through its top 43, which pipe is equipped with sections such as 66, 67 or 68, any or all of which may comprise suitable gauge glasses by which the liquid level in the tank may be observed. 70 represents brackets by which the tank may be suitably supported in an elevated position.

The operation of the embodiment of Figs. 5 and 4 is as follows: dilute paper-mill stock is pumped continually through feed pipe 51 so it flows into the bustle pipe 52 and thence is forced through the plurality of spray nozzles 53, 54, 55 and 56 (each substantially like spray nozzle 28 of Figs. 2 and 3, or their equivalent). Meanwhile the vacuum-producing pump causes suction to operate in the tank 41 through suction pipe 50. The result is that the dilute stock emitted in spray form from the nozzles into the smooth interior of the tank 41 on which the vacuum is sucking, becomes de-aerated (as in tank 11 of Fig. 1[a]) and falls down into leg 45, where it is

collected and accumulates to provide a constant supply of de-aerated stock to be pumped by the suction pump 46 and forced to the paper machine head-box. Since a pump sucks the de-aerated stock from the leg, it is not necessary to hold therein as much hydraulic head as it is when the stock is discharged from the leg by gravity as in Fig. 1a. However, it is still important that the main body portion 42 of the tank be kept free of the liquid level of any accumulated de-aerated stock, but the operator can be sure of this by observing the gauge glasses 68, 67 or 66, as the case may be. Fibers from the stock do not get into the pipe 65 or its gauge glass sections because of the screen provided in the fitting 59 to prevent flow of fibers therethrough. However, sometimes fibers will clog the screen on the coupling section side, but in such an event, they can be back-washed by opening the valve 63 in pipe 61 to allow wash water from pipe 62 to flow back through the screen and coupling 57 into the dilute stock in the leg 45. Water from pipe 62 may also be used to back-wash the bustle-pipe 52 and its associated spray nozzles, by opening valve 64 in pipe 61 that connects with the bustle-pipe.

The degree of suction used in this embodiment should meet the requirements as hereinbefore described, and this also applies to the liquid level of the de-aerated stock in the leg. It is likewise important to maintain a sufficient column or body of de-aerated stock in the leg so that there is an accumulation of such stock for the pump 46 to draw upon because the feed of de-aerated stock to the paper-making machine must be significantly uniform.

A vacuum tank 8 feet in diameter with four nozzles and having a capacity of 250 cubic feet has been found to have sufficient capacity to handle 3,000 gallons of dilute paper stock in one minute, and a tank 4 feet in diameter with a capacity of 50 cubic feet with one nozzle was capable of treating 800 gallons per minute.

While it is believed that the foregoing contains all of the information needed by one skilled in the art to practice this invention, the relative importance of some of the features specified may be better appraised by the following explanation of what is believed to be the theory of the functioning of the invention:

As has been stated, it is the object of this invention to remove from the fibers that are in water-suspension in the paper-making stock so that as they go onto the paper machine, they are sufficiently de-aerated that they are not flocculent; are not scum-forming; are not buoyant; have substantially no occluded air; and tend to sink when submerged. In order to accomplish this, they must be substantially removed or isolated from being in suspension in water. The reason for this is that the effect of the vacuum to which they are subjected, is significantly to withdraw or suck air from the fibers while they are in water-suspension because the vacuum cannot reach through the water to the fibers. It is known that vacuum is ineffective to reach down into a body of water beyond or beneath its liquid level. Therefore, if the fibers are encased in a substantial body of water, the vacuum cannot penetrate that body to de-aerate the fibers. Accordingly, this invention proposes to force-feed the stock to an atomizing device or spray nozzle that is located within the vacuum-induced zone of reduced pressure within the tank, and then forcibly to project the stock from that atomizing device into the reduced pressure zone so that the stock is rendered into an atomized mist of such discrete fine particles that the fibers are substantially segregated from the water particles. In other words, the fibers are sufficiently separated from their water carrier that they are in effect changed into gaseous suspension, and have so little water left on them that the vacuum can reach them and suck the water from them, or at least reduce any water on them to a monomolecular film that is incapable of retaining occluded air in it while under the influence of the vacuum. And when the fibers are relieved of occluded air, they are no longer flocculent, or froth-forming, and indeed they tend to sink when submerged. Meanwhile, the water particles have air sucked therefrom by the suction.

The de-aerated water particles and the de-aerated fibers fall into the pool in the bottom of the tank where the de-aerated fibers are again rendered into water-suspension but since the water is also de-aerated, the resulting condition is such that any tendency of the fibers to be re-aerated by air in the water is minimized.

The formation of the discrete particles and the segregation of the water particles and the fiber particles are facilitated by the use of the type of spray nozzles disclosed herein to which the stock is pressure-fed tangentially and wherein, because of the partially cylindrical and partially conical shape of the nozzle induces swirl of the stock therein with the result that cyclonic or centrifugal action is set up which tends to force the heavier fibers to the outside of the cone and the lighter water to the center thereof. The emission of stock from the nozzle seems to explode the particles into an extremely fine state of subdivision.

These advantageous effects are not to be obtained merely by flowing thin films of paper making stock over a cone in a vacuum tank, such as is shown in my prior Patent No. 1,853,849. Moreover, paper making stock cannot be treated in ordinary water de-aerating sprays under vacuum to de-aerate the fibers because that type of apparatus does not meet any of the requirements carefully set forth herein.

What I claim is:

1. The method of de-aerating air-bearing fibers in dilute paper-making stock prior to being supplied to a paper machine, which comprises establishing and maintaining a gaseous body under the effect of vacuum to be at reduced pressure, force-feeding into an atomizing zone such stock in the form of a dilute water suspension containing such fibers, forceably projecting such suspension from such zone under atomizing conditions that render the suspension into gas-suspended discrete fine particles of water and of fibers in such a state of subdivision that the effect of the vacuum can reach to the fiber particles to remove air occluded by those fiber particles and can reach the water particles to substantially de-aerate them, collecting such de-aerated water particles and de-aerated fiber particles in a pool still under the effect of such vacuum wherein the de-aerated fibers are re-suspended in de-aerated water in which the fibers sink and remain in substantially air-free condition, and conducting such air-free water-suspension to a paper machine.

2. The method according to claim 1, wherein the suspension is swirlingly expelled and projected from the atomizing zone.

3. Apparatus for de-aerating air-bearing

fibers in dilute paper-making stock, which comprises an enclosed tank having a pool receiving- and collecting-portion in the lower section thereof; vacuum producing means for establishing and maintaining a reduced pressure within the tank; a feed conduit for conducting the stock of water-suspended fibers to the tank including a manifold and a plurality of cylindrical spray nozzles having fiber-swirling coned smooth interiors resistant to fiber-adherence with a tangential feed portion connected to the manifold and with a depending reduced outlet for forcibly projecting the stock into the tank as an atomized spray of discrete finely divided particles; the pool-receiving portion of the tank being so placed with respect to the nozzles that atomized spray from them descends to and is collected in that pool-receiving portion as a pool of de-aerated fibers suspended in de-aerated water, and means for passing such suspension to a paper machine.

4. Apparatus for de-aerating air-bearing fibers in dilute paper-making stock, which comprises an enclosed tank having a pool-receiving and collecting-portion in the lower section thereof; vacuum producing means for establishing and maintaining a reduced pressure within the tank; a feed conduit for conducting the stock of water-suspended fibers to the tank, a cylindrical spray nozzle having a smooth interior resistant to fiber-adherence with a tangential feed portion connected with the feed conduit, and with a depending reduced outlet for forcibly projecting the stock into the tank as an atomized spray of discrete finely divided particles; the pool-receiving portion of the tank being so placed with respect to said nozzle that atomized spray from the same descends to and is collected

in that pool-receiving portion as a pool of de-aerated fibers suspended in a de-aerated water, and means for passing such suspension to a paper machine.

5. Apparatus for de-aerating air-bearing fibers in dilute paper-making stock, which comprises an enclosed tank having a pool-receiving and collecting-portion in the lower section thereof; vacuum producing means for establishing and maintaining a reduced pressure within the tank; a feed conduit for conducting the stock of water-suspended fibers to the tank, a spray nozzle comprising a main cylindrical body part with a tangential feed inlet portion connected with the feed conduit, and said spray nozzle having a coned bottom terminating in a depending outlet for forcibly projecting the stock into the tank as an atomized spray of discrete finely divided particles, said spray nozzle having a smooth interior resistant to fiber adherence; the pool-receiving portion of the tank being so placed with respect to the spray nozzle that atomized spray from the same descends to and is collected in that pool-receiving portion as a pool of de-aerated fibers suspended in de-aerated water, and means for passing such suspension to a paper machine.

JUDSON A. DE CEW.

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