United States Patent

[11] 3,627,630

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[21] Appl. No. **882,064**
[22] Filed **Dec. 4, 1969**
[45] Patented **Dec. 14, 1971**
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[54] METHOD OF FLASH DRYING PULP

6 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **162/100,** 34/10, 34/13.8
[51] **Int. Cl.** **D21d 3/00**
[50] **Field of Search** ..... 34/10, 12, 13.4, 13.8, 57 D; 162/100

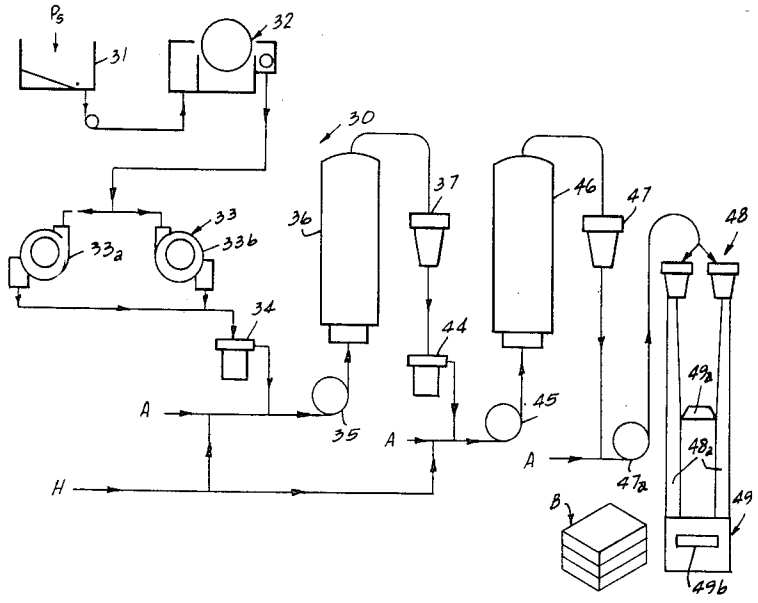
[56] **References Cited**

UNITED STATES PATENTS

3,316,141	4/1967	Bergholm et al.	162/100
3,382,140	5/1968	Henderson et al.	162/100 X
3,492,199	1/1970	Kindron et al.	162/100 X

Primary Examiner—Carroll B. Dority, Jr.
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ABSTRACT: A method of producing pulp bales suitable for storage and repluping comprising fluffing dewatered paper stock, intermixing the stock with a heated gas to partially dry the stock, refluffing the partially dried stock, intermixing the fluffed stock with a heated gas to finish drying the stock and converting the dried stock into a pulp bale.

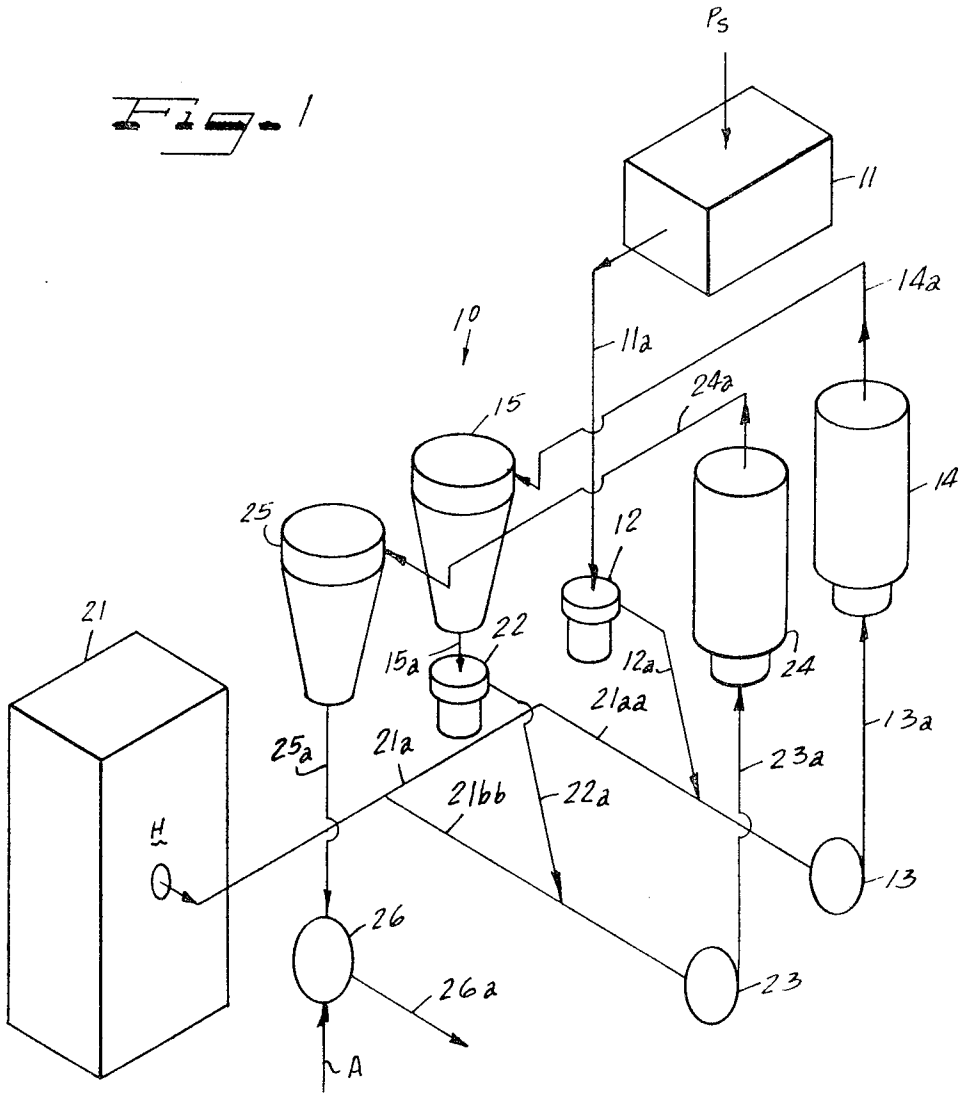


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SHEET 1 OF 2

Fig. 1



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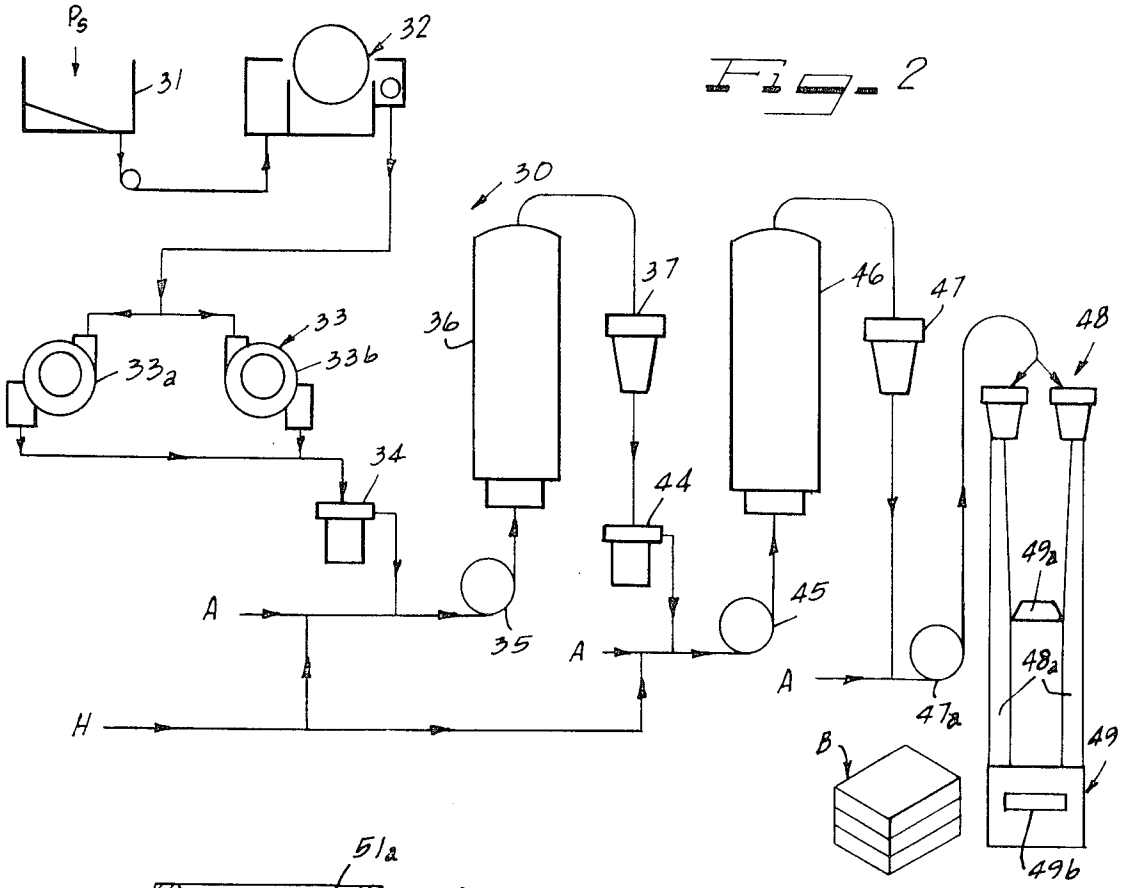


Fig. 2

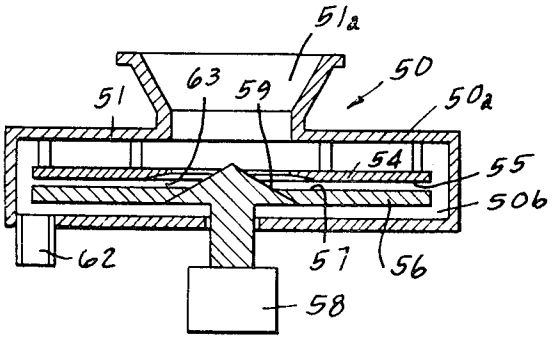


Fig. 3

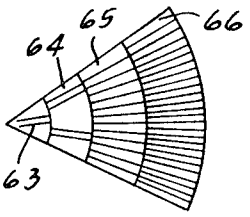


Fig. 4

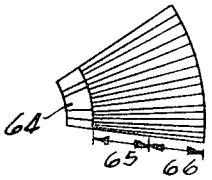


Fig. 5

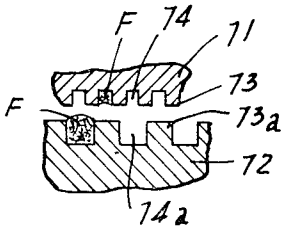


Fig. 6

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METHOD OF FLASH DRYING PULP

BACKGROUND OF THE INVENTION

This invention relates to pulp production and more particularly to new and improved methods of producing high quality pulp bales suitable for storage and repulping.

Flash drying of paper stock to form pulp bales is a relatively recent development, in comparison to the more conventional sheet drying in the field of paper making. Historically, paper was produced immediately from all available pulp. However, as a variety of paper grades increased, each of which required different type or grade of pulp, it became highly impractical to maintain enough paper making lines to produce the various desired paper grades. Accordingly, it became necessary to produce and store a variety of pulp grades until that particular grade of paper was being produced. Quite early in this development it became apparent that it was very practical to dry the pulp stock and store it in that condition for subsequent repulping. The original drying technique was to form a pulp sheet and pass it over a suitable drying means. However, this was time consuming and required costly equipment. Thereafter flash drying techniques were developed and generally comprises mixing relatively high consistency stock with heated air to "flash" moisture therefrom. This was a highly efficient and economical process, however, the pulp so-produced contained objectional "fisheyes" or fiber nodules that could not be dispersed during repulping and formed imperfections in subsequently formed paper. The instant invention provides improvements in such flash drying techniques whereby the aforesaid disadvantages are substantially eliminated and/or reduced.

SUMMARY OF THE INVENTION

The invention features an improved method of flash drying pulp whereby a reduction of fiber nodules and more uniform particle size is attained in a pulp bale. The invention also achieves lower bale moisture, better moisture control in a bale, easier replupability of the bales and allows the utilization of lower drying temperature with resultant reduction in the operating costs.

Generally, the invention comprises fluffing relatively high solid consistency stock, partially flash drying the fluffed stock, refluffing the partially dried stock and completely flash drying the fluffed stock. The dried stock is then converted into pulp bales as desired.

Accordingly it is an important object of the invention to provide an improved method of flash drying pulp stock.

It is another important object of the invention to provide a more economical flash drying system attaining better moisture control and easier repulpability of so-produced pulp bales.

It is yet a further object of the invention to provide a new and improved method of drying paper stock for pulp bale formation wherein relatively high solid consistency paper stock is fluffed, partially flash dried, refluffed and completely flash dried.

Other objects, features and advantages of the invention will become readily apparent from the following description of certain preferred embodiments thereof taken in conjunction with the accompanying drawings, although it will be apparent that variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an essentially diagrammatic three-dimensional flow chart illustrating certain principles of the invention;

FIG. 2 is an essentially diagrammatic flow chart illustrating certain additional principles of the invention;

FIG. 3 is a diagrammatic showing of a preferred form of a fluffing device utilized in the practice of the invention;

FIG. 4 is a diagrammatic showing of a preferred form of one of the attrition surfaces of the device of FIG. 3;

FIG. 5 is a diagrammatic showing of a preferred form of the other of the attrition surfaces of the device of the FIG. 3; and

FIG. 6 is an enlarged diagrammatic view showing the working relationship of a portion of the attrition surfaces of FIGS. 4 and 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, reference numeral 10 generally designates the improved flash drying system constructed and operated in accordance with the principles of the invention. Reference numeral 11 designates a stock storage chest or the like containing a supply of relatively high solid consistency paper stock Ps. The paper stock Ps is generally formed as a relatively low solid consistency slurry, i.e., having a solid consistency of less than 3 percent, which is dewatered, as by mechanical pressing, to increase its relative solid consistency to about 3 percent to 50 percent and suitably conveyed to the storage chest 11 in a conventional manner.

The dewatered, relatively high consistency stock (i.e., having a solids consistency in the range indicated) is then conveyed, as by a pump, screw conveyor, or similar means 11*a* suitable for transporting such stock slurries, to a fluffing device 12. The fluffing device works on the high consistency stock to substantially reduce its relative density, reduce the average sizes of the individual fiber bundles within the stock and cause a relative separation of the moist stock fibers so as to form a moist fluffy fiber mass. A preferred form of a fluffing device especially suitable for practice of the invention will be described hereinafter in greater detail, however, any fluffing device achieving the aforesaid results and capable of working on moist paper stock may also be utilized.

The moist fluffy fiber mass is then conveyed by a stream of hot gas, such as air, and transported from fluffing device 12 via conduit 12*a* to intermix with the stream of heated gas at a conduit 21*aa*. It will be noted that conduit line 21*aa* is in direct communication with conduit line 21*a* leading from a plenum device 21 and providing a supply of heat H to the conduit 21*aa*. As will be appreciated, appropriate fans or the like (not shown) may be positioned within the conduit lines 21*a*, 21*aa*, etc., to provide a necessary force to move the heated air and fluffing fiber mass to the desired location and to provide a turbulence or tumbling and intermixing action between the relatively loosely associated stock fibers and the heated air whereby evaporation begins to take place even as the fibers are transported along the conduit line 21*aa* to a further pumping station 12.

The pumping station 13, which may comprise a high volume, high-speed fan pump or the like, receives the intermixture of hot air and moist fluffy fiber mass and impels the mixture toward a dryer device 14 via conduit line 13*a*. As will be appreciated, evaporation takes place relatively rapidly since the stock fibers are fairly well separated from each other so that the hot air easily penetrates and contacts various individual fiber bundles. The dryer device 14 intermixes the fiber mass with the heated air to cause partial flash drying by evaporating moisture therefrom and thereby increase the solid consistency of the fiber mass to about 60 percent to 75 percent. The dryer device 14 may be of any suitable design and is preferably a flash drying tower wherein the fluffed stock fibers are caused to travel in intimate contact with heated air through a plurality of passageways therein at relatively high speeds so as to achieve a rapid liquid evaporation in a relatively short period of time.

After the fluffed stock fibers have been partially dried to the desired degree, they are conveyed by the heated air stream to a second fluffing device 22, via conduit lines 14*a* and 15*a*. A cyclone device is positioned between such lines to remove the vapor-ladened heated air and, if desired, means are provided to recycle such air to a heat exchange device (not shown) to ensure high thermal efficiency.

The fluffing device 22 performs work on the now partially dried and fluffed stock fibers to further decrease the density of the fiber mass and further reduce the average size of the fiber bundles so as to achieve a substantial uniformity thereof while simultaneously causing a greater degree of fiber separation for

ease of subsequent drying. The fluffing device 22 is somewhat similar to device 12 but is capable of producing a more intensified degree of fluffing and can be operated at lower power requirements as the material worked on has less inherent resistance to fluffing than a material worked on by device 12.

The extremely fluffed and partially dried fiber mass is then conveyed by a relatively hot air stream via conduit lines 22*a* and 23*a* to a second dryer device 24, with a fan pump means 23 positioned in line between the conduit lines to ensure sufficient air velocity to accomplish the transporting operation. It will be noted that the conduit line 22*a* merges with conduit line 21*bb* to allow fresh heated air and the like to be intermixed with the fiber mass. Of course, conduit line 21*bb* communicates with the heat supply H via conduit line 21*a*.

The dryer device 24 receives the intermixture of hot air and extremely fluffy and relatively uniformly sized fibers and completes the flash drying in a relatively short period of time. Since these fibers have been partially dried and preheated, the temperature requirements for dryer device 24 are lower than for dryer device 14. Thus, for example, dryer device 14 utilizes a heated air stream at a temperature in the range of about 500° C. to 650° C. and dryer device 24 utilizes a heated air stream at a temperature in the range of about 250° to 350° C. As indicated, the fibers at this stage are relatively of uniform average bundle size so that they are easily dried to a substantially uniform degree of dryness. As will be appreciated, the fibers have been sequentially passed through fluffing devices 12 and 22, both of which have performed work on the fiber mass to reduce the average fiber bundle size and achieve a uniformity in such bundle size. Of course, moisture removal is considerably easier from such finer sized and uniform fiber bundle, both of which factors materially contribute to the uniform removal of moisture from all portions of such fiber bundles.

The fluffy fiber mass is retained within the dryer device 24 for a relatively short period of time which is, however, sufficient to increase the fiber dryness to a solids consistency in the range of about 80 percent to 95 percent. The completely flash dried fluffy fiber mass is then carried by a stream of heated (and vapor-ladened) air via conduit line 24*a* to a cyclone device 25 for separation of the fibers from such air. Again, if desired, the exhaust air may be recycled for efficient thermal operation. From the cyclone device 25, the fibers drop through conduit line 25*a* to a fan pump means 26 where they may be intermixed with atmospheric air A for cooling purposes and then are passed via conduit 26*a* to a station for bale formation or the like.

Through extensive observations and experimentations, it has been found that the number of fisheyes, "nits," "frog-eyes," etc., i.e., hard fiber nodules that can not be eliminated during subsequent repulping, is substantially reduced during the practice of the invention. This is believed due at least in part to the double fluffing operation wherein better moisture removal, more uniform moisture distribution and smaller and more uniform fiber bundle sizes are achieved. Experimentation has shown that even retaining dewatered fiber stock for longer periods of time in a fluffing device before flash drying does not produce sufficient fluffing but rather appears to increase the number of fisheyes, etc., in the finished product, which in this case comprises a pulp bale which has been stored for a period of time. Further, these experiments have shown that lower amounts of moisture more uniformly distributed throughout the finished bale are achieved by the practice of the invention as compared to known flash drying techniques. Pulp bales having a lower moisture content that is more uniformly distributed throughout the bale, have a lesser tendency to form fisheyes during storage and are easier to repulp during subsequent paper making operations. From the foregoing observations and experimentations, it has been concluded that objectionable fisheyes and the like are formed during mechanical handling or working of moist or relatively moist fiber stocks which apparently causes such fibers to attain high degrees of interwining and association with each other and which later cannot be satisfactorily disassociated. In accordance with the invention, this problem is alleviated by providing controlled amount of work on the moist fibers, partially drying them and then performing additional amounts of work on the partially dried fibers to cause sufficient separation and fluffing thereof before completing the drying operation, whereby the number and size of fisheyes, etc., are substantially reduced and/or eliminated.

Referring now to FIG. 2 wherein a pulp-flash drying system 30 is diagrammatically illustrated, it will be noted that relatively low consistency paper stock Ps (i.e., having less than about 3 percent and generally around 2.5 percent solids) is suitably formed and conveyed to a stock chest 31 in a conventional manner. This lower consistency stock is then passed to a conventional thickener device 32 wherein an amount of the liquid (i.e., water) is removed and a consistency of the stock is increased to about 10 percent or more. The stock is then suitably conveyed to a dewatering station 33, here shown as comprising a pair of parallel dewatering presses 33*a* and 33*b* operating in a conventional manner to remove, as by mechanical pressing, additional amounts of water. The dewatering station 33 removes sufficient water to increase the stock consistency to up to about 50 percent solids. The dewatering presses 33*a* and 33*b* may be of any conventional design, such as centrifuge, screw, disk, roll or slurry-type press, all of which are well known in the art.

The relatively high consistency stock, which still contains appreciable amounts of moisture, is then conveyed, as indicated, to a fluffing device 34. The device 34 performs work on the stock to reduce the average fiber bundle size and provide a greater degree of separation between the fibers whereby more "openness" is introduced into the fiber mass and the density thereof is decreased. The work done by the fluffing device 34 also tends to raise the temperature of the stock in proportion to the amount of work done and further reduces the heat requirements of the drying systems utilized.

The fluffed moist stock is then intermixed with the moving stream of hot air H from a supply, not shown. It will be noted that atmospheric air A is mixed with hot air H to achieve temperature control in an economical manner. The stream of hot air transports the fluffed fiber mass to a drying tower 36. It will be noted that fan means 35 is operatively positioned along the transportation path to aid in moving the intermixture of fibers and air. The drying tower 36 causes a partial flash drying of the fiber mass to occur. The fibers spend only a relatively short period of time within the drying tower 36 since the intimate mixture of pulp fibers in heated air causes rapid but non-detrimental flash evaporation of moisture from the exposed fluffy fiber mass.

The partially flash dried pulp fibers exit from the drying tower 36 having a solids consistency of about up to 75 percent and are passed through. a cyclone 37 (although the cyclone may be bypassed if desired) where the vapor-ladened air is removed, and to a second fluffing device 44.

As indicated hereinbefore, the pulp fibers entering fluffing device 44 are of relatively low density and are fairly well disassociated or separated from each other. The fluffing device 44 performs work on this type of fiber mass and causes a further reduction in density thereof, attaining a greater disassociation and disintegrates any "oversized" fiber bundles and works on any fisheyes formed during the preceding operations. As indicated hereinbefore, fisheyes appear to result from certain entanglements of a minor proportion of fibers whereby relatively small but extremely hard or tight fiber bundles or nodules are formed. These fiber nodules tend to entrap moisture, etc., within their body and progressively become harder to disintegrate throughout a storage period. In other words, a "bonding," primarily of a mechanical nature, appears to occur during storage. However, in accordance with the invention, these types of fiber nodules are reduced in at least two ways. First, the second fluffing step immediately following the partial flash drying step works on any newly formed fiber nodules to disintegrate them and reduce their size so that they

are nondetrimental to subsequent paper formation. Secondly, the second fluffing step serves to further disassociate the various fiber bundles to provide a more uniform particle size thereof whereby better moisture removal is possible at the second drying step. As will be appreciated, pulp bales having a uniform lower moisture content, even if containing some objectionable fisheyes having a higher moisture content, will tend to equalize moisture levels throughout the bale and necessarily remove, as by diffusion, capillary action, etc., the moisture from the fisheyes and distribute it throughout the other portions of the bale. In this manner the fisheyes fail to achieve the necessary degree of hardness or bonding to resist repulping during subsequent paper making.

Referring back to FIG. 2, after the pulp fibers have been refluffed by device 44, they are again intermixed with a moving hot stream of air and passed by a fan means 45 to a second drying tower 46. It will be noted that the air stream comprises a mixture of heated air H and atmospheric air A and appropriate regulating devices (not shown) in the various conduit passageways may be provided to achieve desired temperature ranges. The drying tower 46 finishes flash drying the fluffy pulp fibers and removes, as by evaporation, additional amounts of moisture from the "open" pulp fibers. As indicated hereinbefore, it is considerably easier to achieve the desired degree of uniform dryness, i.e., 80 percent to 95 percent A.D., when the pulp fibers have been fluffed and partially dried. Consequently, lower drying temperatures are utilized to achieve the dryness required and reduce the operating expenses.

From the drying tower 46 the fluffy and uniformly dried pulp fibers are passed to a cyclone device 47 for removal of vapor and recoverable heat. The fibers are then mixed with atmospheric (i.e., unheated but preferably at controlled humidity) air A., as shown, to cool the fibers and pass them via fan means 47*a* to a cooling station 48 having a pair of parallel cyclones 48*a*. The station 48 removes a major portion of air from the pulp fibers and allows the fibers to drop to a sheet press or like device 49. The fibers are allowed to accumulate in their relatively loose and fluffed state until a certain thickness is achieved and then a ram means 49*a* is caused to compact the loose fibers into a pulp bundle 49*b*. A plurality of such pulp bundles may then be stacked one on the other and suitably compressed or bound into pulp bale B which is then stored for repulping, shipping and the like.

Referring now to FIGS. 3 through 6 wherein certain details of a preferred embodiment of a fluffing device 50 are illustrated. The fluffing device 50 has a suitable housing 50*a* defining a fluffing chamber 50*b* having a relatively large upwardly facing opening 51*a* for the introduction of fibrous materials. The upwardly facing opening 51*a* is open to atmosphere. Within the fluffing chamber 50*b* and supported from the upper wall 51 thereof is an upper defibrating and fluffing disk or stator 54 having an attrition surface 55 thereon. Also within the fluffing chamber 50*b* a lower fluffing disk or rotor 56 is provided having a suitable attrition surface 57 thereon. The upper defibrating and fluffing disk 54 is relatively stationary, while the lower defibrating or fluffing disk 57 is mounted for rotation, as by motor means 58 whereby opposed close running attrition surfaces are provided.

The attrition surfaces 55 and 57 define therebetween a distribution zone 63, an initial fluffing zone 65 and final fluffing zone 66 as indicated schematically in FIGS. 4 and 5. For sake of convenience the various zones and the working edges defining such zone will be referred to by identical reference numerals. The central portion of the rotor 56 is somewhat conically shaped and extends upwardly through the upper disk 54 to define a guide surface 59 for uniformly distributing the fibrous mass throughout the zone 63. The guide surface 59 may consist of a generally conically shaped member having a plurality of radially extending distributing vanes 63 attached thereto. The vanes 63 extend generally downwardly along the conical portion of the conical member and direct the fibrous material toward the entrance portion of the zone 63. The guide surface 59 thus supplies substantially uniform amounts of material to each circumferential section of the entrance portion of zone 63. It is important that distribution be as even as possible, since with uneven circumferential distribution, the fibrous material must be retained within the fluffing device for substantially longer periods of time, thus resulting in undue mechanical damage and/or work to individual fiber bundles leading to the formation of excessive fisheyes. The distribution zone 63 is in open communication with the entrance portion 51*a* of the defibrating device and entrance portion 51*a* is in open communication with ambient atmosphere. In this manner pressure buildup is avoided and individual fiber bundles can be worked on by the fluffing device 50 without causing them to entangle with one another and form fisheyes and the like. The distribution zone 63 may consist of a plurality of radially extending bars or work edges 63 mounted on inner annular portions of upper and lower stator 54 and rotor 56 respectively. This material distribution zone is relatively wide at its entrance portion and gradually decreases in width in a radially outward direction. The material distribution zone 63 is in open communication with the guide surface or zone 59 and is thus likewise continuously vented to ambient atmosphere. As the fibrous material leaves the distribution zone in a radially outward direction, it enters into the initial fluffing zone 64 which consists of a plurality of generally parallel grooves and ridges (i.e., radially aligned work edges) mounted on opposed intermediate annular portions of the upper and lower stator and rotor respectively. The entrance portion of the initial fluffing zone 64 is in open communication with the material distribution zone 63 and is thus continuously vented to ambient atmosphere.

As the fibrous pulp material leaves the initial fluffing zone in a generally radially outward direction, it is forced into a final fluffing zone 66 defined by opposed outer annular portions of said upper and lower stator and rotor respectively. The final fluffing zone 66 consists of radially extending angularly spaced grooves and ridges mounted on said upper and lower outer annular portions of said stator and rotor respectively. From the final fluffing zone 66 the fibrous material is thrown radially outwardly into the chamber 50*b* from which it is removed through an exit port 62, which is preferably tangential to the housing 50.

A chemical such as lime, or other suitable agents for pulp preparations may be readily supplied at the entrance portion 51*a* if desired. Preferably any such addition takes place at the second fluffer, i.e., 22 or 47. While the following discussion describes attrition surfaces utilizing bar or vane type work edges, teeth type edges can also be used and are somewhat similarly distributed over the opposite attrition surfaces 55 and 57.

In operation, the fibrous, dewatered pulp material is continuously deposited into the vented guide zone 59 whereby the material is uniformly guided throughout the continuously vented distribution zone 63. In the distribution zone 63, the larger fiber bundles are reduced to a size approximating the average bundle size of the mass and at this point an initial rise in temperature of the fibrous material occurs, due to the mechanical working action of the breaker bars in the distribution zone. From the distribution zone 63, the fibrous material is continuously fed to a continuously vented initial fluffing zone 65 defined by opposed close-running attrition surfaces 55 and 57. In the initial fluffing zone 65, the material is subjected to mechanical rubbing and rolling action under controlled conditions of temperature and pressure. More specifically in the initial fluffing zone, the attrition surfaces impart a mechanical action to the fibrous materials thus rapidly raise the temperature of the mass and cause a fiber separation thereof. Due to the sudden rise in temperature of the fibrous mass, a relatively large amount of steam is created which is permitted to rapidly escape through the open spaces between various fiber bundles in the distribution zone. The rapid escape of steam from the initial fluffing zone avoids the creation of back pressure in the zone and thereby substantially in-

crease the uniformity of material feed into the fluffing zone resulting in increased uniformity of material. By continuously venting the fibrous mass in the initial fluffing zone to ambient atmosphere, substantial increases in quality, with less fisheye formation is provided. Allowing the steam to rapidly escape from the initial fluffing zone positively controls the temperature within the zone at a desired level so that the natural bonding agents holding the individual fiber bundles together are plasticized and softened under optimum conditions whereby the fibrous materials are separated in individual fibers. The individual fibers are obtained through the mechanical action of the opposed close-running attrition surface in the initial fluffing zone. The development of such fibers allows the attainment of characteristics whereby such fibers can intermesh with one another during subsequent paper making formation to produce high quality paper. It is extremely important to provide such developed fibers so as to obtain the multiplicity of finer fibers or fibrils extending therefrom which, however, are not intermeshed with one another by the work performed by fluffing device **50**.

As shown in somewhat greater detail in FIGS. **3** to **5**, the initial defibrating zone **65** is designated in such a manner that the bars or work edges of the upper stationary plate **54** are spaced substantially close together and are of substantially smaller width than the opposed bars of the lower rotating disk **56**. In this manner superior control of both temperature and retention time is provided, because the amount of mechanical action on the fiber stock is substantially reduced while the fiber action within the fiber bundles is increased. During the initial stages of operation, the grooves **74** and **74***a* (best seen in FIG. **6**) of the upper and lower disks respectively are filled up with fibrous materials F which remain in the grooves during the operating life of the disks. With the grooves thus filled with fibrous material, the opposed disk surfaces become relatively flat and present to each other alternating surfaces of a hard metal followed by resilient fibrous material. A bundle of fibers traveling rapidly and circumferentially through the intermediate zone is thus subject to mechanical treatment between opposed fibrous surfaces. By increasing the widths of the fibrous surfaces and metal surfaces of the lower defibrating disk to approximately twice the width of the respective surface of the upper defibrating disk, the fiber defibrating action is substantially increased while the metal to metal action on the fiber bundles is decreased. This advantageous result is in part due to the fact that the fiber bundles progress or roll faster between opposed metal surfaces than between two opposed fibrous surfaces. A retention time between opposed metal surfaces is thus substantially reduced. The friction time between opposed metal surfaces is thus substantially reduced. The friction between the fibrous surface is substantially higher than the friction between the metal surfaces as a consequence the retention time between the latter surfaces is substantially larger. Furthermore, the fibrous surfaces are somewhat resilient and tend to embed the fiber bundles thereby adding to their retention time. By providing the rotating disk with a courser pattern, an individual fiber bundle tends to travel with the rotating disk rather than adhere to the stationary disk and thus markedly increase the fluffing efficiency of the device. The resiliency of the fibrous material F in the grooves **74** and **74***a* will cause the fibrous material to pulsate due to the operating fluid pressure between the plates as the metal ridges **73** and **73***a* pass over their respective grooves. For example, a ridge **73***a* over a groove **74**, the fibrous material therein will be depressed, thus presenting a somewhat concave fibrous surface to the ridge **73***a*. On the other hand, the concave surface will change to a convex surface when the groove **74** of the upper plate is facing the groove **74***a* of the lower plate.

The final fiber bundle disintegration and fluffing, as well as development of the individual fibers, is attained by feeding such fibers to a final fluffing zone **66** defined by the outer annular portions of the close-running attrition surfaces **55** and **57**. In this final fluffing zone **66**, the individual fibers are subjected to abrasive action whereby they are fibrillated and softened while maximum fiber length and separation is achieved. The amount of mechanical work put into the fibrous material at any point within the fluffing device is readily controllable by varying the consistency of the pulp stock, the spacing between the attrition surfaces or by the power input to the fluffing device. The radial spacing of the breaker bar or work edges on the attrition surfaces provides an elongated but annularly irregular path of travel for the fibers whereby they are fluffed and disintegrated in substantially uniform fiber size without intermeshing or entangling with each other to form fisheyes and the like. Thus, the instant device is extremely useful in the practice of the invention since it is the positive means of preventing intermeshing of the individual fibers to form the objectional fiber nodules.

In summation, it will be seen that the invention provides a new and improved method of producing dried pulp suitable for storage and repulping for subsequent paper formation comprising dewatering a pulp stock, fluffing the dewatered pulp stock to decrease the density thereof and cause the relative separation of the stock fibers to form a fluffy mass thereof, subjecting the fluffed fiber mass to a heated gas stream to partially dry the stock, refluffing the partially dried stock to further decrease the density thereof and then subjecting the partially dried fluffed stock to a further gas stream for final drying whereby pulp having a relatively low fiber nodule count is provided that is well suitable for storage and repulping.

I claim as my invention:

1. In a method of producing dried pulp suitable for storage and repulping for paper formation, the steps comprising (1) dewatering a pulp stock, (2) fluffing the dewatered pulp stock to decrease the density thereof and cause a relative separation of the stock fibers therein to form a fluffy stock mass, (3) subjecting the fluffed stock mass to a heated gas stream to partially dry said stock, (4) refluffing the partially dried stock to further decrease the density thereof and cause additional separation of the fibers therein, and (5) subjecting the fluffed partially dried stock to a heated gas stream for final drying whereby a relatively low fiber nodule count is provided within the dried stock.

2. The method as defined in claim **1** wherein the heated gas stream at step (5) is at a lower temperature than the gas stream at step (3).

3. The method as defined in claim **1** wherein steps (2) and (4) comprise passing dewatered stock between opposed close-running attrition surfaces having opposed elongated working edges in a radial plane along said surfaces and being angularly irregularly displaced from one another at different radial positions along said surfaces.

4. In a method of producing flash dried pulp bales, the steps comprising (1) providing a relatively low solid consistency fibrous stock, (2) increasing the solid consistency thereof to about 3 percent to 50 percent, (3) fluffing said stock to reduce the average fiber bundle size therein and reduce the average density of said stock, (4) intermixing said fluffed stock with a stream of heated air to evaporate moisture therefrom and increase the solid consistency thereof to about 60 percent to 75 percent, (5) refluffing said stock to further reduce the average fiber bundle size therein, (6) intermixing said fluffed partially dried stock with a stream of heated air to evaporate moisture therefrom and increase the solid consistency of about 80 percent to 95 percent and (7) converting said stock to pulp bales.

5. A method of producing a flash dried pulp bale suitable for storage and repulping comprising, (1) providing a pulp stock having a solids consistency of about 3 percent to 25 percent, (2) fluffing said stock between opposed close-running attrition surfaces having opposed working edges in a radial plane along said surfaces for reducing the average fiber bundle size while preventing intermeshing of fibers to produce a fluffed nonmeshed fibrous mass, (3) intimately mixing said fibrous mass with a stream of air at a temperature causing flash evaporation of moisture and removing vaporized moisture from said mass to achieve a solids consistency of about 60 per-

cent to 75 percent, (4) refluffing said stock between opposed close-running attrition surfaces having opposed working edges in a radial plane along said surfaces for reducing the average fiber bundle size while preventing intermeshing of fibers to produce a fluffed nonmeshed fibrous mass, (5) intimately mixing said fibrous mass with a stream of air at a temperature below the aforesaid temperature but sufficient to cause flash evaporation of moisture and removing vaporized moisture from said mass to achieve a solids consistency of about 80 percent to 95 percent and (6) converting said mass to a pulp bale.

6. The method as defined in claim 4 wherein a chemical suitable for pulp preparation is added to the fluffed stock at the beginning of step (5).

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