June 27, 1967 GENTARO NIINA ETAL 3,327,463
METHOD AND APPARATUS FOR IMPARTING FALSE TWIST
TO CONTINUOUS FILAMENTS BY FRICTIONAL CONTACT
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Fig. 1

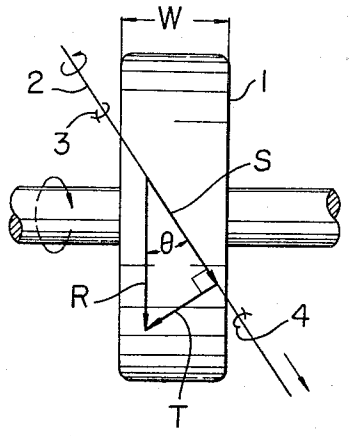


Fig. 2

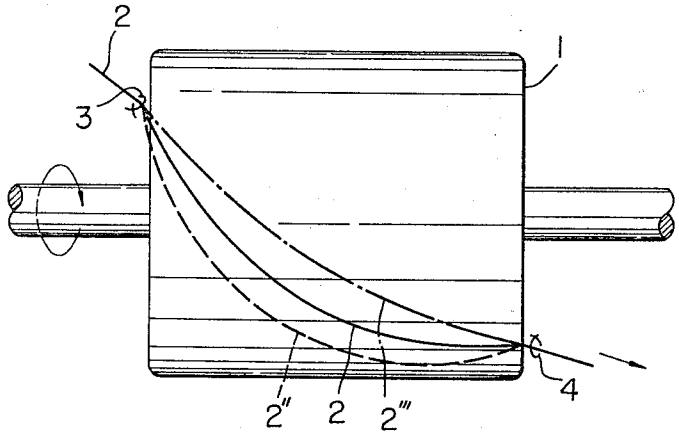


Fig. 3

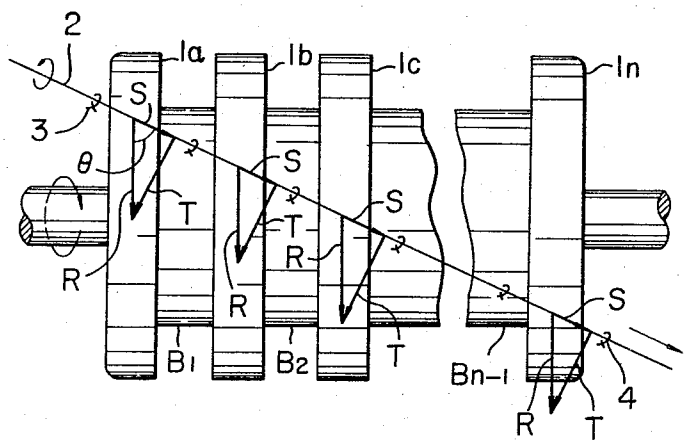


Fig. 3'

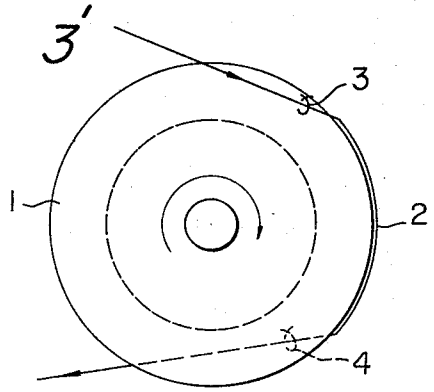
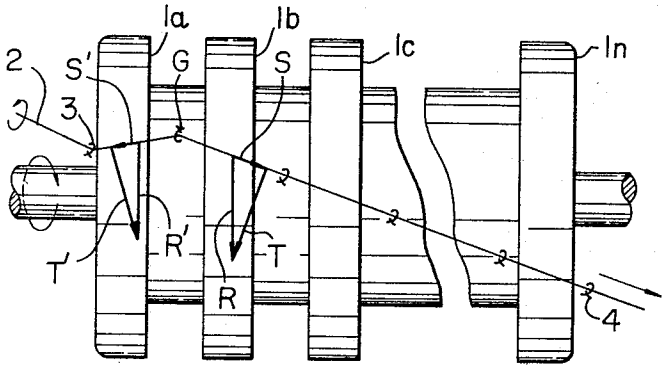


Fig. 4



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Fig. 5

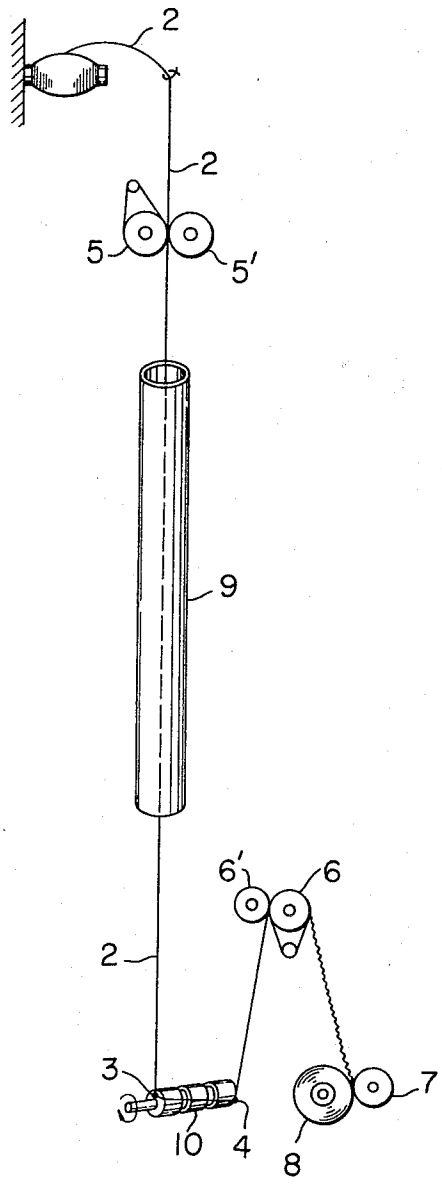


Fig. 6

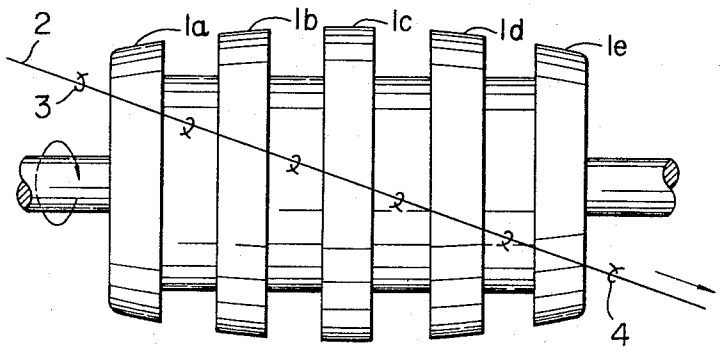


Fig. 7

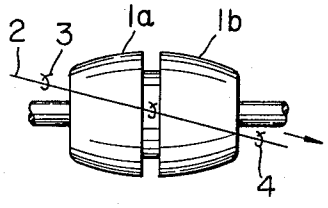


Fig. 8

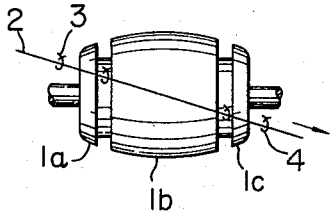
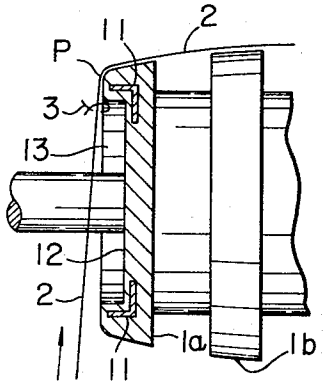


Fig. 9



United States Patent Office 3,327,463 Patented June 27, 1967

3,327,463

METHOD AND APPARATUS FOR IMPARTING FALSE TWIST TO CONTINUOUS FILAMENTS BY FRICTIONAL CONTACT

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7 Claims. (Cl. 57—77.4)

This invention relates to a method of imparting to continuous filaments excellent false twist by frictional contact at high speeds without damaging the filaments, and also to a friction twisting apparatus suitable for use in practicing such a method, and particularly to the twist head in such an apparatus.

More specifically, the invention relates to a method of false twisting by frictional contact which is characterized in that the continuous filaments are run in contact with the external surface of a twist head having a plurality of rotating friction discs, the filaments in this case being run obliquely with respect to the direction of rotation of said surface.

The method of imparting false twist by frictional contact is a method which has as its object to impart torsional force to the advancing filaments by running it in contact with the frictional surface of a rotating member having a frictional surface consisting of a non-abrasive material having a high coefficient of friction (with the continuous filaments). This method is featured in that high speed torsional force can readily be imparted to the filaments.

This method of imparting false twist to filaments by frictional contact can roughly be classified into two types. One is that in which the filaments are run in contact with the internal surface of a rotating hollow tube. This procedure is the one which is most widely practiced. The other is the one in which the filaments are run in contact with the external surface of a rotating member. By the description as used in the present invention that the filaments are run in contact with the external surface of the rotating member obliquely to its direction of rotation is meant that an arc is described when the locus of the filaments is projected on a plane intersecting the axis of the rotating member at right angles thereto.

In the aforementioned two types of conventional methods, the aforesaid locus either describes a straight line or is a dot.

In order to carry out the false twisting continuously in false twisting by frictional contact, the filaments must be subjected to a torsional force and simultaneously a force in their axial direction, i.e., it is necessary that the motion of running the filaments in contact with the frictional surface of the rotating member be made smooth. In general, it goes without saying that for imparting a torsional force efficiently to filaments the higher the coefficient of friction of the frictional surface of the rotating member, the better are the results obtained.

However, if it is attempted to increase the false twisting speed by increasing the coefficient of friction, the coefficient of friction along the filament axis also increases as a matter of course and damage to the filaments and rotating member occurs. Particularly when it is attempted to carry out high speed operations, the passing filaments stick-slip to cause partially twisted filaments to appear. Hence, a situation cannot be avoided where the filaments do not even manifest the form that it must posses as a crimped yarn.

Accordingly, for imparting false twist to filaments by means of frictional contact without the occurrence of stick-slipping or the filaments being otherwise adversely affected, it stands to reason that numerous limitations were

imposed operationally and in addition there was also a limit to any great increase in the false twisting speed.

As a result of our researches with a view to overcoming these inevitable technical bottlenecks which were encountered in imparting false twist by frictional contact and thus to provide an improved method and apparatus which can impart at high speed false twist to continuous filaments by frictional contact without the possibility of stick-slips occurring or damage to the filaments, we found that the foregoing object could be attained by choosing as the method the latter of the aforementioned two types and by imparting a torsional force as well as a positive longitudinal force in the direction of the axis of the filaments which are advancing in contact with the frictional rotating member.

FIGURE 1 is a view for explaining the basic principles of the invention. Namely, continuous filaments 2 are run in contact over a friction disk 1 whose external surface is formed with a non-abrasive material. In this case, the filaments 2 are made to contact the disc 1 at an angle indicated by θ with respect to the rotational direction of the disc by means of guides 3 and 4 disposed at the respective two sides of said disc 1. As a result, the force R of the external surface of the friction disc 1 acts on the filaments 2 as two components of force S and T. That is to say, S is the force acting in the direction of the filament axis (force of feeding the filaments) and T is a force acting to effect the torsional force of the filaments. Their magnitudes are as follows:

$$\text{longitudinal force } S=R\cos\theta$$
$$\text{torsional force } T=R\sin\theta$$

In this case, it is necessary that the contact between the filaments and the frictional external surface be made perfect for the force of R to act efficiently on the filaments.

If, for this purpose, an attempt is made to increase the portion which the filaments contact the disc by increasing the width W thereof greatly, and as shown in FIGURE 2, the width is made, say, greater than the diameter of the friction disc, the filaments which run in contact with the disc 1 by means of the rotation of the disc is bowed, say, as indicated by 2'. Thus the smooth torsional and longitudinal forces of the filaments are impeded. The position of contact of the filaments with frictional external surface lacking stability becomes at times as indicated by the dashed line 2'' and at times as indicated by the dotted line 2'''. When the extent of this swing becomes excessive, the filaments finally become wound up onto the disc to render the false twisting operation impossible.

In the invention method wherein, for eliminating this defect and thus make it possible to carry out the false twisting operation smoothly and moreover accompanied with a filament feeding motion, the filaments are made to run in contact with the external surface of a rotating member having a plurality of friction discs rotating about a common shaft, obliquely to the direction of rotation of said surface, the width W of the friction discs being preferably less than the diameter of said discs. Of course, if the running speed of the filaments is sacrificed, the width W can be increased considerably. In the present invention, however, the friction disc which is divided into at least two discs is used. In this case, it is preferred to ensure the oblique travel of the filaments by providing at least one guide at a suitable location between the plurality of friction discs.

FIGURE 3 is a schematic front view partly broken away of a twist head for false twisting by frictional contact, FIGURE 3' being an end view thereof. Referring to FIGURE 3, by providing grooves B_1, B_2 . . . B_{n-1} so as to interrupt the continuity of the external surface of the friction disc 1, *n* friction discs 1*a*, 1*b*, 1*c* . . . 1*n* hav-

ing a width w were formed. Filament guides totaling $n+1$ were disposed in the following locations; one each at the outer ends of both discs **1***a* and **1***n* and one each at the grooves B_1, B_2 . . . B_{n-1}. Thus the filaments **2** were held in their oblique direction which makes an angle θ with the direction of the rotation of the friction discs. In addition, the filaments were held practically in a straight line.

It is, of course, not necessary to dispose the guides between all of the plurality of friction discs, as shown in FIGURE 3, but it is permissible to dispose a lesser number, as deemed proper, or they can all be omitted. In general, the provision of guides between the friction discs becomes more desirable as the width W of the friction discs becomes greater.

In the invention method, as the aforementioned angle θ made by the filaments running in an oblique direction becomes greater, the longitudinal force S becomes greater while the torsional force T becomes smaller. Conversely, as the angle θ becomes smaller, the longitudinal force S becomes smaller while the torsional force T becomes greater. Accordingly, the inclination in an oblique direction of the angle θ made by the filament running in contact with the rotating surface can be changed at an optional location. In this case, it is desirable to maintain the length of the aforementioned arc of the filament projected locus constant by disposing a guide at the aforesaid point of change.

FIGURE 4 illustrates an instance where a change of the oblique direction has been made at the point of change by means of guide G. In this case, the longitudinal force S′ imparted by the friction disc **1***a* is opposite to the longitudinal force S imparted by the other friction discs. When the filaments are run in this manner, the number of false twist turns increases. Further, while not shown in the figure, the number of false twist turns can also be regulated by varying degree of increase or decrease in the force with which the longitudinal force acts on the filament in its direction of travel, as in FIGURE 3.

The most basic mode of practicing the invention method will be described with reference to FIGURE 5. In the apparatus for producing crimped yarn of FIGURE 5, the continuous, thermoplastic synthetic filaments **2** from the bobbin passing via feed rolls, **5**, **5′** through a heater **9** run in contact obliquely about the external surface of friction twisting twist head **10**, as previously described. The heated filaments, at this time, are imparted a torsional force having a longitudinal force to become a crimped yarn and are then wound up into a package **8** by means of friction roller **7** via take-up rolls **6**, **6′**.

In the figure is shown the instance of a twist head **10** which consists of three friction discs spaced apart from each other and rotated by means of a common shaft in the direction indicated by the arrow.

Thus, according to the invention method, excellent crimped yarn can be produced at extremely high speeds without causing any damage to the yarn or the occurrence of stick-slipping during the false twisting operation. Ultra high speed operations of from 500 to 1000 m./min. are possible by means of the invention method. Further, by varying the angle θ in the oblique direction, the hand of the crimped yarn obtained can also be varied.

Next, the twist head for false twisting by frictional contact which is used for practicing the invention method will be described more fully. While the twist head used in the invention method consists of a plurality of friction discs spaced apart from each other on a common shaft and thus constitutes as whole a single rotating body, its over-all shape is not limited to a cylindrical shape having grooves, as shown in FIGURES 3 and 4. In FIGURES 6, 7 and 8 are shown those which, besides having been varied as to the number of grooves and width of the friction discs, have in all cases an over-all shape which is substantially barrel-shaped.

This barrel-shaped twist head is not only convenient for serving to enhance the force with which the filaments

run in contact with its external surface but also to uniformalize the force of contact between the portions at where the filaments enter and leave the twist head as well as the midsection thereof. Hence, when compared with the instance where the over-all shape is cylindrical, the width of one of the friction discs can be made wide as in FIGURE 8, for example. Generally, the width of the friction dics in the case of a cylindrical twist head is less than its diameter, and usually of the order of 3–100 mm. On the other hand, the width of the groove need only be such as will permit the installation of a guide. Usually a width of the order of 2–30 mm. will be sufficient.

In the invention twist head, it is preferred that a suitable number of guides be provided at suitable locations between the friction discs for assisting the travel of the filament in an oblique direction in contact with said twist head. These guides, inclusive of the guides **3** and **4** and the plurality of guides disposed therebetween, can be installed in coupled relation on a single bar, thus making it possible to freely vary the angle θ by changing the direction in which said bar is disposed. This supporting bar can be designed with a pantographlike linking device and the guides made to move at all times above said grooves B_1, B_2 . . . B_{n-1} in a plane perpendicular to the rotating shaft as the aforesaid angle θ changes.

In carrying out the false twisting by frictional contact, it is preferred to bend the filaments sharply along the outer end surface **12** of the twist head at the point where the filament is introduced and/or taken out, thus increasing the force with which the filaments contact these points to prevent a decrease in the twist. For this purpose, it is preferred that the twist head be so designed, as shown in FIGURE 9, that of the two outermost discs of a plurality of discs making up a twist head at least one of them, and preferably both, have their outer rim potrion P of their rotating surface projecting beyond the outer end surface **12**. Thus, the recessed portion **13** formed at said outer end permits the installation of guide **3** in a position extremely close to the twist head. This makes it possible to bend the filaments sharply without hindering the false twist of the filament **2** to extend back to the heating zone by means of the guide **3**.

In this case, the annular lip including the aforementioned rim portion, tends to be deformed by the centrifugal force resulting from the rotation of the twist head, though there is some difference in degree depending upon such as the shape and material used. Hence, it is desired that the ends of the twist head be reinforced by embedding, for example, an annular reinforcing piece of L section, as shown in cross-section in FIGURE 9, or a reinforcing piece of other suitable shape.

The twist head can be made by fitting elastic rings of natural or synthetic rubber or plastics at suitably spaced intervals about a cylindrical or barrel-shaped twist head proper made of wood, metal or plastics. The twist head proper can be made into a form having suitable grooves therein to which projecting portions are either fitted the elastic rings or coated an elastic material. Alternatively, the whole twist head can be formed in one piece with rubber or plastics.

Further, the force of contact of the filament can be enhanced and the wear of the ends of the twist head can be prevented by using different materials for its ends and its midsection. For instance, by using for the foregoing plurality of friction discs which make up a twist head as a whole, discs whose hardness is relatively great, say, of rubber having a hardness of 60°–75°, for at least one of the discs at the two ends of the twist head and discs whose harndess is relatively small, say, of rubber having a hardness of 40–50°, for the rest of the discs in the middle part of the twist head, the contact of the filaments with the middle part can be enhanced while preventing the wear at the two ends.

The following examples are given for illustrating the production of crimped yarn using the invention twist head for false twisting by frictional contact.

EXAMPLE 1

For making a crimped yarn of 100 denier 24 filament nylon yarn, it was passed through an electrically heated tube whose temperature was controlled so as to be 180°, following which it was fed at the rate of 500 meters per minute to a twist head rotating at 5000 r.p.m. The filaments were in a highly twisted state of 2500 turns per meter at the heated tube. The twist head used was one such as shown in FIGURE 3, and the frictional surface at which the yarn was bent at an acute angle at point P, as in FIGURE 9, was covered with synthetic rubber having a rubber hardness of 60. The other dimensions were as follows:

Twist head length	mm.	88
Disc diameter	mm.	70
Number of discs		5
Disc length	mm.	12
Groove length	mm.	7

The guides were provided at the rate of one for each groove, and the filaments were made to run in contact with the twist head in a straight line making an angle with the axis of the latter of 9°30′. The filaments were then relaxed between the drawing-off rolls and the winding-up roll and wound up into a package under low tension.

EXAMPLE 2

The procedures described in Example 1 were followed except that the twist head was changed. The twist head used was one which was barrel-shaped as in FIGURE 6, and the frictional surface at which the yarn was bent at an acute angle at point P, as in FIGURE 9, was covered with synthetic rubber having a rubber hardness of 60. The other dimensions were as follows:

Twist head length	mm.	69
Disc diameter:		
at the two end portions	mm.	67
at the middle portion	mm.	71
Disc length	mm.	12
Groove length	mm.	7

The guides were provided at the rate of one for each groove. The angle formed by the filaments reaching the guide at the first groove and the axis was varied from 0° to 15° as in FIG. 4. At a point were the longitudinal force changes, the filaments were made to run in contact with the twist head in a straight line making an angle with the axis of the latter of 9°30′. In this case, the number of false twists was 2300 T/M for 0° and 2800 T/M for 15°. The filaments were then relaxed between the take-up rolls and the winding-up roll and wound up into a package under low tension.

We claim:

1. A method of false twisting by frictional contact which comprises running filaments in frictional contact with the external surface of a rotating member having a plurality of friction discs rotating about a common shaft, said filaments being run in an oblique direction with respect to the direction of rotation of said external surface, said filaments being maintained in said oblique direction by at least one guide means located between said plurality of friction discs.

2. The method according to claim 1 wherein the inclination of said oblique direction is changed in the course of the false twisting surface.

3. A twist head for false twisting by frictional contact comprising a rotating shaft and a plurality of friction discs disposed in spaced relation thereon to constitute a single rotating member, said single rotating member being of barrel shape.

4. A twist head according to claim 3 wherein the width of the friction discs making up said rotating member is not greater than the maximum diameter of said friction discs and the intervals therebetween is at least such that guides can be interposed.

5. A twist head according to claim 3 wherein the outer rim of the rotating surface of at least one of the two outmost of said plurality of friction discs projects beyond the outer end surface of said twist head.

6. A twist head according to claim 5 wherein a reinforcing material is embedded inside said projecting rim.

7. A twist head according to claim 3 which comprises using friction discs of great hardness for at least one each of the friction discs disposed at the two outer ends of said twist head and using friction discs of small hardness for the remaining discs disposed in the middle part of said twist head.

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