

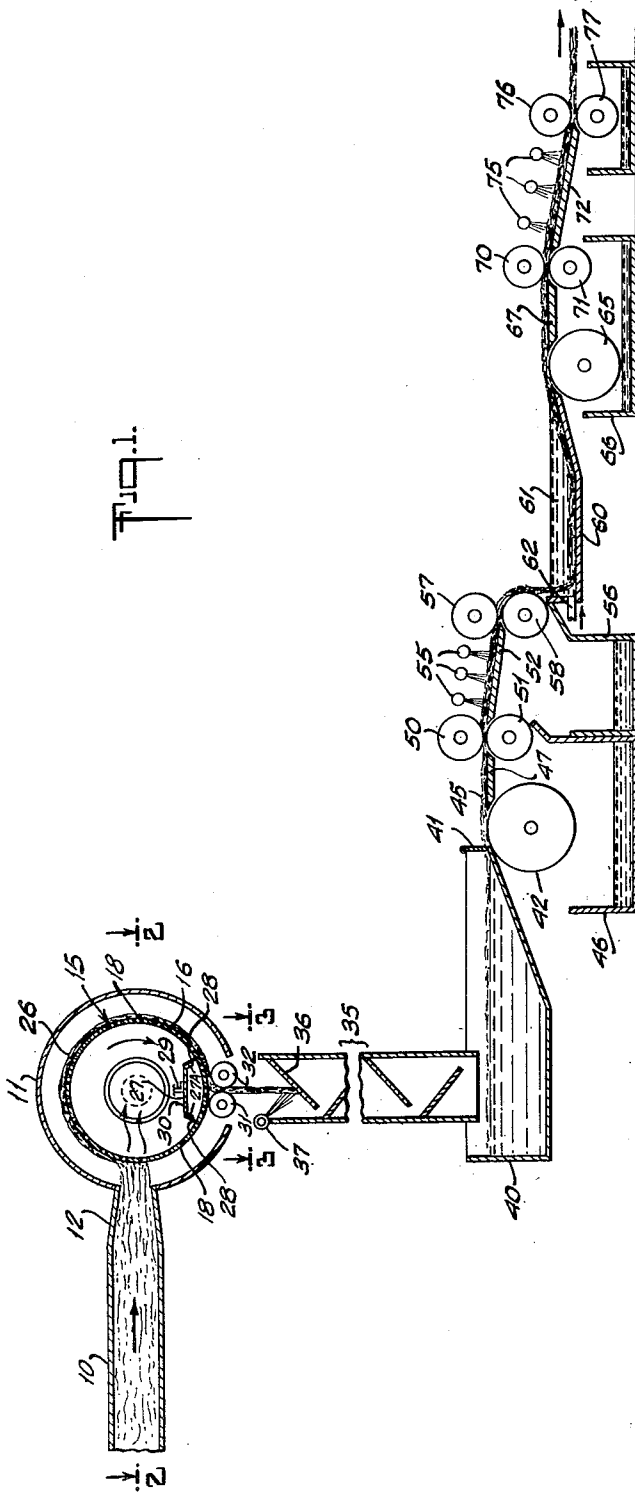
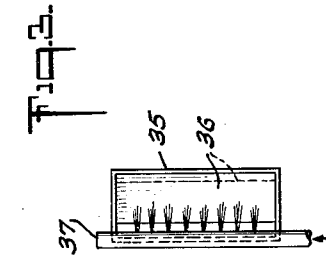
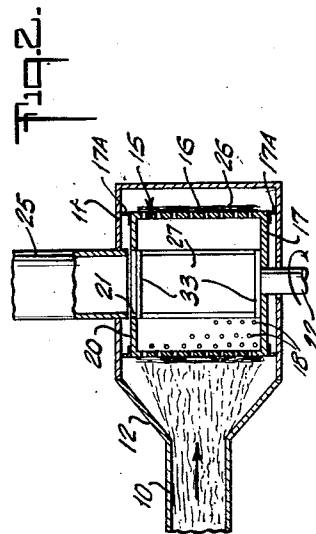
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APPARATUS FOR CONTINUOUS TREATMENT OF FIBERS

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APPARATUS FOR CONTINUOUS TREATMENT OF FIBERS

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This invention relates to chemical processing of textile fibers and, in particular, to continuous treatment of cotton which has previously not undergone any chemical processing.

Cotton contains many impurities such as natural waxes located almost entirely on the outside surface of the fibers. These waxes make the cotton water repellent and hence, in order to produce absorbent cotton it is necessary to effect their removal. This has been done for many years by the well-known batch process which involves kier boiling of the cotton in large vats or kiers for several hours in dilute caustic solution. Caustic treatment is sometimes known as scouring. The caustic treatment, in which steeping and agitation occur simultaneously, effects loosening of the natural water repellents. It is followed by draining the kier, removing the cotton from the kier, washing with water to effect removal of impurities from the fiber surfaces, followed by wringing, then bleaching with, e. g., hypochlorite solution, wringing again, souring with a dilute solution of acetic acid, wringing, washing with water, wringing again, and finally drying.

Various procedures operated more or less on a continuous basis have been suggested for facilitating and economizing on the old kier loading technique, which is quite expensive from the standpoint of both time and equipment. The operations in the suggested procedures are characterized by the formation of a relatively thick bat of fibers, in passing the bat through a series of sprays, tanks, etc. with squeeze rollers located between the various steeping means to restrain carry-over of liquid from one stage to the next. These continuous methods have enjoyed various degrees of success, but in every case it has been impossible or impractical to effect uniform thorough treatment and removal of water-repelling impurities from the cotton. The resulting products have been found to contain zones of fibers having appreciable amounts of water-repelling impurities, which zones are not water absorbent as desired, and which products do not meet the requirements for high grade absorbent cotton. A further characteristic of the proposed continuous methods has been that they effect at best merely loosening of the impurities on the surfaces of the fibers but not transfer of these impurities into the solution. In order to remove impurities from the fiber surfaces uniformly and to the desired degree of completion, it has been necessary to rely upon subsequent washing operations which follow removal of the treating liquid from the fibers.

As of the time this invention was made, therefore, it was not possible to prepare high grade absorbent cotton by any feasible method without utilizing the old time-consuming batch kier loading process.

The advantages of the present invention include the provision of a continuous, rapid and easily controlled process for chemical treatment of textile fibers which will produce a high quality end product comparable to that of the more time consuming batch process.

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A further advantage is the provision of a method which will afford rapid, effective and complete removal of impurities from textile fiber material and, in particular, the removal of waxes and other impurities from the surface of cotton.

An additional advantage of the invention is that apparatus is provided for carrying out the novel method.

A further advantage is that the requirement for procedures following agitation and steeping in the presence of the chemical agent is minimized.

Other advantages of the invention will become apparent with reading of the following description.

The invention provides method and means for realizing the foregoing advantages, by depositing uncompressed textile fibers carried by a gas stream, in a thin, uniform layer over a solid surface, removing the layer from the surface without otherwise changing it, and subjecting the so removed layer to strong agitation in a chemical processing liquid. Contact between fibers and liquid is thereafter continued in a zone in which the liquid washes past the fibers with relatively little agitation for time sufficient to complete the interaction with the liquid, followed by removal of most of the liquid from the fibers. A notable feature of a particular embodiment of the invention, in which impurities such as natural waxes are removed from the cotton, is that the impurities are transferred substantially completely into the liquid phase during the agitation and steeping steps so that subsequent wringing out of liquid from the fibers effects removal of impurities without the need for washing.

The invention and various modifications of the invention will be more readily understood from a consideration of the ensuing discussion read and understood in conjunction with the attached drawings in which:

Fig. 1 is a side elevation view of continuous cotton processing apparatus according to the present invention;

Fig. 2 is a horizontal section of a part of the Fig. 1 apparatus taken along plane 2—2;

Fig. 3 is a sectional view of a portion of the Fig. 1 apparatus taken along plane 3—3 of Fig. 1.

Reference number 10 indicates a straight length of conduit leading toward condensing chamber 11. Conduit 10, near chamber 11, is flared out at 12 so that where it enters chamber 11 the conduit width is substantially coextensive with the axial length of rotating drum 15 mounted within chamber 11. A dispersion of fibers in a moving stream of air or other suitable gas, for example, about 1/3 to 1 1/3 pounds of fibers per 100 cubic feet of air, passes from left to right as shown through conduit 10 and enters chamber 11 through conduit section 12.

Rotating drum 15 is provided with a foraminous peripheral cylindrical surface 16, an impervious end plate 17 and a second end plate 20 provided with opening 21. Circumferentially disposed sealing members 17A are secured to end walls 17 and 20 to seal off to air flow the spaces between walls 17 and 20 and the adjacent end walls of chamber 11. Drum 15 is supported by rotating shaft 22, which in turn is supported and driven by means not shown. Cylindrical surface 16 is provided over its entire area with small closely spaced holes 18 in size and number suitable to permit flow of air but prevent the passage of fibers. The air from duct 10 must pass through these small holes and thence through opening 21 in plate 20 into induced draft exit conduit 25, since there is no other avenue of escape from chamber 11 for the air. The fibers, however, collect as a very thin layer 26 on external cylindrical surface 16. Fiber layer 26 is substantially coextensive in width with foraminous cylindrical surface 16. As the thickness of fiber layer 26 on surface 16 builds up, it is moved away from the opening in conduit section 12 thereby to keep this thickness very small. It will now be seen that the thickness of web 26

will be determined by the density of the fiber-air dispersion entering through conduit 10, the air velocity, and the speed of rotation of drum 15. These three variables are controlled to limit the thickness of the web 26 to not substantially greater than about 3 grains per square inch, preferably not greater than about 1 grain per square inch. In practice, web thickness of about 0.3 grain per square inch has been found particularly advantageous.

It is also important for invention purposes that web 26 be uniform in thickness and density. In other words, it must be substantially free of lumps or dense spots caused, for example, by an undesirably large agglomerate being deposited from the air stream in conduit 10 onto surface 16. By "uniform" density, it is meant that web 26 contains no spots or lumps which have local density greater than the 3.0, preferably 1.0, grains per square inch specified. Any such fiber agglomerate suspended in the air stream in conduit 10 may be deposited on surface 16 so that its minimum cross-sectional dimension is parallel to surface 16, and this condition might be particularly disadvantageous for present purposes, in that it might cause a dense or thick area that would interfere with uniform and thorough treatment of the local fibers in subsequent processing. Hence, fiber agglomerate size is preferably controlled so that density in grains per square inch measured in the plane of the critical minimum cross-sectional area is no greater than the sought for maximum density of web 26, that is, 3.0 grains per square inch, preferably 1 grain per square inch or less.

The agglomerate size is a function of the degree of openness and dispersion of the fibers. The openness of fibers required for invention purposes may be obtained by feeding a bat or web of the fibers to the surface of a rotating drum composed of a plurality of disks having teeth disposed around their peripheries. Means are also provided which, in cooperation with these teeth, serve to pull the fibers apart and away from the original web or bat. These cooperating means may be stationary bars or teeth placed close to the rotating cylinder, or they may be teeth on a second cylinder closely spaced and parallel to the first and rotating in the same direction. Fibers having the openness of uncompressed ginned cotton are suitable. Various types of apparatus adapted to open cotton to the extent required for invention purposes are disclosed in U. S. P. 2,365,793 and 2,569,501. The apparatus illustrated in the first patent is known as the "Southern Regional Laboratory Opener" and it is particularly suitable. The fibers from the opening operation are dispersed in an air stream produced either by the motion of the opening apparatus itself or by supplemental blowers, and the stream is introduced into duct 10 for transfer to condensing chamber 11.

After web 26 has traveled for a distance on cylindrical surface 16, it will be built up to its maximum thickness and therefore be ready for removal. Removal is accomplished by cooperating action of air cut off plate or shoe 30 and rotating rolls 31 and 32. Plate 30 is formed of a chordwise disposed portion 27 and two terminal radially disposed portions 27A. Plate 30 is attached to bracket 29, which in turn is secured to a stationary support, not shown. Secured to the radial portions 27A are radially extending rubber strips 28, the one edge of which rubs against the interior cylindrical surface 16 of drum 15. Both terminal portions of plate 30 are provided with sliding seals 33 which, in cooperation with rubber strips 28, cut off the vacuum inside cylinder 15 from the inward end of holes 18, thereby terminating the positive holding force between web 26 and surface 16. Roll 32 rotates at about the same peripheral speed as cylinder 15, and roll 31 rotates about 1 to 2% faster than the peripheral speed of cylinder 15. Roll 31, therefore, tends to sweep web 26 from surface 16.

The web is thereafter dropped directly into the top open end of vertical loading conduit 35. The width of conduit 35 measured in the direction parallel to the sur-

face of web 26 is substantially greater than the width of the web so as to avoid insofar as possible contact of fibers with the ends of the conduit. Further, the thickness of conduit 35 as measured in the direction perpendicular to the surface of the web is uniform over the extent of the web width. The rectangular conduit shown is readily fabricated, meets the specifications, and hence is preferred. Loading conduit 35 is provided with baffles 36. The baffles are oppositely placed in staggered relation in the conduit and inclined toward the conduit outlet. Liquid treating material, preferably containing a wetting agent, is introduced through manifold 37 and sprayed at high velocity in a plurality of individual fine streams or a uniform sheet onto web 26 and top baffle 36. The liquid stream or streams impinging on the fibers on the first baffle produces violent agitation which affords a substantial amount of the scrubbing action necessary for satisfactory treatment of the fibers. The treating agent temperature is sufficiently high to effect rapid reaction with fiber impurities (at least 190° F. for scrubbing cotton with ½ to 5%, preferably 2% aqueous NaOH) but low enough to avoid excessive steam formation (i. e., not above about 210° F.), which steam might condense on cylinder 16 and/or rolls 31 and 32 thereby to interfere with the formation and removal of web 26. The action of the treating liquid in cooperation with the baffles produces violent agitation of the fibers in the presence of the treating liquid and thereby brings about a scouring and scrubbing action on the individual fibers to effect loosening and some removal of impurities such as natural waxes located on the outside surface of cotton fibers. The amount of liquid, which is greatly in excess of weight of fibers, is controlled to produce this sought-for scrubbing. Preferably the reagent is fed at the rate of about 70 pounds of liquid for 1 pound of fibers. Agitation is continued by repeated impinging of the fiber-liquid suspension stream from the edge of one baffle onto the next subjacent baffle until finally the stream falls into holdup tank 40. The uniform conduit thickness materially assists in maintaining uniform distribution of liquid over the conduit width during the whole course of flow of liquid down through the conduit, thereby insuring thorough treatment of every fiber.

A notable feature of the invention is the fact that the large volume of air used to convey the loose fibers and deposit them on moving surface 16 has been removed from web 26 as the latter enters loading conduit 35. This is a particular advantage, since excessive quantities of gases passing through conduit 35 would tend to cool treating liquid unduly and thereby impair the scrubbing action of the liquid on the fibers.

Holdup tank 40 is preferably designed so as to retard movement of fibers but permit liquid to pass on through the fibers at a greater rate and leave the tank. With this object in view, tank 40 is made deeper at its inlet end and is provided with a gradually sloping bottom so that it becomes progressively shallower at its outlet end. It is also provided with a pivotally-mounted gate 41 which is yieldingly held in a closed position by gravity so as to produce the desired restraining of fiber motion with relatively easier movement of liquid. Fibers are retained in tank 40 for time sufficient to complete the interaction between processing liquid and fibers. The length and depth of the tank are governed accordingly. The size of the tank and holdup time are also governed to some extent by the velocity of liquid flow past the fibers, higher velocity making possible smaller tanks and shorter holdup times. In scouring of raw cotton with hot caustic soda solution, treatment may be accomplished with a residence time of about 2 to 10 minutes. That is, each increment of fibers is soaked in tank 40 for this length of time. A notable feature of the invention is that by following the procedure outlined, namely, subjecting individual fibers in the form of a thin web to intense agitation and scouring in the presence of treating liquid followed by soaking, impurities present on the surface of the fibers are not only loosened

but are substantially completely transferred from the surface of the fiber into the solution so that subsequent treatment of fibers is simplified, as will hereinafter appear.

At 42 is shown a perforated drum which rotates slowly so as to accumulate on its surface a bat 45 of fibers which is now relatively thick, as compared with web 26. Excess free liquid carried with the fibers from tank 40 drains off through the drum perforations into tank 46. The thickness of the bat is controlled by the speed of rotation of drum 42. Bat 45 travels over slightly inclined guide surface 47 into the nip between mangle rolls 50 and 51. The pressure between rolls 50 and 51 is set to squeeze out most of the impurity-containing liquid. This should be accomplished before liquid has had an opportunity to cool appreciably, since such cooling may result in return of impurities from the solution to the fiber surface. The squeezed bat preferably contains about 100% moisture on a dry basis.

At this stage in the operation the fibers themselves are substantially pure, and the only impurities present are those in solution in the treating liquid still adhering to the fibers. Accordingly no washing or rinsing is, strictly speaking, required, and the bat may, if desired, be introduced directly into the bleach solution. However, as a precautionary measure, washing with water prior to bleaching is preferred, and this is accomplished by passing bat 45 over guide surface 52 while impinging thereon multiple streams of water from manifolds 55. Spent wash water is collected in tank 56. The soaked web enters the nip between mangle rolls 57 and 58, where the bat is again squeezed and excess water expelled to the extent of about 100% water, dry basis, remaining on the fibers. Bleach tank 60, containing suitable bleaching solution 61, such as sodium hypochlorite, receives bat 45 at its inlet end. Bleach solution is introduced into tank 60 through inlet pipe 62, which may be two or more in number and uniformly spaced at the inlet end of tank 60. The amount of bleach solution introduced through pipe 62 and the depth of the pool 61 of bleach solution in the tank is sufficiently shallow so that the fiber bat 45 is carried along through the tank by the flow of liquid. The bat passes with the liquid stream up inclined bottom of the discharge end of tank 60 onto the moving surface of rotating drum 65, which is similar in construction to drum 42. Excess liquid drains off through perforations and is collected in tank 66. The bat thereafter passes over slightly inclined guide surface 67 into the nip between mangle rolls 70 and 71, where all but about 100% water, dry basis, is squeezed out of the bat. The pressed bat passes down inclined surface 72, where multiple sprays of dilute aqueous acid solution or "sour" solution from manifolds 75 are impinging thereon to neutralize and wash out any excess alkali and remove any residual bleach remaining in the bat. Sulfuric or other mineral acid, or acetic acid, may be utilized. After being pressed between mangle rolls 76 and 77, the bat then may be washed again with water to remove residual acetic acid and dried in equipment not shown.

Although the foregoing description has been presented in terms of treating raw cotton, the invention principles may be applied to treatment of other fibers, and hence the scope of protection is not limited to treatment of cotton fibers merely. It is similarly true that the invention is not limited to use of caustic soda solution as a treating and scrubbing liquid for the fibers, since other liquid processing agents may be substituted within the

scope of the present invention. A further modification comprises the use of agitating means other than the loading conduit described, although the latter affords advantages not otherwise obtainable, and hence is preferred.

Other modifications and equivalents will be apparent in the light of the foregoing specific illustration of the invention, and hence the scope of patent protection asserted is to be limited only by the appended claims as interpreted in view of the prior art.

The claims are:

1. Apparatus for continuously treating textile fibers comprising a straight conduit for conveying a suspension of fibers in a gas, a condensing chamber communicating with said conduit, a movable foraminous solid surface in said condensing chamber, means for withdrawing gas from the opposite side of said foraminous solid surface, means for removing said fiber layer from said foraminous solid surface, a substantially vertical loading conduit disposed subjacent said condensing chamber in position to receive said removed layer, said conduit having substantially uniform cross sectional area, a width substantially greater than the width of said removed layer and a thickness substantially uniform over the extent of said layer width, means for continuously feeding liquid to the top of the loading conduit uniformly distributed over the width of said conduit, means for agitating fiber-liquid mixture within said conduit, and a container for fiber-liquid mixture communicating with the bottom of said loading conduit.

2. Apparatus of claim 1 wherein the foraminous solid surface is the surface of a cylinder adapted to rotate about its axis, the width of said cylinder is substantially equal to and coextensive with the straight conduit, the loading conduit is adjacent the bottom of the condensing chamber, the container is horizontally disposed, and said container includes means for restraining the flow of fibers therefrom while permitting relatively unrestricted flow of liquid therefrom.

3. Apparatus of claim 2 wherein the layer removing means comprises an axially disposed shoe adjacent a portion of the interior surface of said cylinder adapted to retard flow of gas through said portion, and roll means disposed outside said cylinder opposite said shoe and adapted to contact the fiber layer, and the liquid-fiber mixture agitation means is a series of baffles oppositely placed in staggered relation in the loading conduit, the baffles being inclined toward the outlets and being so spaced as to cause liquid flowing from one baffle to impinge directly upon the next baffle.

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