Nov. 20, 1951 L. W. RAINARD 2,575,838

METHOD OF CRIMPING PROTEINACEOUS FIBERS

Filed Nov. 30, 1948 2 SHEETS—SHEET 1

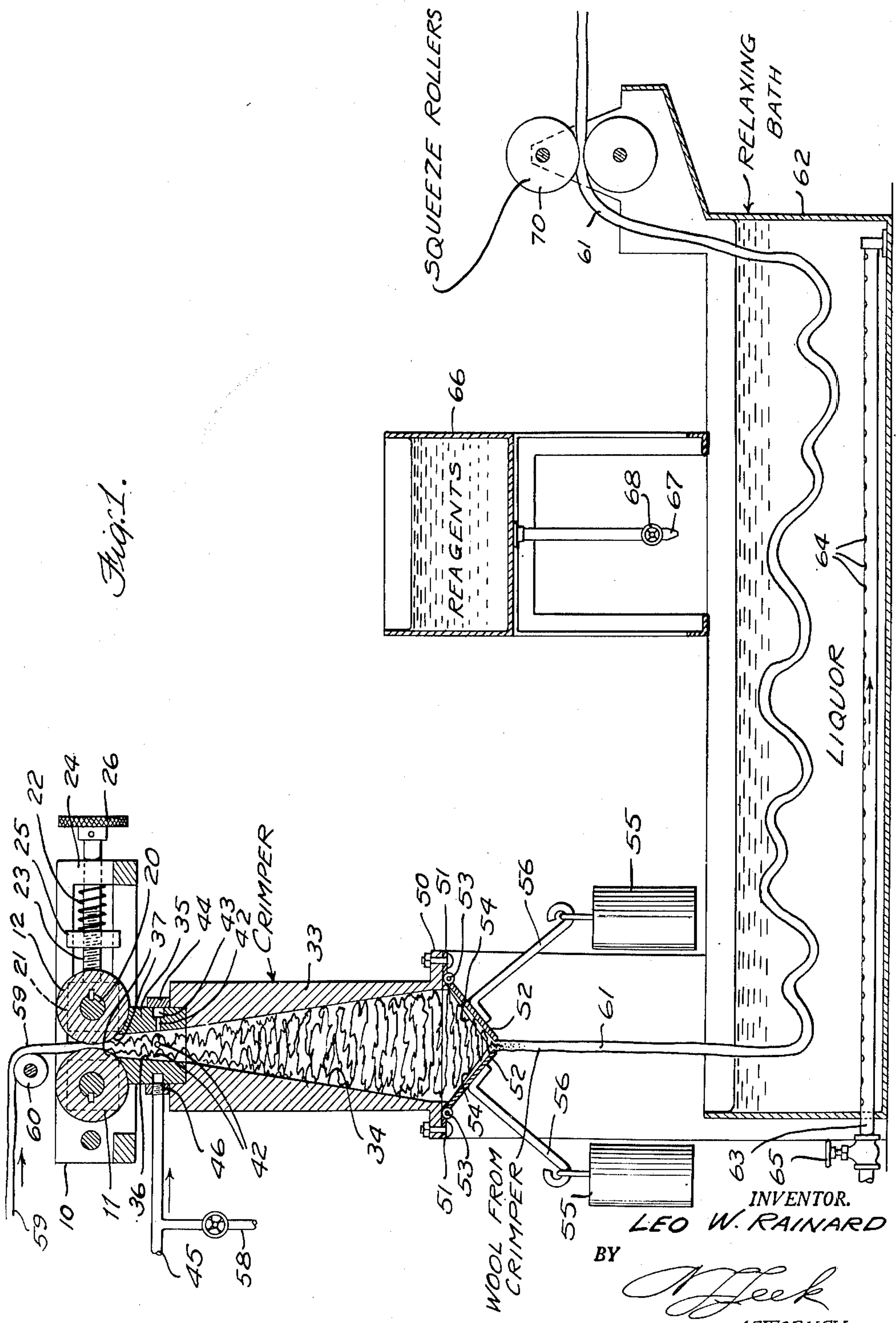

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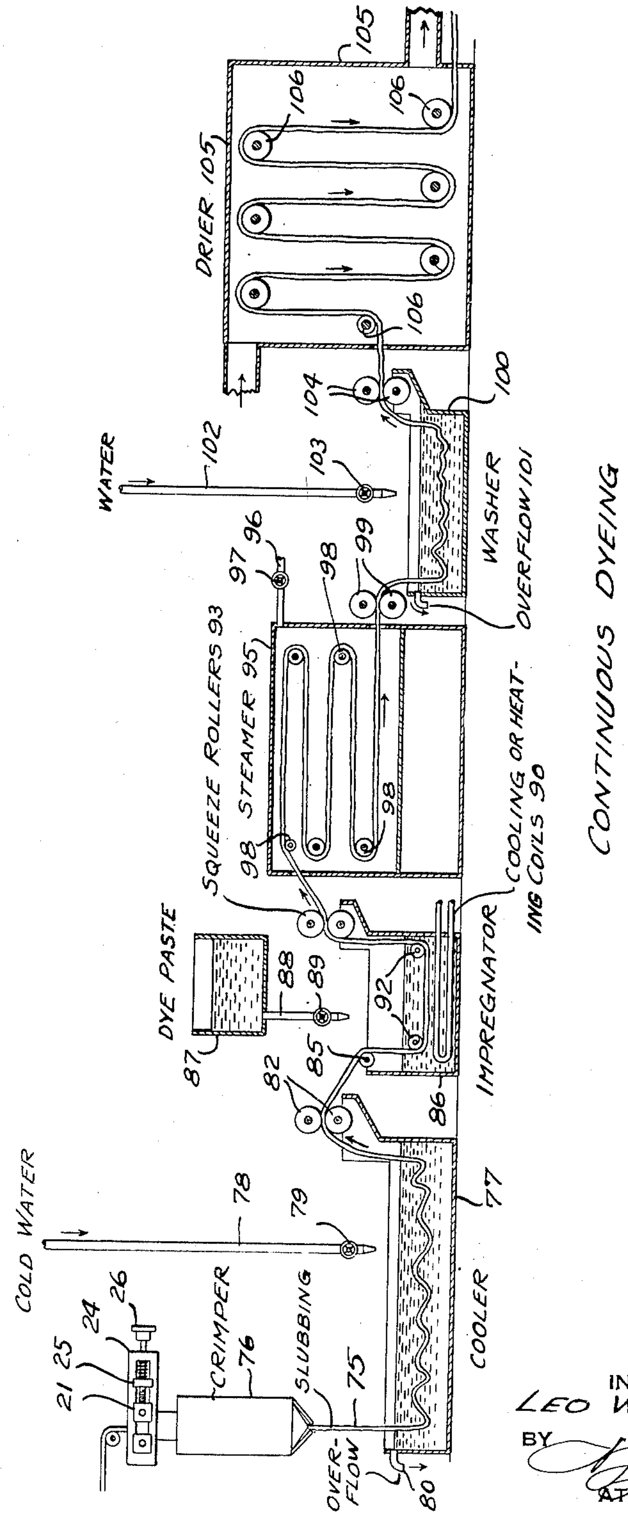
Fig. 2.



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METHOD OF CRIMPING PROTEINACEOUS FIBERS

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This invention relates to the treatment of wool and other proteinaceous fibers and has for an object to improve the carding and spinning characteristics of such fibers.

It is known that certain wools, such as South American, New Zealand, Iceland, Leicester, and others, are naturally less highly crimped than wools from other localities and breeds and are less useful for many purposes, such as for use as fabric pile. Also the lower grade portions of fleece from blooded sheep are generally less highly crimped than the finer fibers. The lack of crimp of such wools affects their tensile strength, compressibility, resilience, and processing, such as carding and spinning, and may determine the limiting fineness of the yarns spun from these wools.

The lack of crimp in such wools results in a roving of such poor drawing characteristics that breakage occurs frequently on the spinning frame or in some cases the lack of crimp makes it practically impossible to form a roving that can be handled on the spinning frame.

The present invention provides for adding crimp to such wools under conditions to improve the drawing and spinning characteristics of rovings made therefrom and also for the addition of crimp to wools higher than carpet grade, but lower than fine clothing grade to increase their usefulness.

In accordance with a process described and claimed in my co-pending application Serial No. 38,657 filed July 14, 1948, the crimp is produced mechanically by feeding the pretreated fibers between feed rolls into a crimping chamber which is maintained full of fibers under a predetermined back pressure. As the fibers are forced into the crimping chamber, they are laid in a zigzag form and are pressed to form angular bends or crimps with intervening straight portions the length of which depends upon several factors, such as the nature of the pretreatment and the pressure to which the fibers are subjected in the crimping chamber.

The crimp is set by treatment in a setting chamber with steam under controlled conditions of time, temperature, moisture and pH in the range below which the natural resilience of the fibers resists deformation and above which degradation occurs, the relationship being such that the fibers are brought to the plastic condition necessary for the formation of a permanent crimp.

Such crimped fibers have improved spinning characteristics as compared with the original fibers before crimping, particularly when the original fibers were of the less highly crimped variety. The present invention, however, provides for still further increasing the carding and spinning characteristics of such fibers by

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partially relaxing the internal stress produced in such fibers by the mechanical crimping operation, thus increasing the apparent tensile strength and the apparent average fiber length as determined by the Suder method, increasing the drawing power of the roving and the tensile strength of the yarn spun therefrom.

A further object of the invention is accordingly to improve the drawing characteristics of rovings made from such fibers, reduce breakage during the spinning, and improve the tensile strength of the yarn.

Another object is to provide a continuous process for crimping and dyeing such fibers.

In accordance with the present invention, the crimps are relaxed to a desired degree by treatment in a relaxing bath under controlled conditions of time, temperature and pH. In one embodiment the relaxing bath may comprise water or a weak acid held at the boiling point and arranged so that the slubbing from the crimper passes through the bath before drying or storage.

In a further embodiment the relaxing is effected in a dyeing zone maintained under controlled conditions through which the slubbing passes continuously as a part of a crimping and dyeing cycle, the dyeing and relaxing being effected in a single step.

The invention also provides for increasing the moisture content of the fibers in the setting chamber to the value required for efficient setting.

The novel features which are characteristic of this invention will be better understood by referring to the following description, taken in connection with the accompanying drawings in which certain specific embodiments have been set forth for purposes of illustration.

In the drawings:

Fig. 1 is a diagrammatic view of one form of apparatus for carrying out the present invention; and

Fig. 2 is a diagrammatic view of an apparatus for the continuous crimping and dyeing process.

Referring to the drawings more in detail, the crimper is shown as comprising a frame **10** carrying a pair of feed rolls **11** and **12** driven by suitable means, not shown. The feed roll **12** is keyed to a shaft **20** journalled in bearing blocks **21** which are slidable in the frame **10**. The roll **12** is held in pressure engagement with the material fed between the rolls by springs **22** seated around threaded rods **23** which bear against the bearing blocks **21**. The rods **23** extend through a bracket **24** attached to the frame **10** and carry nuts **25** and adjusting knobs **26**. The nuts **26** are held against rotation by the frame **10**. The springs **22** are seated between the nuts **25** and the bracket **24** and their tension may be adjusted by means of the knobs **26**.

Positioned below the rolls 11 and 12 is a vertical tube 33 having a conical bore 34, forming a setting chamber. The tube 33 is attached to a saddle 35 having a tapered central bore 36 forming a crimping chamber and having a curved upper surface 37 conforming to the bight of the rolls 11 and 12 and machined to have a slight running clearance from the surface of the rolls. The saddle 35 is formed with a plurality of radial passages 42 for the injection of a setting agent into the crimping chamber. The radial passages 42 communicate with an annular passage 43 in the saddle 35 which is closed by a collar 44 to form an inlet manifold. The fluid is supplied to the annular passage 43 by a pipe 45 registering with a port 46 in said collar. Water may be injected into said fluid in the pipe 45 through a pipe 58.

At its lower end the tube 33 carries a flange 50. A pair of doors 52 are hinged to the flange 50 by hinges 53 and are held closed against the tapered end 54 of the flange 50 by weights 55 attached to arms 56 secured to the doors.

The fibers to be crimped are fed over a guide roll 60 to the feed rolls 11 and 12, preferably in the form of a rope or a web 59. The fibers are held in the crimping and setting chambers by the doors 52 until they have been packed sufficiently to force the doors slightly open against the force of the weights 55. The back pressure of the packed fibers causes the fibers which are forced against the packed fibers by the feed rolls to be folded over in zig-zag crimps, the spacing of which depends upon the nature of the fibers and the back pressure. Due to the fact that the rope or web is compacted to a thin ribbon by the feed rolls, the crimps are formed by bending the fibers back and forth in a direction transverse to the axes of the rolls.

A setting agent, such as steam, is introduced through the pipe 45 and passages 42 into the mass of packed fibers. Water to increase the moisture content of the fibers may be injected through the pipe 58. Of course the area of injection may be varied, but should be sufficiently spaced below the top of the saddle 35 so that the mass of fibers forms a seal. The pressure of the steam and the tapered setting chamber help to overcome or reduce the friction of the fibers against the walls and facilitate their passage through the setting chamber.

The crimped rope or slubbing 61 discharged from the doors 52 is fed to a tank 62 containing the relaxing liquid, such as water, which may be heated by steam from a steam pipe 63 extending into the tank 62 and having holes 64 for the discharge of steam therefrom. A valve 65 in the steam line provides for control of the water temperature. A reagent, such as a weak acid, may be supplied to the liquid in the tank 62 from a receiver 66 disposed above the tank 62, through a feed pipe 67, controlled by a valve 68.

The rope 61 is withdrawn from the tank 62 between squeeze rolls which are disposed to drain the excess liquid back into the tank 62 and is then passed to dryers or is picked and carded to be used as stock wool for dyeing, or treating and spinning in the usual manner.

More specifically the raw wool is first opened, scoured, for example with soap and soda ash in several stages, then washed and dried in the usual manner to form stock wool. The scouring and washing may be carried out under conditions to leave the stock wool with the desired pH for crimping. This pretreated stock wool is fed directly at a uniform rate to the feed rolls 11 and 12 of the crimper or may be fed to a web-forming device such as a card and fed as a web or condensed into a rope which is fed to the feed rolls 11 and 12 as a sliver or slubbing 59. If a more uniform feed is required, the stock wool may be picked and carded and condensed to a rope for the above purpose after one or more stages of carding. A uniformity in density of feed stock is preferred to prevent jamming or slipping at the feed rolls or undue lateral movement of the feed rolls.

In either case, the fibers are stuffed by the feed rolls 11 and 12 into the crimping chamber and through the setting chamber and are forced out of the bottom of the setting chamber against the pressure exerted by the discharge doors 52.

The back pressure at the entrance of the crimping chamber controls the size of the crimp, a higher pressure causing a finer crimp (more crimps per inch) and vice versa.

For equilibrium conditions of moisture content and pH, the setting time varies inversely with the temperature. For temperatures below 212° F., hot water may be injected into the crimping and setting chambers.

For higher temperatures, steam under pressure may be used. The quality of steam should be selected to cause the fibers to reach the desired temperature and moisture content. Due to the packing of the mass of fibers, they are relatively impermeable to steam, and pressures suited to produce the desired high temperatures may be used. With high pressure steam or superheated steam, water may be injected through the pipe 58 to produce the desired moisture content.

The fibers may enter the crimper at pH of 4.0 to 9.0. Steam may be injected under conditions to raise the temperature of the fibers to between 212° F. and 300° F. and sufficient water may be injected to produce a moisture content in the fibers leaving the setting chamber of 20% to 55%. A higher moisture content is not detrimental and may be desirable in certain instances. With a pH of 8.0 to 9.0 a setting time of 60 to 70 seconds at 240° F. to 250° F. is sufficient to produce a set that will resist boiling for three minutes in water, or a 90 minute dyeing cycle with little loss in crimp as evidenced by frequency and amplitude determinations. With a pH of 4.0 to 4.5 at the same temperature, a setting time of 120 seconds to 160 seconds is required to produce the same resistance to loss of crimp. In general the setting time varies inversely with the pH, the other conditions being the same.

The crimped fibers are now passed through the relaxing bath in the tank 62. This bath may be heated to boiling by direct steam injection and a reagent such as hydroxyacetic acid may be added from the receiver 66 at a rate to maintain a pH of 4.0 to 4.5 The slubbing is pulled through the bath by the squeeze rolls 70 at a rate to leave the fibers in the bath for from 30 to 60 seconds.

Referring now to the embodiment of Fig. 2, the slubbing 75 emerges from the crimper 76, which is similar to the crimper described in Fig. 1, and passes first through a cooling bath comprising water in a tank 77 which may be continuously supplied with water through a pipe 78 controlled by a valve 79 and may be provided with an overflow 80. The slubbing is removed from the tank 77 between squeeze rolls 82 which are driven in a suitable manner and are disposed to drain the excess water back into the tank 77. The cooling bath serves to produce uniform conditions of temperature and moisture content in the slubbing, the moisture content being controlled by the pressure exerted by the squeze rolls 82.

The slubbing is then fed over a guide roll 85 into a dye tank 86 containing suitable dye material. Dye paste, for example, may be contained in a receiver 87 and fed through a pipe 88 controlled by a valve 89 to the dye tank 86. Cooling coils 90 may be disposed in the dye tank 86 and connected for the circulation of a cooling medium, such as cool water, therethrough, or, if the dyeing is to take place under elevated temperature, a heating fluid may be passed through the coils 90. The dye bath is preferably maintained cool so as to prevent the dye from being absorbed into the fibers.

The slubbing is shown as passing through the tank 86 around the rolls 92 and as drawn through the tank by means of squeeze rolls 93 which are driven in any suitable manner and are positioned to drain the dye material squeezed from the slubbing back into the tank 86.

After emerging from the dye tank 86 the slubbing is passed through a suitable heating zone for setting the dye, shown as a steam chamber 95, to which steam is supplied from a pipe 96 at a rate controlled by a valve 97. The slubbing is passed back and forth in the steam chamber 95 over guide rolls 98 and is drawn therethrough by squeeze rolls 99 which may be driven in any suitable manner. The relaxing takes place when the fibers are heated in the steam chamber and may be controlled by varying the moisture content, time and temperature. If the dye bath itself is heated to near the boiling point, the relaxing would take place in this bath. In general heat and moisture under controlled conditions are required for this step.

From the setting zone 95, the slubbing is passed through a wash tank 100 having an overflow 101 to which wash water is supplied from a pipe 102 controlled by a valve 103. The slubbing is drawn through the wash tank 100 at a suitable rate by squeeze rolls 104 which are positioned to drain the excess water back into the tank 100. The wash tank removes any dye paste that may have adhered to the fibers.

From the tank 100 the slubbing is passed into a drying zone, shown as a drying chamber 105, which is heated in any suitable manner. The slubbing is passed back and forth over guide rolls 106 in the drying chamber and emerges therefrom as a dried, crimped slubbing which may be fed to the carding machine, formed into a roving, and spun in the usual manner.

The above continuous dyeing process combines the relaxing step with the dyeing step and provides for a continuous crimping-relaxing-dyeing treatment.

The relaxing bath of Fig. 1 may consist essentially of water although the pH may be controlled by the addition of suitable acids or alkalies to adjust the pH content to the value suitable for subsequent dyeing. The time required for the relaxing step depends upon the extent to which the crimp has been set. If the crimp has been highly set, a longer relaxing time is required, and vice versa. Relaxing periods of from 2 seconds to 2 minutes have been found in general to be satisfactory and have produced a marked increase in tensile strength of the fiber and in the average fiber length as measured by the Suder method. It has been found that by this method the breakage of the rovings during the drawing operation on the spinning frame is greatly reduced and fibers which in their original state were spinnable only with great difficulties and careful adjustment may now be readily treated and spun, to form a yarn having improved properties.

What is claimed is:

1. The method of imparting an artificial crimp to proteinaceous fibers which comprises feeding said fibers into a crimping zone maintained full of a mass of said fibers and held under a pressure adapted to cause the fibers to be folded over and crimped as they are forced into said mass of fibers, holding the mass of crimped fibers under pressure in a setting zone, maintaining setting conditions of temperature and moisture content in said setting zone, discharging the crimped fibers from said setting zone, and passing the crimped fibers through a relaxing bath at a temperature and rate to at least partially relax the internal stress produced by crimping and to improve the spinning characteristics of said fibers.

2. The method of imparting an artificial crimp to proteinaceous fibers which comprises feeding said fibers into a crimping zone maintained full of a mass of said fibers and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass of fibers, holding the mass of crimped fibers under pressure in a setting zone, introducing steam and moisture into said setting zone and holding the fibers therein for a time to set the crimp, discharging the crimped fibers from said setting zone, and passing the crimped fibers through a relaxing bath at a temperature and rate to at least partially relax the internal stress produced by crimping and to improve the spinning characteristics of said fibers.

3. The method of imparting an artificial crimp to proteinaceous fibers which comprises feeding said fibers into a crimping zone maintained full of a mass of said fibers and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass of fibers, holding the mass of crimped fibers under pressure in a setting zone, maintaining setting conditions of temperature and moisture content in said setting zone, discharging the crimped fibers from said setting zone, and passing the crimped fibers through a water bath at a temperature and rate to at least partially relax the internal stress produced by crimping and to improve the spinning characteristics of said fibers.

4. The method of imparting an artificial crimp to proteinaceous fibers which comprises feeding said fibers into a crimping zone maintained full of a mass of said fibers and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass of fibers, holding the mass of crimped fibers under pressure in a setting zone, maintaining setting conditions of temperature and moisture content in said setting zone, discharging the crimped fibers from said setting zone, and passing the crimped fibers through a bath of water at boiling temperature at a rate to at least partially relax the internal stress produced by crimping and to improve the spinning characteristics of said fibers.

5. The method set forth in claim 4 in which the water is maintained at the boiling point by direct steam injection.

6. The method of imparting an artificial crimp of proteinaceous fibers which comprises forming said fibers into a slubbing, feeding said slubbing into a crimping zone maintained full of a mass of said slubbing and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass, holding the mass of crimped slubbing under pressure in a setting zone, maintaining setting conditions of temperature and moisture in said setting zone, discharging the crimped slubbing from said setting zone, and passing the same through a relaxing bath at a temperature and rate to at least partially relax the internal stress produced by crimping and to improve the spinning characteristics of said fibers.

7. The method of imparting an artificial crimp to proteinaceous fibers which comprises forming said fibers into a slubbing, feeding said slubbing into a crimping zone maintained full of a mass of said slubbing held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass, holding the mass of crimped slubbing under pressure in a setting zone, maintaining setting conditions of temperature and moisture in said setting zone, discharging the crimped slubbing from said setting zone, and passing the same through a water bath at a temperature and rate to at least partially relax the internal stress produced by crimping and to improve the spinning characteristics of said fibers.

8. A continuous crimping, relaxing and dyeing process for proteinaceous fibers, which comprises passing said fibers into a zone maintained full of a mass of said fibers and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass, feeding the crimped fibers to a setting zone maintained under conditions of temperature, moisture content and pressure suited to set said crimp, discharging the fibers from said setting zone to a dyeing zone, and treating the fibers in said dyeing zone with a dye solution under conditions of time, temperature and moisture suited to at least partially relax the internal stress produced by crimping and to improve the spinning characteristics of the dyed fibers.

9. A continuous crimping, relaxing and dyeing process for proteinaceous fibers, which comprises passing said fibers into a zone maintained full of a mass of said fibers and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass, feeding the crimped fibers to a setting zone maintained under conditions of temperature, moisture content and pressure suited to set said crimp, discharging the fibers from said setting zone to a dyeing zone, treating the fibers in said dyeing zone with a dye solution under conditions of time, temperature and moisture suited to at least partially relax the internal stress produced by crimping and to improve the spinning characteristics of the dyed fibers, setting the dye by heat, and drying the resultant fibers.

10. A continuous method of crimping, relaxing and dyeing proteinaceous fibers, which comprises forming said fibers into a slubbing, feeding said slubbing between feed rolls into a crimping zone maintained full of a mass of said slubbing and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass, passing the crimped fibers through a setting zone under controlled conditions of time, temperature and moisture adapted to set the crimp therein, feeding the crimped slubbing from said setting zone through a cooling bath under conditions to produce uniform temperature and moisture conditions in the slubbing, feeding the slubbing from said cooling bath through a dye bath, thence through a setting zone to set the dye under conditions to at least partially relax the internal stress produced by crimping, then passing the dyed slubbing through a washing zone to remove the excess dye and through a drying zone to form a slubbing containing dyed artificially crimped fibers.

11. A continuous method of crimping, relaxing and dyeing proteinaceous fibers which comprises forming said fibers into a slubbing, feeding said slubbing between feed rolls into a crimping zone maintained full of a mass of said slubbing and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass, passing the crimped slubbing through a setting zone under controlled conditions of time, temperature, and moisture adapted to set the crimp therein, feeding the crimped slubbing from said setting zone through a water bath, squeezing excess water from the slubbing, feeding the slubbing from said water bath through a dye bath, then through a steam zone to set the dye under conditions to at least partially relax the internal stress produced by crimping, and through a drying zone to form a slubbing containing dyed artificially crimped fibers.

12. A continuous method of crimping, relaxing and dyeing proteinaceous fibers which comprises forming said fibers into a slubbing, feeding said slubbing between feed rolls into a crimping zone maintained full of a mass of said slubbing and held under a pressure adapted to cause the fibers to be folded over as they are forced into said mass, passing the crimped slubbing through a setting zone under controlled conditions of time, temperature and moisture adapted to set the crimp therein, feeding the crimped slubbing from said setting zone through a water bath, squeezing excess water from the slubbing, feeding the slubbing from said water bath through a dye bath, then through a steam zone to set the dye under conditions to at least partially relax the internal stress produced by crimping, then passing the dyed slubbing through a washing zone and through a drying zone to form a slubbing containing dyed artificially crimped fibers.

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