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PROCESS AND APPARATUS FOR TREATMENT OF TEXTILE MATERIALS

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FIG.2.

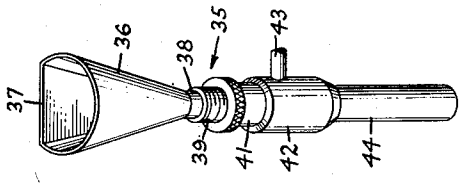
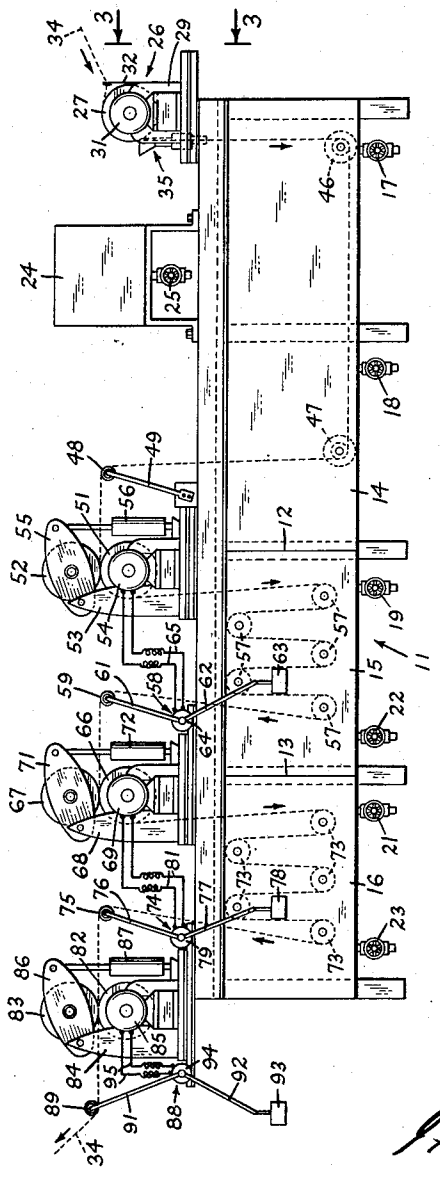


FIG.1.



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FIG. 4.

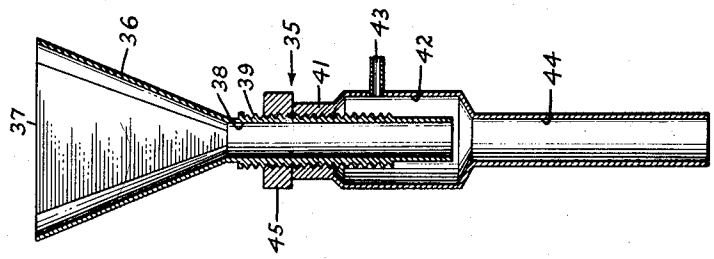
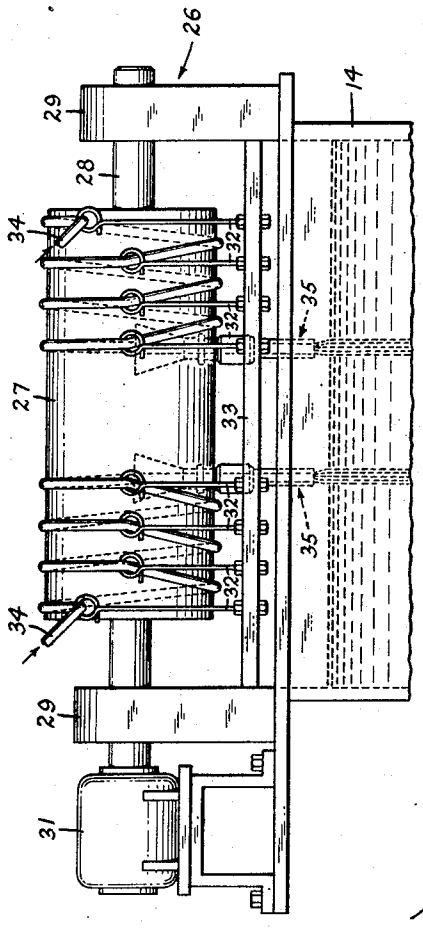


FIG. 3.



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PROCESS AND APPARATUS FOR TREATMENT OF TEXTILE MATERIALS

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Application October 6, 1950, Serial No. 188,816

4 Claims. (Cl. 8—151.2)

This invention relates to the treatment of textile materials and relates more particularly to a process and apparatus for the saponification of a tow of continuous filaments having a basis of cellulose acetate or other organic acid ester of cellulose.

It is a common practice in the textile industry to convert a tow of continuous filaments having a basis of cellulose acetate or other organic acid ester of cellulose into staple fibers and to spin said staple fibers, either alone or in admixture with other textile fibers, into yarns. To render these staple fibers more suitable for certain applications, it is desirable that the cellulose acetate or other organic acid ester of cellulose of which they are composed be partially saponified. The saponification may be effected by treating either the tow or the staple fibers with an aqueous saponification bath having an alkaline material dissolved therein. When the saponification bath is applied to the tow, which may contain from 100 up to 150,000 or more individual filaments arranged in substantially parallel manner, it is difficult to obtain a uniform wetting of, and a uniform access of the alkaline bath to all of the filaments with the result that the degree of saponification of the filaments will not be uniform throughout the tow. If the non-uniformly saponified filaments in the tow are converted into staple fibers and spun into yarns, textile fabrics produced from said yarns will exhibit an undesirable variation in properties.

It is an important object of this invention to provide an improved process and novel apparatus for the saponification of a tow of continuous filaments having a basis of cellulose acetate or other organic acid ester of cellulose which will be free from the foregoing and other difficulties.

A further object of this invention is to provide a process and apparatus for the saponification of a tow of continuous filaments having a basis of cellulose acetate or other organic acid ester of cellulose which will effect a substantially uniform saponification of all the filaments in the tow.

Other objects of this invention, together with certain details of construction and combinations of parts, will be apparent from the following detailed description and claims.

According to the present invention, a tow, comprising a bundle of individual filaments having a basis of cellulose acetate or other organic acid ester of cellulose and arranged substantially parallel to one another, is passed through a conduit having an internal diameter larger than the external diameter of the tow. Simultaneously, there is passed through the conduit, in the same direction as the tow, a stream of fluid which may be a liquid such as water, but which is preferably a gas such as air. As the tow moves through the conduit, the stream of fluid will cause the filaments in the tow to separate one from the other. The tow is then entered into a liquid saponification bath, suitably agitated if desired, wherein, owing to the separation of the filaments one from the other, all the filaments will be readily wetted and saponification of the cellulose acetate or other organic acid ester of cellulose will begin. The tow is then moved through the saponification bath under a tension insufficient to draw the individual filaments tightly one against the other so that the saponification bath will have access to all the filaments in the tow throughout the entire saponification period. If a higher tension is placed on the tow as it moves through the saponification bath, the said bath will not have ready access to the filaments located in the center of the tow and, as a result, the saponification of the filaments will be non-uniform. After the saponification of the cellulose acetate or other organic acid ester of cellulose has proceeded to the desired extent, the tow is washed to remove therefrom all traces of the saponification bath and of the products of saponification, following which the tow may be crimped, lubricated, cut and dried, or otherwise treated to prepare it for further use.

Suitable saponification baths that may be employed in carrying out the process of this invention include, for example, aqueous solutions of sodium or potassium hydroxides having a concentration of from about 0.1 to 25% by weight, to which solutions buffering salts such as sodium or potassium acetates may be added. The saponification baths may be employed at room temperature or they may be employed at elevated temperatures when it is desired to increase the speed of the saponification reaction.

The process and apparatus of this invention will now be described specifically in connection with the partial saponification of a tow of continuous filaments having a basis of cellulose acetate, which is commercially the most important organic acid ester of cellulose at the present time. It is to be understood, however, that this invention is also applicable to the treatment of other organic acid esters of cellulose, such as cellulose proprionate, cellulose butyrate, cellulose acetate-propionate and cellulose acetate-butyrate, for example. The process and apparatus of this invention may also be employed for effecting other liquid treatments on a tow of continuous filaments, such as, for example, the hydrolysis or complete saponification or dyeing of all the filaments in the tow.

A preferred embodiment of the apparatus of this invention is shown in the accompanying drawings, wherein

Fig. 1 is a side elevational view of the apparatus,

Fig. 2 is a perspective view, on an enlarged scale, of a tow opener employed in the apparatus shown in Fig. 1,

Fig. 3 is an end view, on an enlarged scale, of a portion of the apparatus shown in Fig. 1, and

Fig. 4 is a cross-sectional view, on an enlarged scale, of the tow opener shown in Fig. 2.

Referring now to the drawings, the reference numeral **11** designates generally an elongated tank which is divided by means of partitions **12** and **13** into a saponification compartment **14** and washing compartments **15** and **16**. A suitable saponification bath is entered into the compartment **14** through a valve **17** and may be drained therefrom through a valve **18**. Wash water is fed into the compartments **15** and **16** through valves **19** and **21**, respectively, and is drained therefrom through valves **22** and **23**, respectively. Positioned above the saponification compartment **14** is a storage tank **24** provided with a valve **25** through which a concentrated alkaline solution may be added continuously to the saponification bath so as to maintain the strength of said bath constant during the saponification.

Positioned at one end of the compartment **14** is a metering-roll assembly, indicated generally by reference numeral **26** and comprising a metering roll **27** mounted on a shaft **28**, which is journalled for rotation in standards **29**, and which is positively driven by means of a motor **31**. Guides **32**, fastened to a cross-bar **33** supported between the standards **29**, are located adjacent the metering roll **27** and serve to direct a pair of tows **34**, drawn from any suitable source (not shown), to form a number of wraps around the metering roll **27**. As the tows **34** leave the metering roll **27**, they pass through tow openers, indicated generally by reference numeral **35**, and into the saponification bath contained in the compartment **14** where the desired saponification of the cellulose acetate or other organic acid ester of cellulose takes place.

Each of the tow openers **35**, as shown in Figs. 2 and 4, comprises a funnel-shaped entrance passageway **36**, which is flattened along its surface **37** so that it will fit snugly adjacent to the metering-roll **27** and leads to a downwardly extending conduit **38** that is provided with external threads **39**. In engagement with the threads **39** is a fitting **41** comprising a fluid chamber **42** concentric

with and of larger diameter than the conduit 38 and to which a fluid under pressure is supplied from any suitable source (not shown) through a tube 43. The fluid chamber 42 leads to a conduit 44, which is of larger diameter than the tow 34 and which has its axis aligned with and is positioned below and slightly spaced from said conduit 38. The fitting 41 is held securely in place by means of a knurled lock-nut 45 in engagement with the threads 39. As the tows 34 pass through the tow openers 35, i. e. from the conduit 38 to the conduit 44 and through said conduit 44, the individual filaments therein will be separated one from the other by the action of the fluid flowing from the chamber 42 to and through the conduit 44. As a result, when the tows 34 reach the saponification bath contained in the compartment 14, the individual filaments will all be wetted quickly and the saponification thereof will begin immediately.

The tows 34 are guided through the saponification bath by means of rollers 46 and 47 positioned adjacent the bottom of the compartment 14. On leaving compartment 14, the tows 34 pass over a guide roll 48 rotatably supported at the upper ends of arms 49, and then between squeeze rolls 51 and 52 which remove from the tows 34 a portion of the entrained saponification bath. The lower squeeze roll 51, like the metering roll 27, is mounted for rotation in standards 53 and is positively driven by means of a motor 54. The upper squeeze roll 52 is mounted for free rotation in plates 55 pivotally fastened to the standards 53 and may be moved, to a position out of contact with the lower squeeze roll 51 to permit the tows 34 to be threaded between the squeeze rolls 51 and 52, by means of a hydraulic cylinder 56, one end of which is fastened to the standard 53 and the other end of which is fastened to the plate 55. The squeeze rolls 51 and 52 are advantageously maintained apart a distance sufficient to avoid imposing excessive pressure on said tows while they are wet with the saponification bath, which excessive pressure would tend to give the tows 34 and the filaments therein a harsh, unpleasant texture.

The tension on the tows 34 is kept at a minimum as they pass through the compartment 14 by adjusting the motors 31 and 54 so that the peripheral speed of the metering roll 27 is greater than the peripheral speed of the squeeze roll 51. As a result, the metering roll 27 will tend to feed the tows 34 into the compartment 14 at a faster rate than they are drawn from said tank by the squeeze roll 51. However, as the faster feed rate causes slack to accumulate in the tows 34, slippage will develop between the metering roll 27 and the said tows until the feed rate of the tows 34 into the compartment 14 is substantially equal to the withdrawal rate of said tows from said tank. This arrangement will maintain the tension on the tows 34 at a minimum and will automatically compensate for any changes in the length of said tows during the saponification thereof.

From the squeeze rolls 51 and 52, the tows 34 pass into and through the wash compartment 15, over guide rolls 57, and on leaving the wash compartment 15, pass over a dancer roll assembly, indicated generally by reference numeral 58. The dancer roll assembly 58 comprises a dancer roll 59 mounted on the upper end of an arm 61 which is secured to an arm 62 having a weight 63 depending therefrom. The arms 61 and 62 are fastened to and operate a speed control rheostat 64, which is connected by leads 65 to the motor 54. The dancer roll assembly 58 serves to maintain a uniform tension on the tows 34 as they pass through the wash compartment 15. Thus, as the tension on the tows 34 increases it will cause the dancer roll assembly 58 to rotate in a counterclockwise direction, raising the weight 63 and moving the rheostat 64 to increase the speed of the motor 54, thereby increasing the rate at which the tows 34 are entered into the compartment 15 and reducing the tension thereon. Conversely, as the tension on the tows 34 decreases, the weight 63 will cause the dancer roll assembly 58 to rotate in a clockwise direction, lowering the speed of the motor 54 and thereby decreasing the rate at which the tows 34 are entered into the compartment 15 and increasing the tension thereon.

From the dancer roll 59, the tows 34 pass between squeeze rolls 66 and 67 which bear one against the other and remove from the tows a portion of the entrained wash water. The lower squeeze roll 66, like the metering roll 27, is mounted for rotation in standards 68 and is positively driven by means of a motor 69. The upper squeeze roll 67 is mounted for rotation in plates 71 pivotally fastened to the standards 68 and may be moved, to a position out of contact with the lower squeeze roll 66 to permit the tows 34 to be threaded between the squeeze rolls 66 and 67 by means of a hydraulic cylinder 72, one end of which is fastened to the standard 68 and the other end of which is fastened to the plate 71.

The tows 34 then pass into and through the wash compartment 16 over guide rolls 73, and, on leaving the wash compartment 16, pass over a dancer roll assembly, indicated generally by reference numeral 74. The dancer roll assembly 74 is identical in construction and operation with the dancer roll assembly 58 and comprises a dancer roll 75 mounted on the upper end of an arm 76 which is secured to an arm 77 having a weight 78 depending therefrom. The arms 76 and 77 are fastened to and operate a speed control rheostat 79, which is connected by leads 81 to the motor 69 and which acts to control the speed of said motor so as to maintain a uniform tension on the tows 34 as they pass through the wash compartment 16.

From the dancer roll 75, the tows 34 pass between squeeze rolls 82 and 83 which bear one against the other and remove from the tows a portion of the entrained wash water. The lower squeeze roll 82, like the metering roll 27, is mounted for rotation in standards 84 and is positively driven by means of a motor 85. The upper squeeze roll 83 is mounted for rotation in plates 86 pivotally fastened to the standards 84 and may be moved, to a position out of contact with the lower squeeze roll 82 to permit the tows 34 to be threaded between the squeeze rolls 82 and 83 by means of a hydraulic cylinder 87 one end of which is fastened to the standard 84 and the other end of which is fastened to the plates 86.

The tows 34 leave the apparatus over a dancer roll assembly, indicated generally by reference numeral 88, identical in construction and operation with the dancer roll assembly 58, and comprising a dancer roll 89 mounted on the upper end of an arm 91 which is secured to an arm 92 having a weight 93 depending therefrom. The arms 91 and 92 are fastened to a speed control rheostat 94, which is connected by leads 95 to the motor 85 and which acts to control the speed of said motor so as to maintain a uniform tension on the tows 34. The saponified tows may then be crimped, lubricated, cut into staple fibers and dried or otherwise treated to prepare them for use.

The tows 34 may, if desired, be passed through tow openers, similar to the tow opener 35, as they enter the washing compartments 15 and 16 to facilitate the washing operation, and also after passing between the rolls 82 and 83 to facilitate drying. As the tows 34 leave the saponification compartment 14 and the washing compartments 15 and 16 they may be passed over vacuum extractors to assist in the removal therefrom of entrained liquids.

The following example is given to illustrate this invention further.

Example

A pair of 108,000 denier tows each containing 36,000 filaments of cellulose acetate having an acetyl value of 54.3%, calculated as acetic acid, is passed at a rate of about 18 yards per minute through the apparatus shown in the accompanying drawings. As the tows enter the apparatus, they are opened by a stream of air which flows through the tow openers and sink vertically into the saponification bath which is a 2% aqueous solution of sodium hydroxide maintained at a temperature of 85° C. and replenished to full strength by the continuous addition thereto of 1600 ml./min. of a 4% aqueous solution of sodium hydroxide. After being immersed in the saponification bath for about 13.4 seconds, the tows are entered into the wash compartments through which are passed 18 to 24 gallons per minute of water maintained at a temperature of 34 to 36° C. The washed tows have an average acetyl value of 42.5%, calculated as acetic acid, and are substantially uniform as evidenced by a cross-dyeing test with a dyebath containing a mixture of acetate and cotton dyestuffs.

It is to be understood that the foregoing detailed description is given merely by way of illustration and that many variations may be made therein without departing from the spirit of our invention.

Having described our invention, what we desire to secure by Letters Patent is:

1. Apparatus for the treatment of a tow of continuous filaments with a liquid bath, comprising a container for the treating bath, means for feeding the tow to and through said container for the treating bath, tow opening means for separating the filaments of the tow one from the other before they enter the treating bath and means for preventing the build up of sufficient tension in the tow as it passes through said container for the treating bath to cause the filaments of the tow to be drawn tightly one against the other, said tension control means comprising a feed roll for feeding the tow into said container for the treating bath, guide means for directing the tow to form a number of wraps around the feed roll, a roll for withdrawing the tow from the bath and means for driving said feed roll at a peripheral speed greater than the peripheral speed of said other roll.

2. Apparatus for the treatment of a tow of continuous filaments with a liquid bath, comprising a container for the treating bath, means for feeding the tow to and through said container for the treating bath, tow opening means for separating the filaments of the tow one from the other before they enter the treating bath, and means for preventing the build up of sufficient tension in the tow as it passes through said container for the treating bath to cause the filaments of the tow to be drawn tightly one against the other, said tow opening means comprising a first conduit, a second conduit of larger diameter than the tow spaced from the first conduit and having its axis aligned with the axis of the first conduit, through which conduits the tow is adapted to pass in succession, a fluid chamber concentric with and of larger diameter than said first conduit and leading to said second conduit, and means for introducing a fluid under pressure into said chamber whereby the fluid will flow from said chamber to and through said second conduit together with the tow, and said tension control means comprising a feed roll for feeding the tow into said container for the treating bath, guide means for directing the tow to form a number of wraps around the feed roll, a roll for withdrawing the tow from said container for the bath, and means for driving said feed roll at a peripheral speed greater than the peripheral speed of said other roll.

3. In a process for the partial saponification of a tow of continuous filaments having a basis of an organic acid ester of cellulose, the steps which comprise continuously passing the tow through a conduit having a diameter larger than that of the tow, passing a stream of air through said conduit concurrently with the top at a pressure and velocity sufficient to open the tow and separate the filaments therein one from the other, continuously entering the tow with its filaments in separated condition into an aqueous alkaline saponification bath, continuously drawing the tow with its filaments in separated condition through said bath, maintaining the tension on the tow as it passes through the bath below that which will cause the filaments to be drawn tightly one against the other, and removing the partially saponified tow from the saponification bath.

4. In a process for the partial saponification of a tow of continuous filaments having a basis of cellulose acetate, the steps which comprise continuously passing the tow through a conduit having a diameter larger than that of the tow, passing a stream of air through said conduit concurrently with the tow at a pressure and velocity sufficient to open the tow and separate the filaments therein one from the other, continuously entering the tow with its filaments in separated condition into an aqueous alkaline saponification bath, continuously drawing the tow with its filaments in separated condition through said bath, maintaining the tension on the tow as it passes through the bath below that which will cause the filaments to be drawn tightly one against the other, and removing the partially saponified tow from the saponification bath.

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