March 24, 1959 J. E. McMASTER ET AL 2,878,547

FILAMENT CRIMPING APPARATUS AND METHOD

Filed April 4, 1956 2 Sheets-Sheet 1

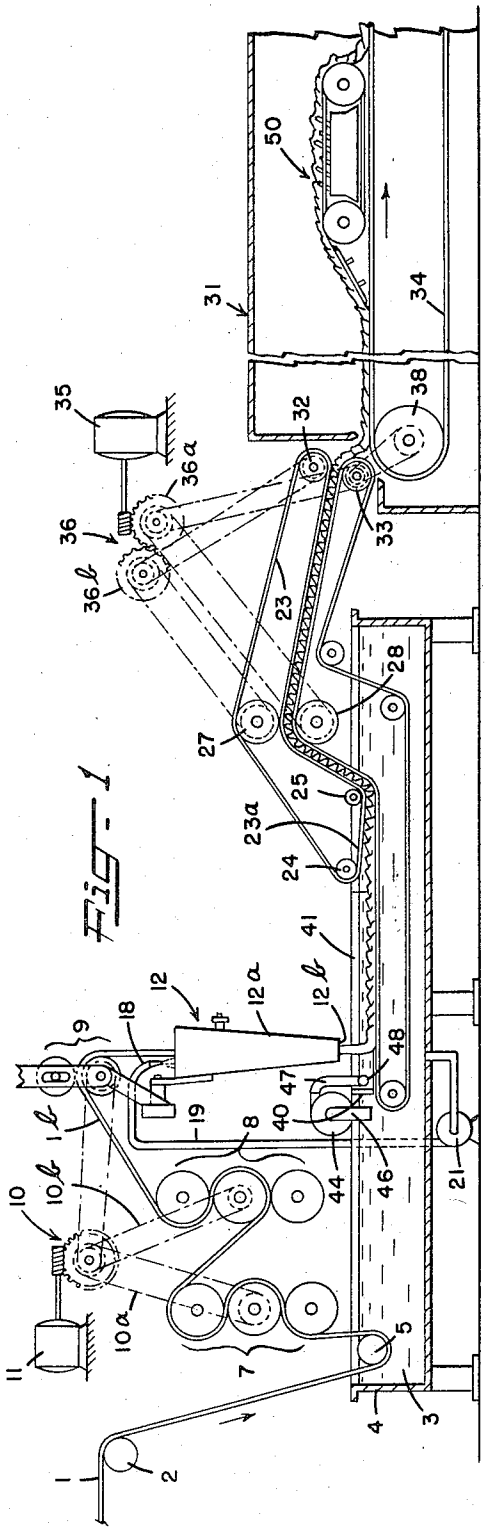

Fig. 1

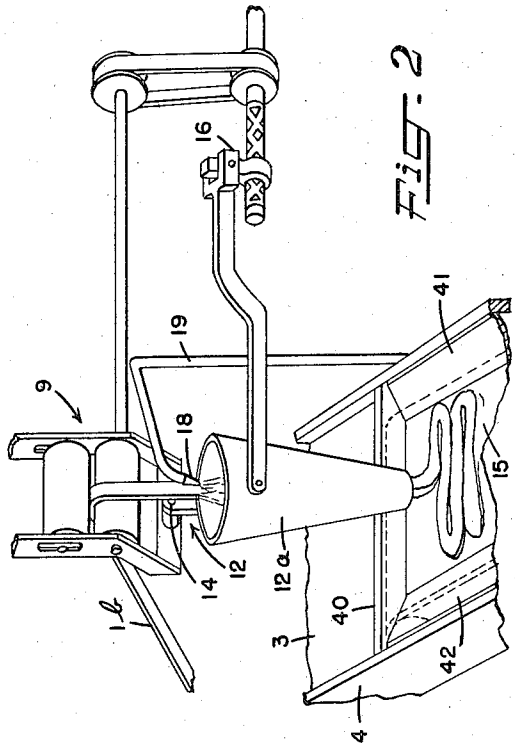

Fig. 2

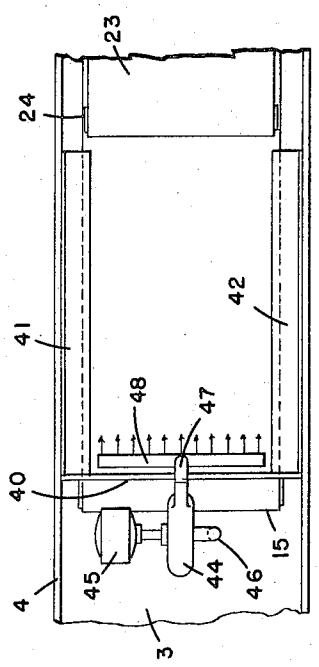

Fig. 3

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FILAMENT CRIMPING APPARATUS AND METHOD

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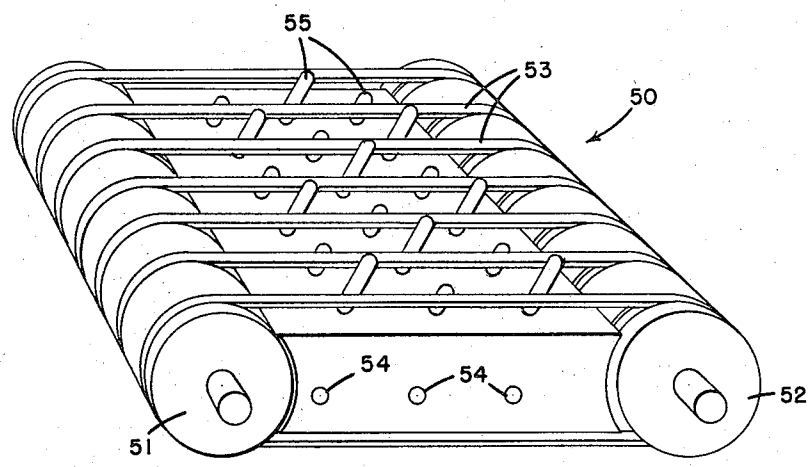

Fig. 4

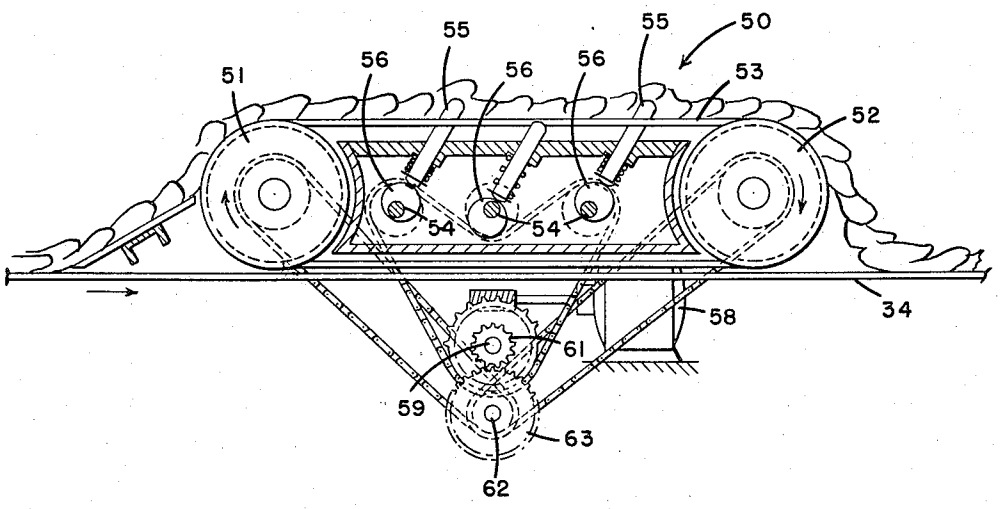

Fig. 5

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FILAMENT CRIMPING APPARATUS AND METHOD

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Application April 4, 1956, Serial No. 576,212

25 Claims. (Cl. 28—1)

The present invention relates to the crimping of strands comprising continuous filaments and particularly to a method for developing, to as full an extent as possible, a crimpiness that is derivable from filaments having an inherent crimp-producing characteristic imparted to them in the spinning thereof. This application is the continuation in part of application 478,712, now abandoned.

The invention is particularly applicable to the manufacturing of viscose yarn, and more specifically to the manufacturing of high total denier strands, such as the tow produced as an intermediate product in the manufacturing of rayon staple fibers. The continuous filamentary material, supplied as a raw material in the process of the invention, is manufactured in such a manner as to provide it with an inherent tendency to crimp. The crimp is then developed in the material when it is subjected to certain known conditions administered after the usual after-spinning treatments have accomplished cellulose regeneration, and washing and/or bleaching of the filaments. The tow to be treated in accordance with this invention comprises filaments which may be obtained in accordance with the procedure disclosed in the Merion and Sisson Patent No. 2,517,694. That is, viscose filaments are spun in a bath which rapidly sets up a skin which has a strong tendency to shrink such as to rupture and expose the relatively non-compressible, soft, plastic, and liquid core which thereupon extrudes through the rupture. The exposed core material, in turn, coagulates to form skin of different texture than that of the initially-formed skin. The resulting skin portions have different stretching and shrinking characteristics and thus provide the filaments with an inherent tendency to crimp under the conditions provided by the present invention.

It is found that the capability of filaments to crimp, as prepared according to the Merion and Sisson procedure, may be partially or wholly nullified, or perhaps not fully utilized in carrying out the treatments conventionally applied to strands of such filaments to develop the crimp thereof. For example, in bringing about the present invention, it was discovered that any tension whatsoever applied to the filaments at the critical crimp-forming stage, tended to permanently destroy the crimpability of the filaments. It was observed also that pressure such as that applied when relaxed newly crimped fiber was passed longitudinally through nip rolls at least partially destroyed its crimpability. It was further observed that strands of heavy total denier could not always be treated to successfully develop the crimp by processes that were satisfactory with respect to light total denier strands. Another condition giving rise to difficulty was that, in general, processes for crimp development at one speed of strand travel were substantially less effective at greater speeds of the strand.

Therefore, one object of the invention is to provide a method and an apparatus for treating inherently crimpable filamentary material for the purpose of developing as fully as possible the crimp that may be derived as the result of the crimping tendency of the filaments.

Another object is to provide a crimping process adapted for the handling of tows of any total denier. Still another object is to provide a method of crimping adapted to any linear speed of processing a strand. A further object is to provide apparatus for practicing the process of the foregoing objects that is, compact, simple in construction and operation, and sparing of floor space. Other objects, features and advantages will become apparent in the invention and the drawing relating thereto in which

Fig. 1 is a diagrammatic elevation of apparatus for handling strands in accordance with this invention;

Fig. 2 is a perspective view of part of the apparatus shown in Fig. 1;

Fig. 3 is a fragmentary diagrammatic plan view of a portion of the apparatus shown in Fig. 1;

Fig. 4 is an oblique view illustrating essential parts of the blanket-opening device shown enclosed by the drier of Fig. 1, and

Fig. 5 is a side view, with parts removed, of the blanket-opening device shown in Fig. 4.

In brief, the invention is concerned with an apparatus and a method for developing to the fullest extent, potential crimpiness of inherently-crimpable filaments by delivering a strand thereof in a condition substantially free from tension to a system for opening or separating the filaments which utilizes a liquid. After opening the strand to a condition wherein the filaments are completely separated from each other by the liquid, the strand and accompanying liquid is passed through a shallow bath of hot liquid disposed above the upwardly-facing carrying surface of a liquid-permeable belt-like element or conveyor with respect to which the strand is distributed along a sinuous path as a series of plaits extending transversely of the conveyor as the conveyor advances. The filaments are buoyantly supported in the shallow bath and to some extent by the element or conveyor. As a result of movement of the conveyor and the liquid of the bath (the liquid being preferably propelled also), the strand is carried while suspended in the hot liquid for a short distance while in the meantime the filaments thereof become fully crimped. Thereafter, the conveyor moves in converging concurrently-running relation with another overhead permeable belt-like conveyor until the plaited newly crimped filaments become sandwiched between opposing portions of the conveyors as the assembly comprising the conveyors and the strand plaited therebetween advance between a pair of squeeze rolls which wring loosely held liquid from the strand. After the assembly leaves the rolls, the upper conveyor may be withdrawn from further contact with the strand which is thereafter delivered into and passed through a dryer with the strand being maintained in the plaited relaxed condition. Drying may be accomplished on an extended portion of the lower conveyor or on another upwardly-facing conveyor associated primarily with the dryer. In handling some types of potentially crimpy filaments such as those of regenerated cellulose, it is essential that they be passed through a plasticizing medium, such as a hot aqueous bath, and substantially stretched before entry into the shallow bath maintained above the conveyor.

As has been stated before, the filamentary material to which this invention applies, is that which is inherently crimpable as a result of some condition obtained in the spinning of the filaments. Potential crimpiness may be imparted to filaments by initially forming the filaments with two or more components extending longitudinally in each filament which have different stretching and shrinking behavior in response to heating and/or liquid treatments. For example, filaments have been produced by spinning two different viscose yarns together

in side-by-side relation to form single filaments suitable for use in the invention. These filaments may be obtained also from filament-forming materials of entirely different character such as those which are normally extruded in a soft or plasticized state or in the form of solutions thereof in separate or only partially intermingled phases through a common orifice, or a plurality thereof, where they are joined together in eccentric or side-by-side relation into a setting medium which may be either gaseous or liquid and may function either as a cooling, precipitating, or evaporative medium to form unitary filaments in each of which the different materials from separate portions of the body of the filament, but are joined by coalescence and are disposed with a portion of the peripheral surface of each component entirely outside of the periphery of any other adjacent component throughout the entire length of the filament, or in conjugate sections of the filament. Such composite filaments may be formed from any filament-forming material including different viscoses, different cellulose derivatives, different proteins, and different resins such as different nylons, different vinyl resins, and different vinylilene halides.

It is recognized in practicing the present invention that some types of potentially crimpy filaments may not need prestretching or liquid treatment prior to opening the strand in developing crimp thereof. The opening of the strand comprising such and deposition thereof in the hot relaxing bath, results in the development of the crimp. However, filaments derived from viscose and made in accordance with the procedure disclosed in the Merion-Sisson Patent 2,517,694 are preferably subjected to a hot aqueous plasticizing bath and stretched 50 percent or more. Due to the unbalanced cross-section of such filaments caused by regenerated cellulose components of different characteristics side-by-side in each filament whereby the plastic recovery of each component is substantially different, crimp development is achieved by providing the opportunity for the components to effect their respective states of recovery in the shallow bath provided over the conveyor on which the plaited blanket of the filaments is initially formed. To maximize the recovery differences of the components and thus the magnitude of the crimp, it is necessary to pre-stretch the filaments. The crimping or relaxing bath may be composed of any liquid which is capable of swelling the filaments. For treatment of rayon fibers, it comprises water which may be acidic, neutral, or alkaline. It may contain salts dissolved therein to impart a desired swelling action to the filaments and to thus enhance the crimping in a desired manner. Organic liquids suitable for use with hydrophilic fibers include mono and polyhydric alcohols. In the case of hydrophilic fibers, the crimping or relaxing bath may comprise organic liquids, or emulsions comprising organic swelling agents suspended in aqueous media.

By way of example however, the invention is described with respect to filaments that are spun from a single viscose solution which have skin sections of varying composition as has been suggested hereinbefore. In accordance with this method of forming filaments, the viscose is extruded into an aqueous acid coagulant and regenerating bath which has, because of high total salt content, a rapid dehydrating effect upon the surface material of the extruded xanthate filaments and rigidly sets up such surface material as at least partially regenerated skin of substantial thickness about a still substantially liquid or exceedingly soft and plastic core. This skin has a strong tendency to shrink circumferentially as a result of the dehydrating action of the coagulating bath. It is prevented, by the incompressible core, from exerting a mere reduction in the diameter of the filaments. Thus, the skin splits or ruptures longitudinally of the filaments thereby causing part of the softer core material to flow through the rupture which in turn coagulates to form a skin over the rupture. Thus, the filaments are formed with longitudinal skin portions of different texture which respond differently to subsequent heating, stretching, or wetting operations to produce crimp in such filaments.

As a general rule, it has been found that best filaments of the type just described are obtained by spinning in a coagulant having from about 7.0 to 8% sulfuric acid, 1 to 1.5% zinc sulfate, 19 to 22% sodium sulfate, with the exception of those viscoses having a particularly high or low percent of carbon disulfide. A coagulating bath should have a temperature between 40 and 60° C., preferably 45 to 50° C. The immersion and the speed of spinning should correlate to substantially complete the coagulating of the filaments before stretching is performed thereon so that maximum differential in shrinkage may be obtained. Customarily, the yarns comprising such filaments are stretched by the godets after the coagulation by 40% or more. The stretching at this point may be varied to a constant degree inversely with respect to stretching performed at a later stage in accordance with the present invention described herein below. Viscoses which are satisfactory for use in the present invention from the standpoint of producing good crimp in filaments, are preferably constituted as follows: 38 to 42% carbon disulfide, 7.8 to 8.2% cellulose, and 6.5 to 8.5% sodium hydroxide, with a common salt test of 4 to 6 and a ball fall viscosity of 40 to 50 sec.

The yarn or other aggregations of filaments spun in accordance with the method hereinabove indicated are subjected to the conventional regenerating, washing, and/or bleaching treatments necessary for packaging the yarn for commercial use. The filamentary material may be supplied after such conventional treatments in a continuous manner directly to the apparatus illustrated in the drawing for carrying out the process of the present invention, or the filamentary material may be placed in containers in either dry or wet condition and stored, as local practice requires, until needed for further processing.

As illustrated in Fig. 1, a tow **1**, or other aggregation of filaments, prepared as hereinbefore described, advances over a guide roll **2** into a bath **3** of the container **4** around a guide roll **5** submerged in the bath. The bath **3** is preferably heated to a temperature of at least 150° F. to heat the strand **1** passing therethrough to condition it for the stretching that occurs in the section extending between a set of stretching rolls **7** and another set of stretching rolls **8**. For the sets of rolls **7** and **8** to accomplish stretching, they are driven in a conventional manner by sprocket chains **10***a* and **10***b* connected to a common work-driving system **10** driven by a motor **11**. The tow **1** passes from the stretching rolls **8** to a pair of nip rolls **9** which are driven at approximately the same peripheral speed as the rolls **8** to maintain such tension as to hold the stretch in the section of the strand **1***b* passing between the set of rolls **8** and **9**. The tow is discharged by the rolls **9** into a device **12** which is essentially a funnel **12***a* and a pivotal support **14** therefor. The funnel **12***a* is oscillated transversely of a belt-like conveyor **15** by a reverse-screw mechanism **16** driven by a source not shown. The rolls **9** should feed the tow at a rate slightly faster than the linear speed of the tow desired at the end **12***b* of the funnel. This is to allow for shrinkage of the tow which occurs as a result of crimping.

As the tow **1** passes downwardly into the funnel **12***a*, it is opened by a jet of liquid, preferably liquid pumped from the tank **4**, issuing from a nozzle **18** and supplied thereto through a tube **19**, as shown, by a pump **21**. The opening of the strand by the liquid is a function that is important in carrying out the process of this invention in a satisfactory manner. It is also highly important that the strand be thoroughly opened before it is dis-

charged into the bath 3. It is found that to satisfactorily form the tow 1 into plaits which are suspended within the shallow body of liquid which overlies the horizontally-extending load-receiving portion of the conveyor 15, it is necessary to thoroughly open the filaments with liquid to form a mixture of separated filaments suspended in the liquid before it enters the bath 3. To open the filaments, for example, with a gaseous material, or to not open them at all, would cause the tow to float to some extent on the bath. In order to obtain maximum crimping of the filaments within the bath, it is essential that each filament be free of adjacent filaments and be submerged within the bath in order that it will be wetted and heated efficiently by the liquid.

The speed of oscillation of the funnel 12*a* is related to the rate of movement of the conveyor belt 15 along its path so as to form closely spaced or superposed plaits of the tow 1 upon the load-receiving portion of the belt. Due to the closeness of the specific gravity of viscose filaments with that of water, the plaits of the tow are practically buoyant within the bath 3 and thus loosely and lightly supported on the belt. However, the filamentary material is to a substantial extent, suspended into liquid of the bath. This is nearly an ideal condition for developing crimp in the filaments since crimp forming is very readily inhibited by any lateral or longitudinal constraint placed upon the filaments at this stage. However, maximum crimp is developed in the filaments by the time the plaited tow supported on the belt reaches the confluence of the belt 15 with another upper belt 23 at the point where it passes around a guide roll 24. The belts 15 and 23 are disposed in opposed relation for the remaining portion of the distance in which they pass toward the right as shown in Fig. 1. The opposed concurrently-traveling portions of the belts are spaced, or held apart, by the plaited section of the tow 1.

A section 23*a* of the belt passes along a path converging with the belt 15 as it passes from the guide roll 24 to the guide roll 25. In this narrowing region defined by section 23*a* of the belt 23 and the opposed section of the belt 15, the plaits of fully crimped filaments are gathered and compressed to a mild extent in a vertical direction between the two belts. With the material thus supported between the two belts, the belts pass upwardly out of the bath and between two squeeze rolls 27 and 28 disposed above the bath. The squeeze rolls express the liquid loosely held in the plaited tow. Preferably, the belts are permeable or foraminous to allow prompt escape of the liquid and the drainage thereof back into the container 4.

As shown, the opposed portions of the belts are terminated at the end of a dryer 31 over a pair of guide rolls 32 and 33 in proximity with the upper pass of the dryer conveyor 34. The speed of the dryer conveyor is approximately that of the belts 15 and 23, such as by speed correlation obtained by a common driving means, so that the plaits of the tow may be received from the opposed pair of belts upon the upwardly-facing surface of the upper pass of the conveyor 34 without substantial change in the pattern of plait formation, or subjecting the tow to any further lateral or longitudinal forces which disturb the crimp, since the crimp of the filament is readily removed at this stage. The dryer is operated at any practical temperature short of chemically affecting the material of the filaments to set the crimp.

The various conveyors of the apparatus herein described may be driven, as illustrated in Fig. 1, by a common driving system. As illustrated, the driving system comprises a motor 35 which is connected in driving relation with a power transmission unit 36 by a worm-gear drive. The transmission unit comprises spur-gears 36*a*, 36*b* in meshing relationship. Rolls 27 and 32 are connected by means, such as sprockets and chains in driving relation with the shaft of the gear 36*b* to effect positive driving of the conveyor 23. The shaft of gear 36*a* is connected in a similar manner in driving relation with rolls 28 and 33 thereby effecting positive driving of conveyor 15. The conveyor 34 of the dryer may be connected in positive driving relationship with the conveyors 15 and 23 by a sprocket and chain system connecting the shaft of roll 38 with the roll 33. Thus, the entire conveying system of the apparatus is correlated in speed with different ratios of speed possible between the dryer conveyor and the opposed conveyors 15 and 23 simply by changing the sizes of sprockets.

A factor which effects the uniformity and quality of the blanket and thus determines to some extent the efficiency to which the apparatus described above may be operated, is the manner in which a blanket is formed over the strand-receiving conveyor 15 before it passes into the confluence of this conveyor with the conveyor 23. It has been discovered that the uniformity of the blanket may be greatly improved by overcoming the effects which result in movement of the upwardly-facing surface of the belt of the conveyor 15 relative to the portion of the bath which is disposed above it. One arrangement for overcoming this condition is illustrated in Fig. 1 which comprises apparatus for obtaining movement of the liquid overlying the conveyor 15 at approximately the same rate as that of the conveyor. This is accomplished by providing a vertical baffle 40 and side baffles 41 and 42 which form a substantially enclosed chamber for liquid above the strand-receiving portion of the conveyor 15. The baffles 41 and 42 slightly overlie the lateral edges of the conveyor 15. Liquid is pumped from a region within the tank but outside the region enclosed by the baffles to a point inside the latter region adjacent to the baffle 40 by a pump 44 driven by a motor 45. The pump has an intake duct 46 and an outlet duct 47. The outlet duct 47 terminates in a manifold 48 which extends approximately the width of the conveyor 15 with outlet apertures aligned to discharge liquid horizontally in a direction approximately parallel to and concurrent with the movement with the upper pass of the conveyor 15. The speed of the pump and the motor are adjusted to obtain a discharge rate from the manifold 48 which produces the movement of the entire body of the liquid 15 at a linear rate of approximately that of the conveyor. The liquid moving along with the conveyor and the strand escapes in opposite lateral directions at the right ends of the baffles 41 and 42 as viewed in Figs. 1 and 3.

Another feature of the present invention found to be important, particularly when there is a tendency to form a blanket in a non-uniform manner, is a device for opening the blanket after it has been partially dried. Such a device may be conveniently placed in the dryer at a station spaced from the blanket-receiving portal of the dryer at sufficient distance so that, for example, 25 to 75 percent of the moisture may be removed from the blanket before it is opened. Various mechanical devices are available for this purpose. However, the one illustrated (see Figs. 4 and 5) is characterized by operation which minimizes the placing of the relaxed crimped fibers under any appreciable tension. Such tension is to be avoided as much as possible since tension tends to remove the crimp from moist filaments.

An opening device 50 (as illustrated in Figs. 4 and 5) comprises a pair of parallel spaced rolls 51 and 52. Each roll has a plurality of circumferential grooves for maintaining a plurality of belts 53 along fixed paths around the rolls. Disposed between the rolls is a plurality of cam shafts 54 having axes approximately parallel to the rolls 51 and 52. The cam shafts reciprocate a plurality of rounded-end push rods 55 which reciprocate between a level below the belts 53 and a level of, for example, an inch or two above the belts. The cams 56 supported on the cam shaft 54 may be so arranged that alternate push rods, in any one row, taken either transversely of the path of the blanket or longitudinally there-

of are in raised positions, while the other set of push rods are in the lowered positions.

The rolls 51 and 52 and the belts 53 extending thereabout operate to advance the blanket from a point on the moving conveyor 34 just rearward of the device 50 to a point immediately forward of the device at which the blanket is redeposited on the conveyor 34. The rolls may be driven at a peripheral speed slightly faster or slower than the linear speed of conveyor 34 by a motor 58 in worm-drive relation with a sprocket shaft 59. The faster speed is preferred since it tends to temporarily open and rearrange the plaits of the blanket. A gear 61 mounted on the shaft 59, drives another shaft 62 which supports a gear 63 in mesh with the gear 61. The shaft 62 supports sprockets connected by sprocket chains to sprockets on the shafts of rolls 51 and 52 in accordance with the driving system diagrammatically shown. The cam shafts 54 are rotated at a much greater angular rate than the rolls 51 and 52. Ratios in the speeds of the rolls and the cam shafts 54 should be obtained whereby the push rods 55 may be reciprocated from 200 to 400 cycles per minute. These ratios may be changed as desired to get the reciprocation rate of the push rods desired, and any desired ratio of blanket advancement speeds of the device 50 and the conveyor 34. The push rods, as shown, are inclined forwardly in the direction of blanket advancement so that they aid in forwarding the blanket and avoid any possibility of restricting the advancement by the belts 53. By regulation of the speed ratios, as just indicated, a great deal of variation may be obtained in the manner in which the blanket is subjected to opening forces.

Since all that is necessary to induce crimping in stretched regenerated cellulose filaments made as hereinbefore described, is a heated liquid, plain water is a satisfactory medium for constituting the bath. However, the passage of the strand through the bath is an advantageous stage for applying a sizing material or other material to the filaments. Thus, in the usual employment of the invention, the bath 3 will comprise a sizing solution and contain any other ingredients which may be desirably applied to the tow at this time.

While a preferred embodiment of the invention has been shown and described, it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

We claim:

1. Apparatus for crimping a strand of filaments including a container for a liquid crimping bath, means within said container positioned below the level of the crimping bath for moving the strand of filaments therethrough in a relaxed condition, means for opening and delivering the strand of filaments in a relaxed condition to said first-mentioned means, and means outwardly of said container for removing excess crimping bath liquid from the strand of filaments and setting the same in its crimped condition.

2. Apparatus as defined in claim 1 further including means for stretching the strand of filaments as it is delivered to said strand opening and delivering means.

3. Apparatus as defined in claim 1 wherein said last-mentioned means includes a dryer, and further including means within said dryer for opening the strand of filaments.

4. Apparatus as defined in claim 1 further including means for moving at least the upper level of the liquid crimping bath concurrently with the movement of the strand of filaments therethrough.

5. Apparatus for crimping a strand of filaments including a container for a liquid crimping bath, means for opening the strand of filaments and delivering the same into said container in a relaxed condition, means for receiving and carrying the opened and relaxed strand of filaments, said last-mentioned means including a first portion positioned within said container below the level of the liquid bath for carrying the strand of filaments through the bath in a relaxed condition and a second portion extending outwardly of said container for removing the strand of filaments from the liquid bath, and means cooperating with said second portion of said last-mentioned means for removing excess liquid from the strand of filaments.

6. Apparatus as defined in claim 5 wherein said opening and delivering means includes a distributor movable relative to said strand receiving means and a supply means for mixing fluid wit hthe strand of filaments as it travels through said distributor.

7. Apparatus as defined in claim 5 further including means for moving at least the upper level of the liquid crimping bath concurrently with the movement of said first portion of said receiving means.

8. Apparatus as defined in claim 5 wherein said last-mentioned means includes a dryer, means for carrying the strand of filaments through said dryer in a relaxed condition and means for opening the strand of filaments within the dryer.

9. Apparatus for crimping a strand of potentially crimpable filaments including a container for a liquid bath, means for opening the strand of filaments and delivering the same into the bath in a relaxed condition, means for receiving the opened and relaxed strand of filaments, said last-mentioned means including a first portion positioned within said container below the level of the liquid bath for carrying the strand of filaments therethrough in a relaxed condition and a second portion extending outwardly of said container for removing the strand of filaments from the liquid bath, said means for opening and delivering the strand of filaments including a distributor mounted for movement relative to said receiving means for delivering the strand of filaments thereto along a sinuous path and a supply means for mixing liquid with the strand of filaments as it travels through said distributor, means cooperating with said second portion of said receiving means for removing excess liquid from the strand of filaments and a dryer for setting the strand of filaments in its crimped condition.

10. Apparatus as defined in claim 9 further including means for conducting crimping bath liquid from said container to said supply means, and means within said dryer for opening the strand of filaments.

11. Apparatus for crimping a strand of potentially crimpable filaments including a container for a liquid bath, means for opening the strand of filaments and delivering the same in a relaxed condition into the crimping bath, an endless conveyor having a portion positioned within the liquid bath at a level below the surface thereof for receiving and carrying the strand of filaments through the liquid bath in a relaxed condition, said conveyor having a second portion extending outwardly of said container for removing the strand of filaments therefrom, an endless conveyor cooperating with said second portion of the first-mentioned conveyor for gripping the strand of filaments therebetween to prevent movement of the strand of filaments from its relaxed condition as it is withdrawn from the liquid bath, and means cooperating with said conveyor for removing excess liquid from the strand of filaments as it leaves the liquid bath.

12. Apparatus as defined in claim 11 further including means for moving at least the upper level of the liquid bath in a direction concurrent with the movement of the strand of filaments carried by said first-mentioned conveyor.

13. Apparatus as defined in claim 11 wherein said opening and delivering means includes a distributor, means mounting said distributor for movement transversely of said first-mentioned conveyor, and a supply means for mixing fluid with the strand of filaments as it travels through said distributor.

14. Apparatus as defined in claim 11 further including

a dryer, means receiving the strand of filaments after the excess liquid has been removed therefrom and conveying the same through said dryer in a relaxed condition, and means within said dryer for opening the strand of filaments.

15. Apparatus as defined in claim 14 wherein said opening means within said dryer includes a plurality of rods and means for reciprocating said rods to project the same into and through the strands of filaments.

16. A method of crimping a running strand of filaments including the steps of opening and relaxing the strand of filaments, passing the opened strand of filaments into and through a liquid crimping bath while maintaining the same in a relaxed condition, removing the strand of filaments from the liquid bath while maintaining the same in a relaxed condition and drying the strand of filaments while maintaining the same in a relaxed condition to set the crimp of the filaments.

17. A method as defined in claim 16 further including the step of opening the strand of filaments during the drying thereof.

18. A method as defined in claim 16 further including the step of stretching the strand of filaments prior to opening and passing the same into and through the liquid bath.

19. A method as defined in claim 16 further including the step of moving the liquid crimping bath concurrently with the travel of the strand of filaments therethrough.

20. A method of treating a running strand of potentially crimpable filaments including the steps of mixing a liquid with the running strand of filaments to open and relax the same, passing the strand of filaments into and through a liquid bath in a relaxed and generally suspended condition to induce a crimping thereof, withdrawing the strand of filaments from the liquid bath and removing the excess liquid bath therefrom while maintaining the strand of filaments in a relaxed condition, and drying the strand of filaments in a relaxed condition to set the crimp of the filaments.

21. A method of treating a running strand of potentially crimpable filaments including the steps of mixing a liquid with the running strand of filaments to open and relax the same, passing the strand of filaments into and through a liquid bath in a relaxed and generally suspended condition to induce a crimping thereof, moving the liquid bath concurrently with the travel of the strand of filaments therethrough, withdrawing the strand of filaments from the liquid bath and removing the excess liquid bath therefrom while maintaining the strand of filaments in a relaxed condition, and drying the strand of filaments in a relaxed condition to set the crimp of the filaments.

22. A method of treating a running strand of potentially crimpable filaments including the steps of mixing a liquid with the running strand of filaments to open and relax the same, passing the strand of filaments into and through a liquid bath in a relaxed and generally suspended condition to induce a crimping thereof, withdrawing the strand of filaments from the liquid bath and removing the excess liquid bath therefrom while maintaining the strand of filaments in a relaxed condition, drying the strand of filaments in a relaxed condition to set the crimp of the filaments, and opening the strand of filaments during the drying thereof.

23. A method of treating a running strand of potentially crimpable filaments including the steps of stretching the strand of filaments, mixing a liquid with the running strand of filaments to open and relax the same, passing the strand of filaments into and through a liquid bath in a relaxed and generally suspended condition to induce a crimping thereof, withdrawing the strand of filaments from the liquid bath and removing the excess liquid bath therefrom while maintaining the strand of filaments in a relaxed condition, and drying the strand of filaments in a relaxed condition to set the crimp of the filaments.

24. A method of treating a running strand of potentialy crimpable filaments including the steps of mixing a liquid with the running strand of filaments to open and relax the same, delivering the opened and relaxed filaments into a liquid bath in loosely packed plaits, submerging and passing the strand of filaments through the liquid bath in a relaxed and generally suspended condition to induce crimping thereof, firmly holding the strand of filaments in its plaited and relaxed condition while withdrawing the same from the bath and removing excess liquid therefrom, and drying the strand of filaments in its relaxed condition to set the crimp of the filaments.

25. A method of treating a running strand of potentially crimpable filaments including the steps of mixing a liquid with the running strand of filaments to open and relax the same, delivering the opened and relaxed filaments into a liquid bath in loosely packed plaits, submerging and passing the strand of filaments through the liquid bath in a relaxed and generally suspended condition to induce crimping thereof, moving the liquid bath concurrently with the travel of the strand of filaments therethrough, firmly holding the strand of filaments in its plaited and relaxed condition while withdrawing the same from the bath and removing excess liquid therefrom, drying the strand of filaments in its relaxed condition to set the crimp of the filaments, and opening the strand of filaments during the drying thereof.

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