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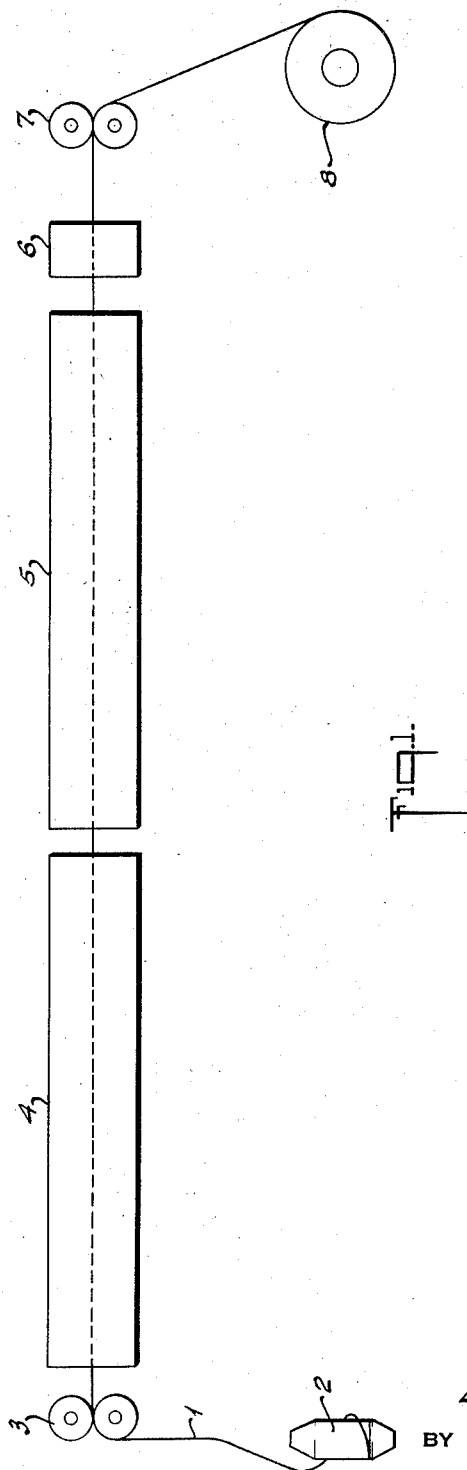
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2,863,280

METHOD OF CRIMPING FILAMENTS

Filed April 16, 1953

5 Sheets-Sheet 1



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Dec. 9, 1958

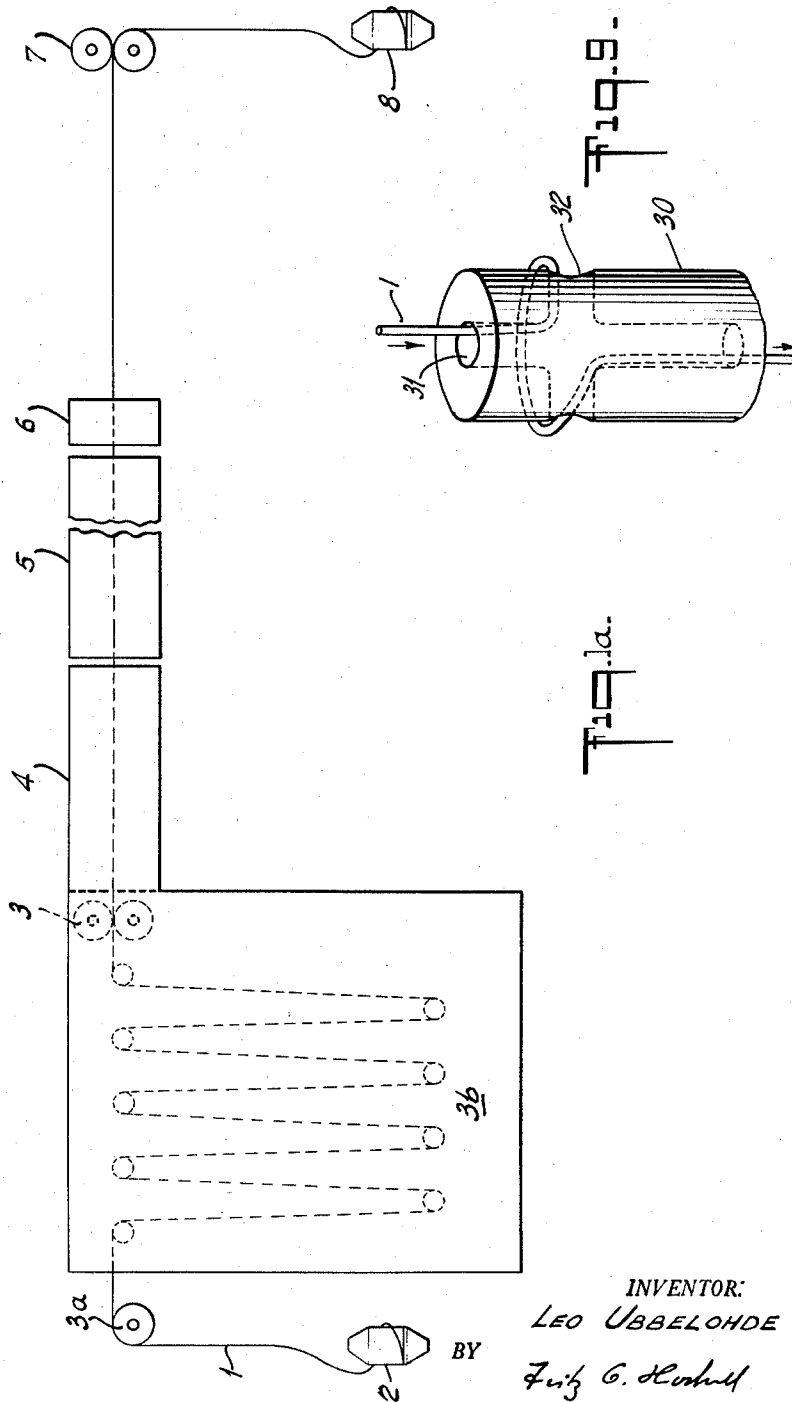
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METHOD OF CRIMPING FILAMENTS

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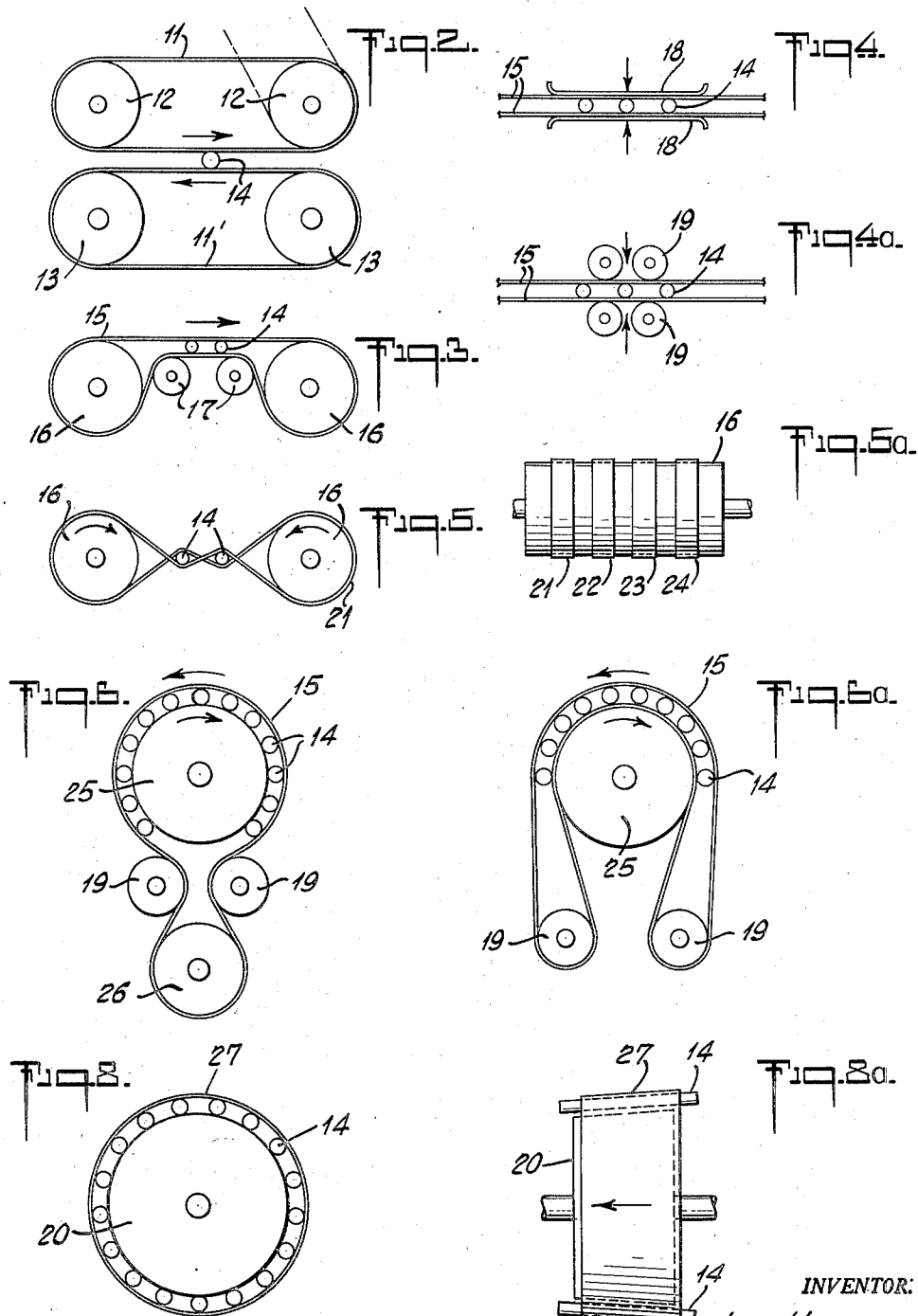
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METHOD OF CRIMPING FILAMENTS

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5 Sheets-Sheet 3



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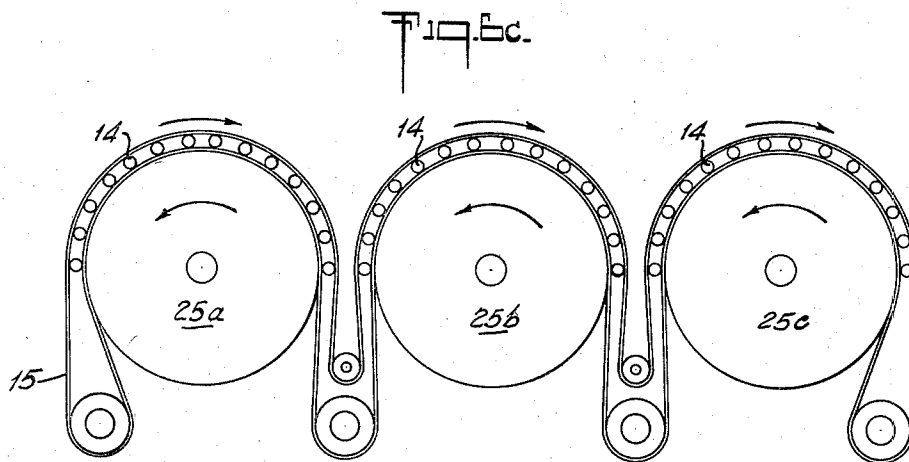
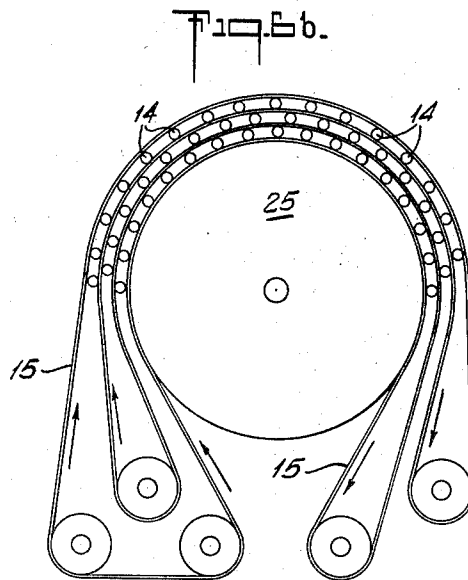
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METHOD OF CRIMPING FILAMENTS

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5 Sheets-Sheet 4



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METHOD OF CRIMPING FILAMENTS

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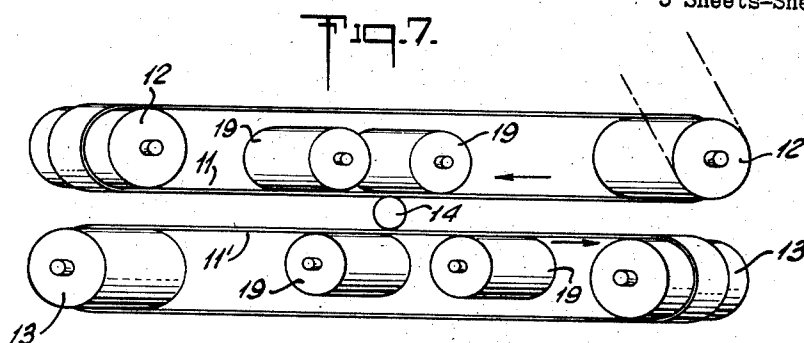


Fig. 7a.

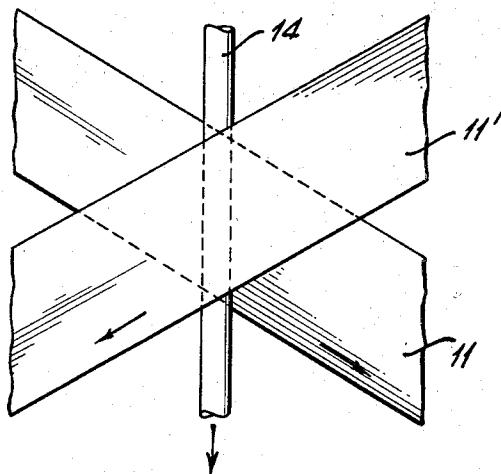
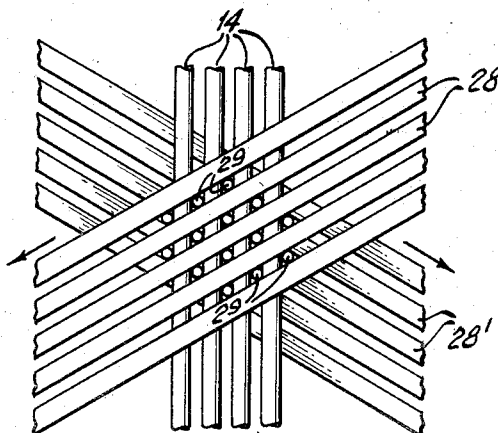


Fig. 7b.



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METHOD OF CRIMPING FILAMENTS

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Application April 16, 1953, Serial No. 349,285

Claims priority, application Germany May 23, 1952

8 Claims. (Cl. 57—157)

This invention relates to a method of crimping filaments, fibers and yarns, especially filamentary materials made of thermoplastic synthetic polymers.

Various methods have been attempted to impart a high permanent crimpiness to artificial normally straight filaments; means proposed for this purpose include spinneret holes of particular shape, toothed or grooved rollers, chemical solutions, shrinking, sharp drying, and the like.

Another known method consists in impressing on filamentary bundles a twist far exceeding the normal number of turns so as to impart a corkscrew structure to the filaments; this is effected by overtwisting filamentary bundles while spun into centrifugal boxes or by means of ring spindles, flyers, and the like, whereby fine artificial filaments are given thousands of turns per meter. At this high twist, individual filaments of the bundle attain a corkscrew form. Said corkscrew form is set by treating the fibers in cakes or on bobbins with suitable means, in the case of rayon, for instance, with formaldehyde. Subsequently, the filamentary bundles are drawn from the cakes or bobbins with removal of the twist previously impressed in the centrifuges or on the spindles. In this way, the individual filaments which have been set in their corkscrew structure, do not longer remain in their tight parallel position but spread out to form a very voluminous bundle. This effect can be increased when the filamentary bundle is not only untwisted to the zero point but given a slight reverse twist.

It will be noted that the above described method of crimping filamentary bundles involves two twisting operations, i. e., overtwisting and untwisting, which both require very high numbers of revolutions and are, therefore, very expensive.

In order to avoid those drawbacks, attempts have been made to use false twist: for instance, a method has been proposed, which consists essentially in passing a continuous bundle of cellulose acetate filaments through a false twisting device. In said device, a pipe is provided in which the filamentary bundle is subjected to the action of steam. This method does not give satisfactory results and has not found technical application for reasons which will become apparent from the following description of my invention.

A principal object of my invention is to provide an economic and very simple false-twisting method for producing crimped fibers and filaments.

Another object of the invention is to provide an apparatus suitable for carrying out the new method.

Other objects and advantages will become apparent from a consideration of the specification and claims.

According to the invention, a continuous filamentary bundle is passed through a twisting zone only after it has been previously softened and plasticized and resolidified during its travel. The bundle is softened, twisted and solidified before it enters the twisting zone. This method is completely at variance with the known false twisting methods where it has been considered essential to place the twisting device at the point where the filamentary

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bundle was in the plastic state, and where it was attempted to set the imparted twist after the bundle had left the twisting device. It is, however, a characteristic of false twist that it automatically snaps back after leaving the twisting device. In the known methods, therefore, the filamentary bundles, softened and twisted in the twisting zone, necessarily lost their corkscrew structure on leaving the twisting device because they left the twisting device while still in the plastic state and inherently resumed their straight structure because of the automatic release of the twist.

This drawback cannot be overcome by simultaneous twisting and setting, because the setting or solidification destroys or impairs the very plasticity necessary for allowing the bundle to receive the corkscrew turns.

I have found that the only satisfactory manner of setting the false twist of the individual filaments is as follows: The filamentary bundle is first passed through a zone in which it is softened and plasticized, then through a zone in which the filaments of the bundle are again solidified, and only then through the twisting zone. In this way, the twist imparted in the twisting zone runs backwardly through the solidifying zone into the plasticizing zone, and it is in this zone where the twist is actually impressed on the plasticized filaments. Therefore, I designate this zone, in which the filamentary bundle is softened, the twist receiving zone. The twist received in said zone is then set in the solidifying zone, and only subsequently does the filamentary bundle pass into the twist imparting zone. In its broadest aspect, the invention may therefore be defined as based on the discovery that the twist receiving zone has to be separated from, and placed before the twisting imparting zone, and that the twist has to be set between those two zones. In view of the foregoing, it will be understood that it is also possible to impart twist to a filamentary bundle in which the filaments are still in the plastic state, i. e. to a bundle of newly spun still plastic filaments, provided that the twist is set in the bundle before the bundle enters the twist imparting zone.

For applying the treating steps in the recited particular sequence, it is necessary to pass the filamentary bundle in a straight undisturbed path through the three zones because any change of direction of travel of the bundle would more or less disturb the backward run of the twist.

If, however, it is necessary, for operative or other reasons, for instance for lack of a sufficient length of space, to turn the traveling bundle into another direction, a second twisting device must be provided at a suitable point in the path of the bundle, e. g. in the solidifying zone or in the preheating zone; this second twisting device turns at the same speed as the main twisting device. Unexpectedly, I have found that false twist is not disturbed by a change of direction of travel of the filamentary bundle, for instance by passing the bundle around a roll, if said change is effected between two twisting devices.

The invention will best be understood by referring to the accompanying drawings, showing diagrammatically various embodiments of the invention.

In the drawings:

Figs. 1 and 1a are diagrams showing the successive steps of the method of the invention, and

Figs. 2 to 8 show, by way of example, diagrammatically various embodiments of apparatus suitable for carrying out the invention. In particular,

Fig. 2 shows a device where a bundle of filaments or a twisting tube is rolled between two belts driven in opposite directions;

Figs. 3, 4 and 4a show a similar device where the rolling movement is effected by the two runs of a single belt;

Fig. 5 shows a device using a plurality of belts driven by rollers for twisting a plurality of filamentary bundles;

Fig. 5a is a plan view of the right hand roller of Fig. 5, showing the parallel arrangement of the belts;

Fig. 6 shows an embodiment of the invention where a plurality of filamentary bundles or twisting tubes are rolled between a roller and a belt;

Fig. 6a shows a modification of the device illustrated in Fig. 6, where the bundles or tubes are rolled between the two runs of the single belt;

Figs. 6b and 6c are modifications of the same principle as used in Figs. 6 and 6a for placing a larger number of bundles or tubes between the two runs of a belt;

Figs. 7, 7a and 7b show a modification of the device of Fig. 2, where the two belts do not run parallel but at an angle to each other;

Figs. 8 and 8a are a front view and a side view of a device where the bundles or twisting tubes are rolled between a conical roller and ring, and

Fig. 9 is a perspective view of a novel form of twisting tube suitable for the method of the invention, showing the path of the filamentary bundle to be twisted.

Referring to Fig. 1, a continuous traveling bundle 1 of filaments made of a thermoplastic synthetic polymer or the like is drawn off a suitable supply of yarn 2, such as a spool or bobbin, and fed by a driven pair of rollers 3 into a heating zone (twist receiving zone) 4. In the heating zone, the traveling bundle is heated to a temperature which softens and plasticizes the filaments sufficiently for readily receiving the twist. In the case of nylon filaments, this temperature is preferably above 100° C. After twist has been impressed in this heating zone on the bundle, in a manner described hereinbelow, the bundle is passed through a cooling zone (solidifying zone) 5, in which it is cooled to a temperature where the filaments lose their plasticity. The cooling sets the corkscrew structure imparted to the individual filaments in the twist receiving zone 4, so that the filaments are no longer able to resume their original straight form.

The cooled bundle proceeds now into the twist imparting zone 6, where a twisting device turns it around its axis. The twist imparted in said zone is a false twist: the bundle on its entire travel from the roller pair 3 to the twisting device 6 is twisted in one direction (right hand), but on its way from the twisting device 6 to the pair of rollers 7, it is twisted in the opposite direction (left hand). The right hand twist runs back to the rollers 3 in the direction opposite to the direction of travel of the bundle. Therefore, though the impulse for the false twist is imparted to the filamentary bundle as late as in the twisting device in zone 6, the twist itself is impressed in the twist receiving zone 4 on the bundle softened therein. Said twist is set in the cooling zone 5, and the traveling bundle enters the twist imparting zone 6 in the already twisted, cooled, and set state.

When the filamentary bundle on its further travel from the twist inserting zone 6 reaches the pair of driven rollers 7, the twist of the bundle—which is a false twist—is removed. The bundle has retained only such twist as it had in front of the roller pair 3.

The individual filaments, however, retain the impressed corkscrew form. The bundle is, therefore, more voluminous than before it entered the bite of the rollers 3; it is very elastic, and has a woolly appearance.

It is of advantage to pass the traveling bundle in front of the pair of rollers 3 over a roller 3a into a preheating zone 3b, as shown in Fig. 1a. The filamentary bundles are not yet twisted in front of the roller pair 3 and they are in a looser condition than that which occurs after the succeeding overtwisting operation behind said pair of rollers 3. Therefore, they take up the heat more readily and are heated more uniformly

than in the case of Fig. 1 where they enter directly into the heating zone.

In the heating as well as in the preheating zone, the heating may be effected by means of hot air or by superheated steam. At sufficiently high traveling speeds of the bundle, I may use in the heating zone a heating medium having temperatures up to 200° C. and more. Where it is necessary to carry out the heating step within a very limited space, high frequency heating, ultrasonic or infra-red irradiation may be used. It is, of course, also possible to use well known gaseous or liquid softening agents, particularly if synthetic filaments made of cellulose derivatives, or the like, are subjected to the crimping operation. In such cases, I replace the cooling zone 5, where cold air is injected and the filaments may be cooled so far down as to resume room temperature, with a solidifying zone in which the softening agent is removed or neutralized.

On leaving the pair of rollers 7, the bundle is much shorter than on entering into the pair of rollers 3 because it is no longer under tension and consists of corkscrewlike crimped individual filaments. It may now be collected, for instance on the bobbin 8 (Fig. 1), if desired without stretch but it may also be provided with a slight twist opposite to the originally inserted twist, for instance by means of a revolving spindle. By such opposite twist, the bundle becomes still more voluminous than before. It may also be of advantage to twist two bundles with each other, of which the one had received a left-hand false twist and the other a right-hand false twist.

Though the description refers only to one filamentary bundle, it will be obvious that a plurality of bundles may be treated simultaneously according to my new method and in the apparatus described.

Neither is it necessary to pass the bundles only in a horizontal direction through the various zones; they may also travel in a vertical or any other straight direction.

Sometimes it is of advantage to heat the product collected behind the pair of rollers 7 again for a certain length of time and then to cool it again. In this way, the product contracts still more and its elasticity is further increased.

The false twist in the twisting zone 6 may be produced, for instance, by well known rotating tubes, which at the inside are provided with studs, projections or rolls so as to force filamentary bundles passing through the tube to rotate therewith. However, these tubes are strongly built and fixedly supported and are, therefore, suitable only for about 100 revolutions per second, because at higher numbers of revolutions the friction in the bearings and the speed of the driving ropes become excessive. But frequently a twist of up to 4,000 turns per meter is required for the production of good crimping effects, and thus it is necessary to pull the bundle through the rotating tubes so slowly that the output becomes too small and renders the process uneconomical.

This drawback can be obviated according to my invention by the following arrangement:

The filamentary bundle itself is rolled between two elements, for instance two belts, which run at equal speeds but in opposite directions to each other; the bundle is rolled and simultaneously advanced in a direction which is at a right angle to the direction of movement of the belts, and is twisted thereby. As is the usual case in such devices, the distance from the belt surfaces to the axis of the rolling bundle of filaments is at a minimum, and the number of revolutions of the rolling bundle in relation to the speed of the belts is at a maximum. With belt speeds of only 1 m./sec., it is possible to impart several thousands of turns per second to thin bundles of filaments, which renders the apparatus fully satisfactory for commercial operation.

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Instead of rolling the bundle of filaments itself, it may be passed through a fine tube which rolls between the belts. As such a tube need not be supported and is not subjected to bending or other mechanical stresses, it may have a very small diameter; therefore, also in this case a relatively very small belt speed is sufficient to obtain a high number of revolutions per second and thus allow a high rate of travel of the bundles through the apparatus.

The device shown in Fig. 2 comprises two belts 11 and 11', of which belt 11 runs over the rolls 12 and the belt 11' runs over rolls 13. The rolls drive the belts in the direction of the arrows, so that the belts roll between themselves the bundle of filaments or a twisting tube 14. In order to insert the bundles, the belt 11 may be lifted around a roll 12, as indicated by the broken lines.

A device using only one belt is shown in Fig. 3. One of the large rolls 16 is the driving roll for the belt 15; smaller displaceable pressure rolls 17 are provided for equalizing the pressure on the filamentary bundles or twisting tubes rolling between the two runs of the belt 15.

Other means to increase or to equalize the pressure on the belts are shown in Fig. 4 in the form of plates 18, and in Fig. 4a in the form of idler rolls 19, which are pressed against the belts in the direction of the arrows.

Figs. 5 and 5a show a modification where four belts, 21, 22, 23, and 24 pass side by side over the rolls 16 and around the twisting tubes 14 in such a way that e. g. the belts 21 and 23 pass around the top of the one tube and around the lower side of the other tube, whereas the belts 22 and 24 pass around the lower side of the first tube and the top of the second tube. In this way, the tubes are rolled, and it will be seen that always one of the parallel filamentary bundles receives a right-hand twist and the adjacent one a left-hand twist. It is, of course, possible to employ more than four belts and more than two tubes.

Another embodiment of the invention is shown in Fig. 6 where the belt 15 is driven by the roller 26 around a roll or wheel 25 rotating in opposite direction and is tensioned by the pressure rolls 19 in order to press the twisting tubes or filamentary bundles 14 against the roll 25, so as to impart a rolling movement to the tubes or bundles.

The device of Fig. 6 can be modified according to Fig. 6a by omitting the roller 26 and guiding the belt 15 twice around the large roll 25. In this case, the inner run of the belt 15 lies directly on the roll 25 and the outer run passes, in opposite direction to the inner run, over the twisting tubes, so as to cause their rolling movement.

Figs. 6b and 6c show modifications of the device for rolling a large number of twisting tubes with a single belt. According to Fig. 6b a single belt 15 passes in four superposed runs over the large roll 25, so as to accommodate three superposed groups of twisting tubes. As the belt 15 has the same speed at all contact points with the tubes, all the tubes receive the same numbers of revolution per unit of time. This has the advantage that all the filamentary bundles drawn through the twisting tubes receive the same number of turns, and, therefore, the same elasticity. The same effect is obtained with the arrangement of Fig. 6c, where the same belt is passed over three rolls 25a, 25b, and 25c. Instead of three such rolls, a greater number of rolls can be arranged side by side or one above the other in similar manner.

In the embodiment of the invention shown in Fig. 8, the twisting device comprises a driving roller 20 having a slightly conical outer surface and a ring 27, which is tapered at the inside according to the taper of the roller 20 and is rotated in a direction opposite to the direction of rotation of said roller. This opposite movement imparts a rolling movement to the filamentary bundles or rotatable tubes 14 uniformly arranged between the roller and the ring. As will be noted in viewing Fig. 8a, the roller 20 can be axially displaced in the direction of

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the arrow so as to reduce the clearance between its surface and the inner face of the ring 27 and to increase the pressure on the tubes or filamentary bundles.

In all the described constructions, the twisting tubes or filamentary bundles are rolled between two machine elements (belts or rigid surfaces) which are moving at equal speed but in opposite direction to each other. Theoretically, therefore, the axes of the tubes or filamentary bundles remain always at the same place. In practice, however, this result can only be accomplished by providing guide rods, forks, combs, rolls, or the like, which prevent the tube from being displaced to the one or other side. In addition, the tubes are subjected to a pull—small as it may be—in axial direction because the filamentary bundle drawn through the tubes tends to carry them along. The tubes must therefore be secured also against axial displacement. As the pressures in both cases are very small, the friction on these holding means is so small that hardly any frictional heat development can be observed even at highest numbers of revolutions.

The embodiments of the invention represented in Figs. 2 to 6, and 8, illustrate devices in which the belts or rolling surfaces run parallel to each other and engage frictionally the filamentary bundles in a direction perpendicular to the axes of the bundles. As the filamentary bundle must not only be rolled but also drawn off in axial direction, the belts exert a braking effect on the bundle being drawn. This braking effect must be overcome by an increased pull in axial direction. Any pull or stretch, however, reduces the number of turns of the twist. The reason therefor is that a filamentary bundle is shortened while twisted; consequently, a pull tends to detwist the twist, i. e., it decreases the efficiency of the twisting device.

If two belts 12 and 13 are not operated parallel to each other but at an angle as shown in Figs. 7 and 7a, the resultant of the belt movement on the filamentary bundle 14 imparts not only a twisting movement but also advances the bundle in the direction of the arrow. In order to make the advancing action conform to the requirements, the angle formed by the belts 12 and 13 can be made adjustable. Such a twisting device can, therefore, exert also a pulling action and be used to stretch the bundle. The rolls 19 have the same function as those in Fig. 4a, and they have the same oblique position as the rolls 12 and 13.

If it is desired to roll a plurality of filamentary bundles side by side, comb-like thread guides may be arranged in front of and/or behind the belts in order to prevent adjoining bundles from running together and becoming entangled with each other. This result is still more securely obtained by replacing the wide belts 11 and 11' of Fig. 7a by a plurality of narrow bands 28 and 28' running at a small distance parallel to each other so that several thread guides 29 may pass through the interspaces of the bands at their crossing points (Fig. 7b).

Frequently, wetted filamentary bundles are more easily twisted than dry ones. As belts I may employ leather or rubber belts. Also belts made of plastics such as nylon or perlon are suitable; since they are very smooth and of uniform thickness, they are particularly adapted for twisting very thin filamentary bundles.

As shown in Fig. 9, the twisting tube 30, which may be made of metal, plastics, or glass, has an axial bore 31 and in addition thereto a transverse bore 32 crossing said axial bore 31. The twisting tube is represented on a much enlarged scale; preferably I use tubes having an outer diameter of only about 2 mm. The filamentary bundle 1 is axially fed, in the direction of the arrow, at one end of the tube into the axial bore, passes laterally out through one end of the transverse bore, is wound one half turn around the tube, enters again through the other end of the transverse bore, and is finally drawn off from the tube through the other end of the axial bore. The

winding compels the bundle to take part in the rotation of the twisting tube.

I do not wish to limit myself to the exact construction and arrangement of the parts of the twisting device, as various changes may be made without departing from the spirit and scope of my invention. It will be further obvious that the method and apparatus can be applied to filaments, horse-hair and the like made of other materials than those specifically mentioned, and to mixtures of natural and synthetic fibers and filaments. The fibers and filaments may also be impregnated with setting agents at a suitable stage of the process to improve their permanent curliness.

What I claim is:

1. A method of crimping filaments of synthetic thermoplastic polyamides comprising passing a traveling continuous bundle of said filaments through a heating zone to render said filaments plastic, cooling said plasticized filaments below the softening point, so as to remove the plasticity imparted in the preceding step and to solidify the filaments applying a false twist to said solidified filaments in a twist inserting zone, which false twist runs backwardly along said solidified filaments against the direction of their travel from said twist inserting zone into said heating zone where it is received by said filaments while plastic, and continuing the travel of the bundle after said twist inserting zone for a length sufficient to allow untwisting of said inserted false twist.

2. A method of crimping filaments of synthetic thermoplastic polymers comprising passing a traveling continuous bundle of polyamide filaments through a heating zone and heating said bundle to a temperature above 130° C. so as to render said filaments plastic, cooling said plasticized filaments below the softening point, so as to remove the plasticity imparted in the preceding step and to solidify the filaments applying a false twist to said solidified filaments in a twist inserting zone, which false twist runs backwardly along said solidified filaments against the direction of their travel from said twist inserting zone into said heating zone where it is received by said filaments while plastic, and continuing the travel of the bundle after said twist inserting zone for a length sufficient to allow untwisting of said inserted false twist.

3. A method of crimping filaments of synthetic thermoplastic polyamides comprising passing simultaneously a plurality of traveling continuous bundles of said filaments through a heating zone to render said filaments plastic, cooling said plasticized filaments below the softening point, so as to remove the plasticity imparted in the preceding step and to solidify the filaments applying false twist to said solidified filaments in a twist inserting zone, which false twist runs backwardly along said solidified filaments against the direction of their travel from said twist inserting zone into said heating zone where it is received by said filaments while plastic, and continuing the travel of the bundles after said twist inserting zone for a length sufficient to allow untwisting of said inserted false twist.

4. A method of crimping filaments of synthetic thermoplastic polymers comprising passing simultaneously a plurality of traveling continuous bundles of polyamide filaments through a heating zone and heating said bundles to a temperature above 130° C. so as to render said filaments plastic, cooling said plasticized filaments below the softening point, so as to remove the plasticity imparted in the preceding step and to solidify the filaments applying a false twist to said solidified filaments in a twist inserting zone, which false twist runs backwardly along said solidified filaments against the direction of their travel from said twist inserting zone into said heating zone where it is received by said filaments while plastic, and continuing the travel of the bundles after said

twist inserting zone for a length sufficient to allow untwisting of said inserted false twist.

5. In a method of crimping filaments, the steps of passing a traveling continuous bundle of thermoplastic polyamide filaments in the hot plastic state into a cooling zone so as to cool said filaments below the softening temperature, applying immediately afterwards a false twist to said solidified filaments, and allowing said false twist to run backwardly into and beyond said cooling zone so as to act on said filaments while still in the hot plastic state.

6. A method of crimping filaments of synthetic thermoplastic polyamides comprising passing a traveling continuous bundle of said filaments through a heating zone to render said filaments plastic, cooling said plasticized filaments below the softening point, so as to remove the plasticity imparted in the preceding step and to solidify the filaments applying a false twist to said solidified filaments in a twist inserting zone, which false twist runs backwardly along said solidified filaments against the direction of their travel from said twist inserting zone into said heating zone where it is received by said filaments while plastic, continuing the travel of the bundle after said twist inserting zone, untwisting said inserted false twist beyond the zero point, and imparting to said bundle a reverse twist.

7. A method of crimping filaments of synthetic thermoplastic polyamides comprising passing simultaneously a plurality of traveling continuous bundles of said filaments through a heating zone to render said filaments plastic, cooling said plasticized filaments below the softening point, so as to remove the plasticity imparted in the preceding step and to solidify the filaments applying a false twist to said solidified filaments in a twist inserting zone, which false twist runs backwardly along said solidified filaments against the direction of their travel from said twist inserting zone into said heating zone where it is received by said filaments while plastic, continuing the travel of the bundles after said twist inserting zone for a length sufficient to allow untwisting of said inserted false twist, and twisting at least some of said bundles with each other.

8. A method of crimping filaments of synthetic thermoplastic polyamides comprising passing a traveling continuous twisted bundle of said filaments through a heating zone to render said filaments plastic, cooling said plasticized filaments below the softening point, so as to remove the plasticity imparted in the preceding step and to solidify the filaments applying a false twist to said solidified filaments in a twist inserting zone, which false twist runs backwardly along said solidified filaments against the direction of their travel from said twist inserting zone into said heating zone where it is received by said filaments while plastic, and removing said inserted false twist after said twist inserting zone so as to retain the original twist.

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