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MANUFACTURE OF STAPLE FIBER

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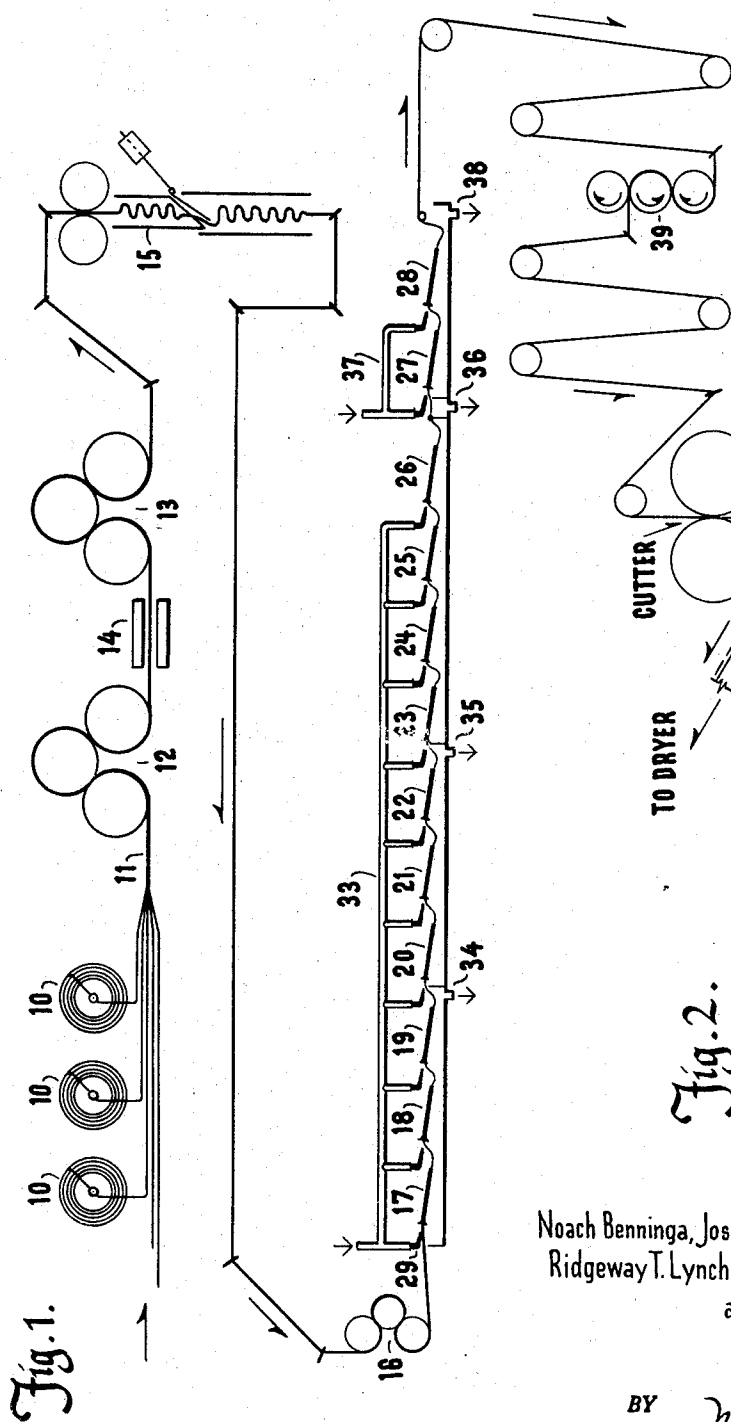
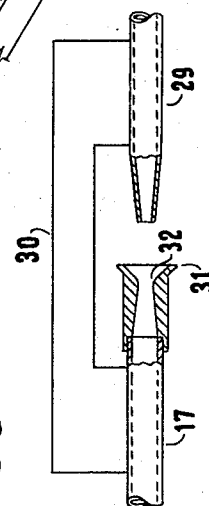


Fig. 2.



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MANUFACTURE OF STAPLE FIBER

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This invention relates to the production of staple fiber and more particularly to the manufacture of polyamide staple fiber from polymeric caprolactam.

Heretofore, in the manufacture of this type of nylon staple fiber it has been customary to form a tow which after drawing and crimping is cut up into lengths of staple fiber. Since this type of nylon is characterized by having a substantial amount of water soluble monomeric or low molecular weight polymeric material present, it is usually necessary to subject the cut staple fiber to a washing operation with hot water to reduce the concentration of the water soluble materials before the staple fiber can be baled and shipped. If the staple fiber is not washed to remove some of the water soluble materials present, serious difficulties are encountered in opening and spinning the fiber into yarn and otherwise processing the fiber in subsequent textile operations.

It has been found that the staple fiber produced according to the foregoing process tends to have particularly poor opening and carding characteristics. Various ways have been suggested for correcting this shortcoming, but until the present invention, none of them has been entirely successful in operation.

It is an object of the present invention to provide an improved process for preparing nylon staple fibers.

Another object is to provide an improved, softer nylon staple fiber having better opening, carding and spinning characteristics.

Another object is to provide a more efficient and economical method for removing water soluble constituents from nylon staple fiber.

Other objects will appear from the following description taken in conjunction with the annexed drawings wherein:

Figure 1 is a diagrammatic view in elevation showing one method of practicing the present invention; and

Figure 2 is a sectional view showing details of the jet and tube assembly used in the practice of the invention.

In general, the present process for manufacturing nylon staple fiber comprises the steps of preparing a tow, drawing the tow, and thereafter passing the tow into and through a series of conduits, the tow being propelled through the conduits solely by virtue of the flow of a liquid through the conduits. During this operation, the water soluble materials may be removed from the tow and at the same time a most beneficial effect is achieved with regard to the opening, carding and spinning properties of the resulting staple fiber.

Referring now to the drawings, individual ends of undrawn nylon yarns composed of polymeric caprolactam are withdrawn from packages indicated with the numeral 10 which are contained in a creel and combined to form a tow 11. Tow 11 is fed through a first set of anchoring rolls 12, to a second set of anchoring rolls 13. Rolls 13 are operating at a higher peripheral speed than rolls 12 in

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order to impart a drawing action, as well known in the art. If desired, a heating means such as a steam chamber 14 may be disposed between the two sets of anchor rolls 12, 13. It will be understood that more than two sets of anchoring rolls may be used so as to conduct the drawing operation in several stages, if desired.

The drawn tow is passed via suitable thread guides into a crimping device 15. Crimping device 15 may be of any suitable form such as the one disclosed in U.S. Patent No. 2,311,174, and will not be further described. The drawn crimped tow is withdrawn from crimper 15 by roller assembly 16 and fed into and through the liquid treating system now to be described.

The liquid treating system used in carrying out the present invention comprises a series of spaced tubular conduits 17-28, inclusive. These conduits are of a suitable diameter so as to accommodate the tow which is fed through the series of conduits. At the entrance end of each of the conduits 17-28, there is disposed in spaced relation a jet nozzle such as the one shown in detail in Figure 2 and designated with the numeral 29. It will be noted that the nozzle 29 is maintained in aligned spaced relation to tube 17 by means of bracket member 30 which is attached firmly to nozzle 29 and tube 17. The exit end of nozzle member 29 is of smaller diameter than the remainder of nozzle member 29. The entrance portion 31 of tubular member 17 is flared so as to facilitate the introduction of the running tow and liquid, and a venturi effect is obtained by a portion 32 of reduced diameter located between the flared portion 31 and the main body of treating tube 17. Tubes 18-28 have parts corresponding to those shown in Figure 2 and just described.

Hot water is supplied under pressure to the jet nozzles feeding tubes 17-26 from a liquid header 33. The water issuing from the exit end of these tubes empties into a common trough and is withdrawn by means of conduits 34, 35, 36. The jet nozzles supplying liquid to treating tubes 27 and 28 are connected to a header 37 which is supplied with a finishing solution. The finishing solution issuing from the exit ends of tubes 27 and 28 empties into a trough and is withdrawn via conduit 38.

The tow issuing from treating tube 28 is withdrawn by means of squeeze roller assembly 39, and passed via suitable thread guides and rollers into a staple fiber cutter which cuts the tow into lengths of staple fiber. The staple fiber cutter may be of any suitable design such as the one shown in Grunert Patent No. 2,184,452. The cut lengths of staple fiber issuing from the cutter are deposited on a conveyor mechanism 40 and transported to a drier. After being dried the staple fibers are passed through an opener, introduced into a baler mechanism and packaged for shipment.

Particularly satisfactory results have been obtained in an apparatus where the treating tubes 17-28 were constructed of 7/8 inch O.D. type 316 stainless steel tubing having a wall thickness of 0.088 inch. These tubes were 27 1/4 inches long. The flared mouth at the entrance end of the tubes had a diameter of 1.5 inches and the venturi section had a diameter of 7/16 inch. The narrowest part of the venturi section was 3/4 inch from the entrance or flared end of the tube. The jet nozzle used to introduce liquid into the treating tubes was disposed one inch from the mouth of the tube and was constructed of 5/8 inch O.D. type 316 stainless steel tube having a wall thickness of 0.065 inch, and the last 1 1/2 inch section of this nozzle was tapered to a 1/4 inch I.D. opening. The jet nozzles used were about 6 inches long overall.

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It has been found that a pressure of about 20 p.s.i. in headers 33 and 37 is sufficient to convey a tow of about 100,000 total denier through the tubes and adequately wash the water soluble material from it, while imparting the beneficial characteristics according to this invention. The temperature of wash water should be about 75° C. or above.

The invention will be further illustrated by the following specific examples. The nylon tow in each of the examples was composed of polymerized caprolactam.

Example 1

An undrawn delustered polymerized caprolactam nylon tow of 292,000 denier was drawn about 3.3 times its original length and crimped in the conventional manner. Thereafter the drawn crimped tow was introduced by means of a feed roll assembly into a series of twelve liquid treating tubes such as those described above and arranged as in Figure 1. The first ten treating tubes were supplied with water at 75° C. issuing from a header at 20–25 p.s.i. The last two treating tubes were supplied with a commercially obtained finish solution maintained at 20° C. and fed to the treating tubes by jet nozzles under a pressure of 20–25 p.s.i. The finish solution used was a concentration of about 3% finish oils in a water emulsion. The finish oils were composed of "2169 Nopco M." supplied by Nopco Chemical Co., Harrison, N. J., and an anti-static agent. Under these conditions, the tow ran through the tubes at a speed of about 100 meters per minute. The washed and finished tow was withdrawn from the series of tubes, passed through a set of squeeze rolls and introduced into a cutter which cut the tow into lengths of 3 denier staple fiber. The moisture content after cutting was 25–30%. The staple fiber was then dried in a hot air tunnel drier, opened in the usual way, and passed to the baler. The fiber was maintained in each of the three drier zones for about twenty minutes; the three zones were held at 70° C., 75° C., and 45° C. wet bulb—53° dry bulb, respectively. The finish concentration on the dried fiber was 0.4–0.75%; water soluble content was 1.3–1.9% compared to 10% in the drawn tow.

Staple fiber prepared in this way was found to have opening, carding and spinning qualities far superior to nylon staple fiber prepared according to a mat washing procedure. For example, staple fiber prepared according to the foregoing scheme was found to load to the extent of only about 1½ to 2 ounces on the card cylinder, compared to a loading of 17 to 21 ounces when processing staple fiber made with a mat washing procedure. In addition, the fiber was softer and almost free of "tangled" fibers. The uniformity of finish was also found to be improved.

Example 2

An undrawn undelustered polymerized caprolactam nylon tow of 320,000 denier was drawn 4.0 times its original length and crimped in the conventional manner. Thereafter the drawn crimped tow was introduced into a series of treating tubes as in Example 1. The first ten treating tubes were supplied with water at 90° C. issuing from a header under 20–25 p.s.i. The last two treating tubes were supplied with the finish solution used in Example 1 at 20° C. fed to the treating tubes by jet nozzles under a pressure of 20–25 p.s.i. The tow ran through the tubes, propelled solely by the treating liquids, at a speed of about 100 m./min. The washed and finished tow was withdrawn from the series of tubes and passed through a set of squeeze rolls after which it was introduced into a cutter which cut the tow into lengths of 6 denier staple fiber.

The moisture content after cutting was 25–30%. The staple fiber was then dried as in Example 1 in a hot air tunnel drier, opened and passed to the baler. The

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finish concentration of the dried fiber was 0.45–0.65%; the water soluble content was 1.6–2.6%, compared to about 5% in the undrawn tow. This staple fiber was found to have excellent opening, carding and spinning characteristics.

Example 3

An undrawn nylon tow similar to the one in Example 2 and having a denier of 307,000 was drawn about 4.0 times the original length and crimped as in the above example. Thereafter the drawn crimped tow was introduced into a series of twelve treating tubes. The first ten treating tubes were supplied with water at 90° C. issuing through jet nozzles from a header maintained at 20–25 p.s.i. The last two treating tubes were supplied with the same finish solution as in the above examples at 20° C. which was fed to the treating tubes by jet nozzles under a pressure of 20–25 p.s.i. The tow was propelled through the tube system at a speed of about 100 m./min. solely by means of the liquid passing through the tubes. The tow was withdrawn from the tubes, passed through a set of squeeze rolls and cut into the lengths of 15 denier staple fiber. Moisture content after cutting was 25–30%. The staple fiber was dried as in Example 1 in a hot air tunnel drier, opened and baled. The finish concentration on the dried fiber was 0.42–0.88%, and the water soluble content was 2.0–3%, compared to about 5% in the undrawn tow. Processing characteristics of the fiber thus prepared were found to be far superior to comparable staple fiber which had been mat washed.

The explanation for the beneficial effect on opening, carding and spinning properties obtained according to the present invention is not completely understood. It may be that the action of the jets of liquid on the running tow sufficiently separates and disturbs the individual filaments to prevent intermingling and tangling which otherwise tends to occur. The uniformity of the washing and finish treatment is also believed to be important. Whatever the reason, it is believed that it is necessary for the nylon tow to be subjected to an operation which separates and disturbs the individual filaments before the tow is cut up into lengths of staple fiber. Thus the washing and finishing of the nylon tow could be carried out in any desired manner and the tow then passed in either wet or dry form into and through an air jet such as the one disclosed in Patent 2,379,824, after which it is cut up into lengths of staple fiber. Other methods of disarranging the filaments or opening the tow may be used instead of the air jet. Of course, the procedure described above for washing the tow in tubes has the advantage that the washing and finishing operation is effected simultaneously with the opening-separating operation.

It is not necessary for the tow to be cut into staple fiber before drying. In practicing this invention. If desired, the tow may be dried and then cut and sent directly to the baler. Other modifications will occur to those skilled in the art, and it is contemplated that the invention will be limited only by the following claims.

What is claimed is:

1. A process for the manufacture of staple fiber from a tow of filaments composed predominantly of polymerized caprolactam and still containing water soluble materials comprising the steps of drawing said tow, subjecting said tow to a crimping operation, propelling said tow through a series of conduits solely by virtue of the flow of hot water therethrough, said water being maintained at a temperature of at least 75° C., propelling said tow through a second series of conduits solely by virtue of the flow of a finishing liquid therethrough, the individual filaments of said tow during their travel within said conduits being separated and disturbed by the flowing liquid therein, and thereafter cutting said tow into staple lengths.

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2. A process for the manufacture of staple fiber from a tow of filaments composed predominantly of polymerized caprolactam and still containing water-soluble materials comprising the steps of drawing said tow, subjecting said tow to a crimping operation, washing said tow with water maintained at a temperature of at least 75° C., propelling said tow through a series of conduits solely by virtue of the flow of a finishing liquid there-through, and thereafter cutting said tow into staple lengths.

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