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METHOD AND APPARATUS FOR CRIMPING AND RELAXING FILAMENTS

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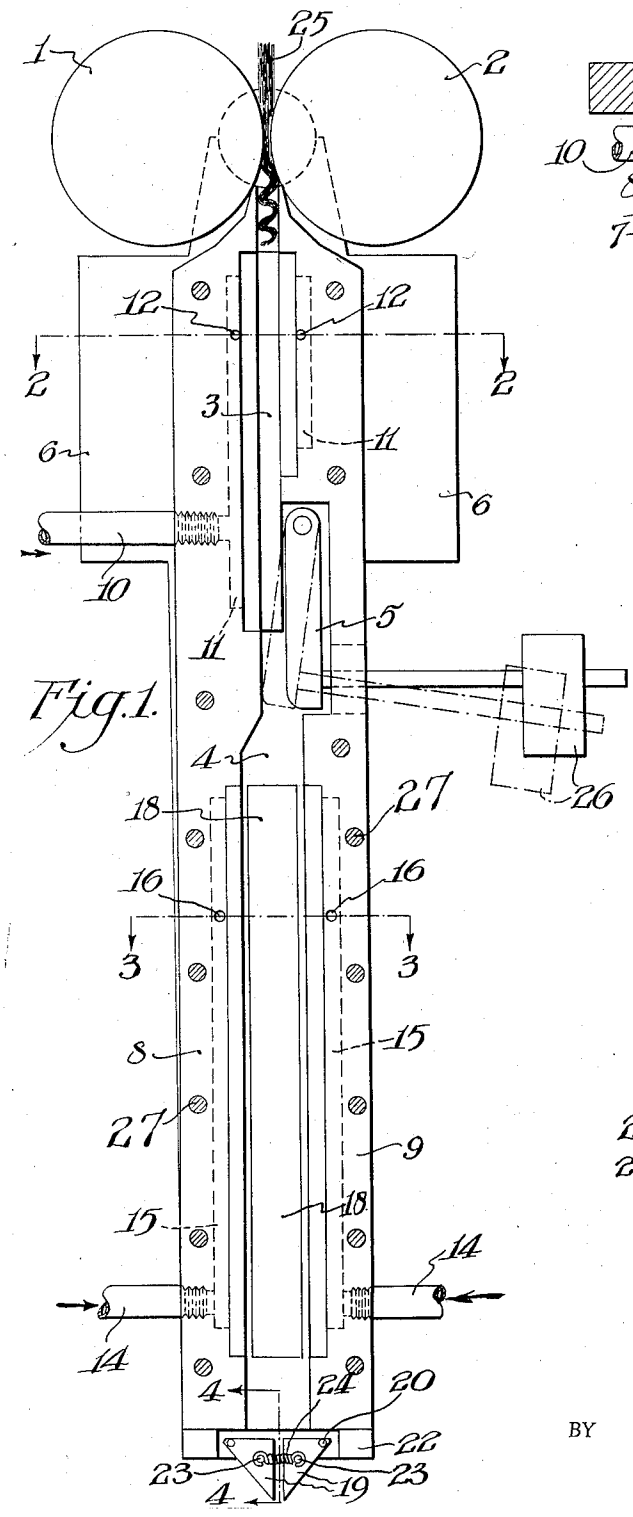

Fig. 1.

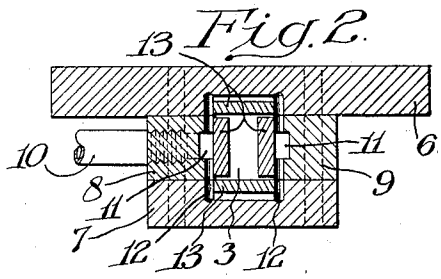

Fig. 2.

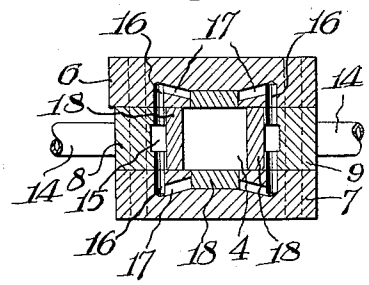

Fig. 3.

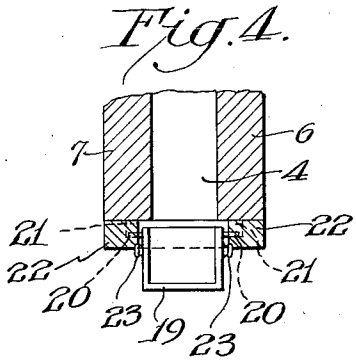

Fig. 4.

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METHOD AND APPARATUS FOR CRIMPING AND RELAXING FILAMENTS

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9 Claims. (Cl. 28—1)

This invention relates to the crimping of a bundle of filaments, such as a tow of continuous filaments of an acrylonitrile polymer and to relaxing the tow produced.

It has long been known that filaments can be crimped by feeding them into a confining space wherein the filament mass is accumulated until sufficient push is developed to open a force-pressed exit door. Such is commonly referred to as a "stuffer-box" crimper.

More recently, the introduction of steam into the crimping chamber has been advocated. The steam, being both moist and hot, softens the filaments so that they crimp more readily. After the filaments are crimped, the steam further aids by hastening relaxation. However, attempts to crimp and relax filament bundles uniformly in a stuffer box crimper have not been at all satisfactory. Generally, shrinkage of the tow could not be reduced below about 10% while maintaining fair uniformity and normal tenacity. In one test on acrylonitrile polymer yarn, when the shrinkage of the filament bundle was reduced from 15% to an average of about 6%, the spread in shrinkage values was from about 4% to 9%, and dyed samples were very streaked and the physical properties were poor.

It is, therefore, an object of this invention to provide an improved method and apparatus for crimping filaments and relaxing the crimped filaments so as to produce crimped filaments having more uniform dye affinity and more uniform physical properties. Other objects will be apparent from the description that follows.

In the drawings

Figure 1 is an elevational view of the apparatus of this invention with the front plate removed.

Figure 2 is a section taken on line 2—2 in Figure 1, but with the front plate on;

Figure 3 is a section taken on line 3—3 in Figure 1, also with the front plate on the apparatus; and

Figure 4 is a section taken on line 4—4 in Figure 1.

The feed rolls 1 and 2 and their mountings and contiguous parts are fully described in the patent to Hitt, U. S. Patent 2,311,174. Since this invention is primarily concerned with the apparatus located below the nip of the feed rolls, no further description of the upper feeding portion of the apparatus is necessary. The instant invention provides two chambers 3 and 4, chamber 4 being an enlarged continuation of 3 and separated therefrom by weight-pressed clapper door 5. These parts in combination are the essence of this invention and will be described in detail hereinafter.

The chambers 3 and 4 are formed by elongated plates 6 and 7 bolted together as indicated in Figure 1 by bolts 27. The back plate 6 and the front plate 7, shown in Figure 2, are joined with the two side plates 8 and 9, thus forming the elongated channels 3 and 4.

These channel-forming members are suitably cut away to provide steam passages behind sintered metal inserts of microporous structure which allows the passage of steam in very finely divided and well distributed streams to all sides and substantially throughout the length of

these chambers. For instance, steam under a predetermined pressure is admitted to chamber 3 through the pipe connection 10 through channel 11 and connecting holes 12 and through the sintered metal inserts 13. Figure 2 shows the interrelationship of these elements in a sectional view. The connecting holes 12 permit the steam from inlet 10 to feed into chamber 3 from all sides. Similarly, steam under the same or different predetermined pressure is admitted to chamber 4 through pipe connections 14 through channels 15, connecting holes 16 and channels 17 and through the sintered metal inserts 18. Figure 3 further exemplifies these parts. The various channels can be drilled at any desired angle.

At the exit end of chamber 4 is located a force-pressed door which, in the specific apparatus shown, comprises a pair of scoop-like, hingably mounted members 19. These members are supported on pins 20 mounted in slots 21 or other equivalent holding means in a bottom plate 22. The scoop-like members carry on each side knobs 23 and around the knobs on each side is looped a tension spring 24 or other tension means tending to hold the members together. For best distribution of the force acting on the door it is desirable to have a set of knobs and springs in front and in back of the door. In respect to the pressurized door 5 and the exit door at the bottom of the setting chamber, various means of attaining the desired pressure may be used. These include weights, springs, hydraulic means, fluid means such as compressed steam or air and electrical means.

With the chambers preheated and filled with steam at substantially atmospheric pressure, a bundle of filaments 25 such as a tow of continuous filaments of acrylonitrile polymer is introduced between the feed rolls 1 and 2 and pushed into the chamber 3 against the action of the weighted clapper door 5. The weight 26 can be adjusted in accordance with the need. Herein the filament bundle is folded back and forth on itself in the restricting chamber until sufficient pressure is built up to force the bundle past the clapper plate. The door then moves from the closed position (dotted lines) to the open position (solid lines). The filament sections leaving this upper chamber are well crimped due to the softening action of the steam and the pressure exerted on them in forcing past the clapper plate. In the lower chamber, also fed with steam, the crimped filaments are maintained folded over preferably under somewhat reduced pressure until they have traversed the length of this chamber, which treatment relaxes the crimped filaments. The steam being fed into either chamber 3 or 4 is taken up largely by the tow in the chamber. There is generally no excess steam after operations have continued for a while, for the mass of the tow under pressure assists in keeping the steam from leaking out, for example, at the edges of the clapper door.

Thus, the crimping is effected by gripping the fibers between closely spaced conveyor surfaces, such as two rolls, and discharging them into a pressure zone in which the fibers are compacted and folded over each other progressively so that crimping occurs. The crimped fibers are subsequently passed to a second pressure zone without substantially releasing the compacting pressure. In both zones the fibers are subjected to the action of a softening agent such as steam, but in the second zone the steam or equivalent softening agent acts over a period of time sufficient to produce a substantial relaxing of the crimped filaments.

Numerous changes and modifications can be made in this apparatus without departing from the spirit of this invention. Instead of sintered metal steam distributor plates, multiperforated sheet metal members may be used. These porous or microporous inserts need not be metallic, for plastic inserts can be used. The force-pressed exit doors may take various forms and pressed against open-

ing by springs, weights or other means alone or in combination. The relative dimensions of the two chambers can be varied widely, but in general it is desirable to maintain a high ratio of length to width or thickness. Generally, the second or relaxing chamber will be considerably larger than the first or crimping chamber and preferably will be about 3 to 8 times as big in volume.

The apparatus of this invention is adaptable to filament bundles of widely varying sizes. Many kinds of materials may be beneficially treated in this apparatus, such as filaments of acrylonitrile polymers and copolymers, nylon, linear polyesters, regenerated cellulose and cellulose derivatives, other linear polymers produced by condensation or addition polymerization, as well as natural filaments and fibers, such as silk, cotton, wool, linen and the like. The steam pressures used in the crimping chamber may vary from about 1 pound per square inch gauge up to 10 or more pounds per square inch gauge. In many cases, it will be found advantageous to use pressures in the range of from about 1 to 4 pounds per square inch in the crimping chamber and about 0.1 to 0.2 the gauge pressure in the second chamber. Preferably wet steam is used, but dry or superheated steam may be used if desired. The loading on the exit force-pressed doors may be varied widely and generally in keeping with the steam pressure used within the chambers.

Through the use of this invention uniformity in the residual shrinkage of the crimped tow is greatly improved while maintaining good filament strength and elongation. At very satisfactory operating speeds sufficient relaxation can be imparted to the filament bundle to produce average residual shrinkage values on the wet crimped tow of 6% with an overall variation of not over $\pm 1\%$ which compares very favorably with shrinkages ranging from 4% to 9% when crimping and relaxing is carried out in a conventional single chamber stuffer-box. When crimping and relaxing is attempted in a single chamber crimper and conditions are such as to reduce the average residual shrinkage to about 6%, the tenacity is reduced as much as 30 to 40% while the elongation increases, but about 10% or less. In contrast, by means of this invention under conditions producing a crimped tow with $6\% \pm 1\%$ residual shrinkage, there is no substantial loss in tenacity while the elongation is increased as much as 30 to 40%. Furthermore, after cutting the tow into staple and drying relaxed, residual shrinkage can be easily reduced to a desirably low level of about 2% to 3%. Dyed samples of the crimped relaxed tow and of the cut staple showed excellent uniformity and complete freedom from the streaked dyeing previously obtained in trying to crimp and relax in a single chambered crimper.

A further advantage of the apparatus of this invention lies in the fact that steam or other treating fluid can be applied to the tow under different conditions of temperature and pressure and the treatments in the two chambers may be different. The apparatus may be used in processing a variety of filamentary material including those from polyamides, polyesters, polyacrylonitriles, cellulose, cellulose derivatives and the like.

Any departure from the above description which conforms to the present invention is intended to be included within the scope of the claims.

I claim:

1. In apparatus comprising a stuffer-box crimper having a pressure chamber in which filamentary material is crimped, the improvement which comprises a second chamber adjoining said pressure chamber and a pressurized door between said chambers capable of closing one chamber from the other, each chamber having an inlet for a softening agent.

2. Apparatus in accordance with claim 1 wherein the volume of said second chamber is about 3 to about 8 times the volume of said pressure chamber.

3. Apparatus in accordance with claim 1 wherein said pressurized door is a weighted door.

4. In apparatus comprising a stuffer-box crimper having a pressure chamber in which filamentary material is crimped, the improvement which comprises a second chamber adjoining said pressure chamber and a pressurized door between said chambers capable of closing one chamber from the other and under certain pressure capable of opening one chamber to the other, each chamber having an inlet for a softening agent.

5. A process for producing uniform, crimped filaments which comprises gripping the filaments between closely spaced conveyor surfaces; discharging them under pressure into a chamber to effect a progressive folding over and crimping of said filaments; introducing a softening agent into said chamber; passing the resultant crimped filaments past a yielding pressurized door to a second and larger chamber while maintaining a lower pressure on said filaments, applying a pressure on the said second chamber lower than that applied to the said first chamber and subjecting the filaments to the action of a softening agent in said second chamber for a period of time sufficient to produce substantial relaxing of the crimped filaments.

6. A process in accordance with claim 5 wherein the said softening agent in both chambers is steam.

7. A process in accordance with claim 5 wherein the said softening agent in the first chamber is steam under a pressure of from about 1 to about 10 pounds per square inch.

8. A process in accordance with claim 5 wherein the said softening agent in both chambers is steam and is under a pressure of about 1 to 4 pounds per square inch in the first chamber, and the pressure in the second chamber is about 0.1 to about 0.2 that in the first chamber.

9. A process in accordance with claim 5 wherein the second chamber has a volume of about 3 to about 8 times the volume of the first chamber.

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