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Ishizawa et al.

[11] **3,803,826**

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[54] **METHOD FOR CONTINUOUSLY SETTING WOOL SILVER**

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[52] **U.S. Cl.** ..... **57/156,** 57/157 TS, 57/157 MS
[51] **Int. Cl.** **B02g 1/00,** D02g 1/02
[58] **Field of Search** ..... 57/1, 34 R, 34 HS, 35, 57/36, 51, 55, 5, 77.3, 156, 157 R, 157 TS, 157 MS, 157 S, 164; 19/66 T; 28/59, 61

[56] **References Cited**

UNITED STATES PATENTS

3,686,845	8/1972	Okada et al.	57/34 HS
3,505,802	4/1970	Okada et al.	57/156
3,447,310	6/1969	Bok et al.	57/35 X
3,650,103	3/1972	Farrar et al.	57/34 HS
3,742,692	7/1973	Bense	57/34 HS
3,247,569	4/1966	Gliksmann et al.	57/34 HS
3,204,396	9/1965	Foster et al.	57/157 TS X
2,891,376	6/1959	Stoddard et al.	57/34 HS
3,339,250	9/1967	Comolli	57/34 HS X

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[57] **ABSTRACT**

During the process of manufacture of a wool "top" among the entire worsted spinning operation, the sliver is first heated by steaming in its state of containing moisture, and then is imparted false twist while steaming the resulting sliver under tension, and thereafter is dried, at a temperature lower than that of said steaming, by the use of an apparatus having, in series combination, a steaming chamber, a heating and false twisting chamber and a drying chamber which are coupled to each other. By this method, the crimps of the fibers in the silver disappear to such an extent as can be recovered only by a specific crimp recovering step which is performed in the final finishing process.

7 Claims, 7 Drawing Figures

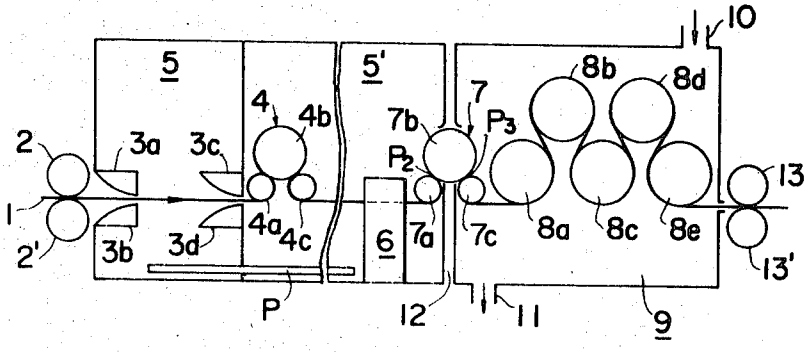


FIG. 1

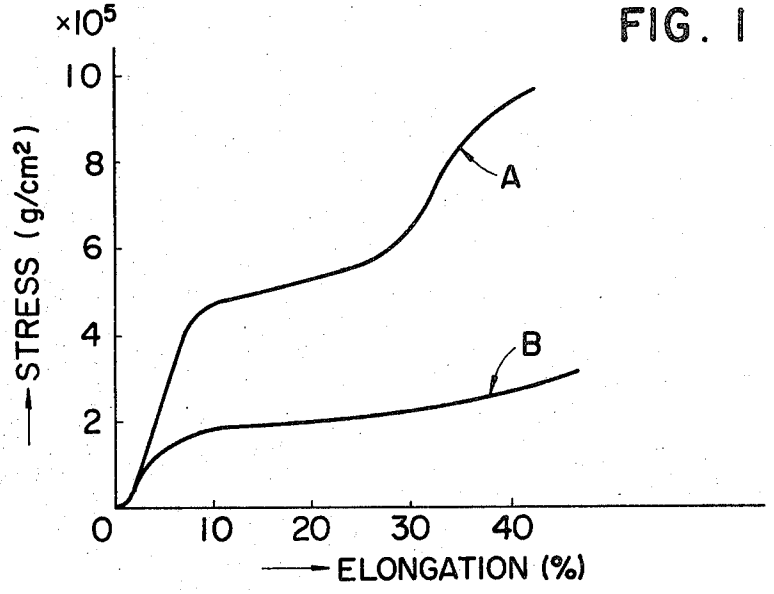


FIG. 2

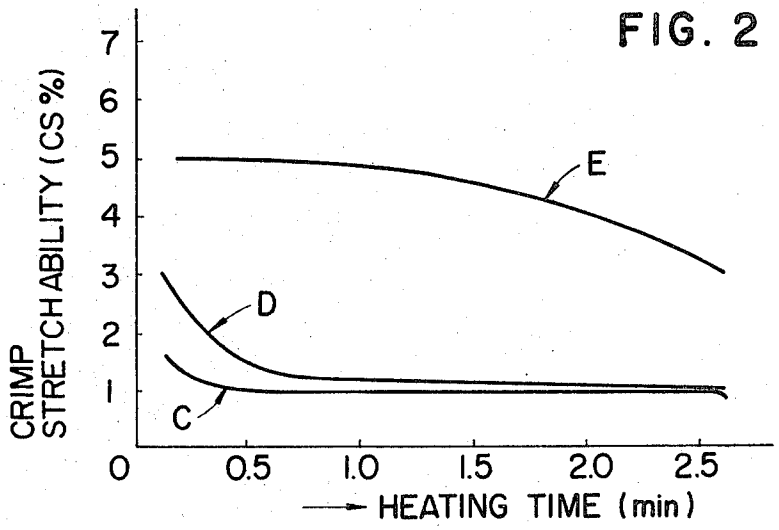


FIG. 3

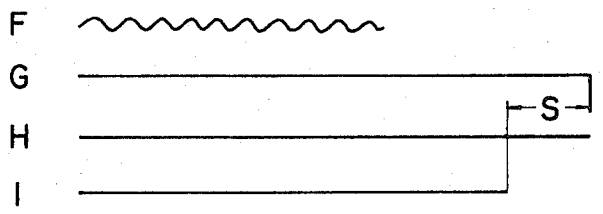


FIG. 4

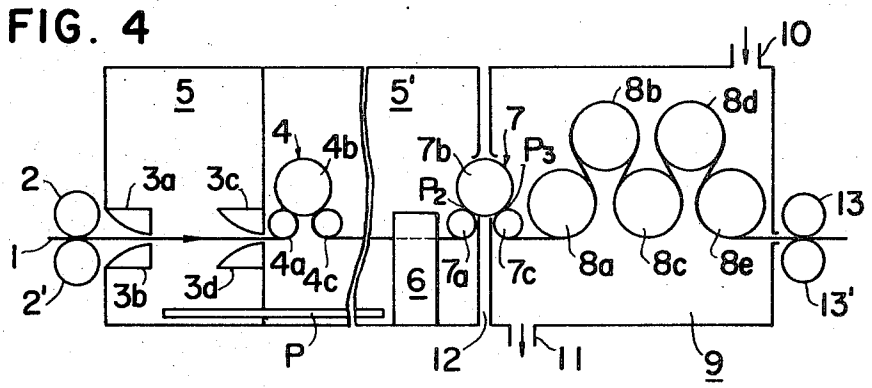


FIG. 5

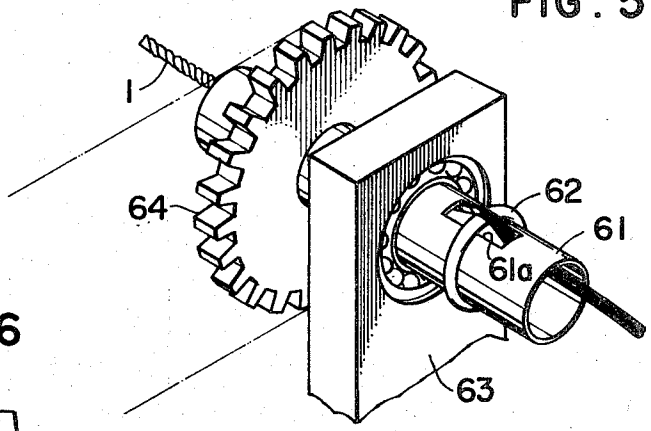


FIG. 6

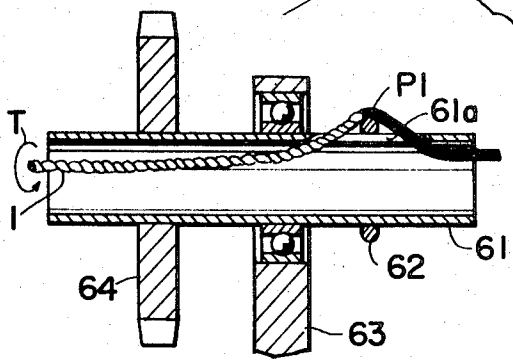
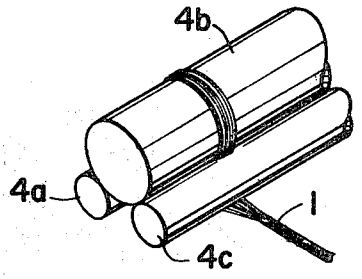


FIG. 7



METHOD FOR CONTINUOUSLY SETTING WOOL SILVER

BACKGROUND OF THE INVENTION

a. Field of the invention:

The present invention is concerned with a method an apparatus for continuously setting a wool sliver, and more particularly, it relates to a method and an apparatus for provisionally straightening the crimps of the individual fibers constituting the sliver for later recovery of these crimps in the final finishing step.

b. Description of the prior art:

In the manufacture of a worsted wool "top" - during the entire course of the worsted spinning process - from a wool sliver formed with a number of individual wool fibers, it is known that, by removing the crimps from the wool fibers, the sliver will exhibit better spinnability and permit its drafting to be performed smoothly, with the resulting many advantages in the subsequent spinning process that the occurrence of yarn breakages can be greatly reduced and that it is possible to enhance the yield in the combing process.

However, if the wool sliver is given such a drastic setting as will cause the wool fibers to lose their inherent crimps permanently, the final product will lack the bulky hand which is peculiar to wool and accordingly will markedly lose its value as an article of commerce. Therefore, it is necessary that this crimp straightening treatment be only provisional to insure that the fibers will continuously remain in a substantially crimpless state throughout the spinning process and that the fibers will regain their crimps for the first time when they are subjected later to a crimp recovering treatment either after the sliver is spun into a yarn or after the yarn is woven or knitted into a fabric.

To meet this requirement, it has been the practice in the prior art to soak the fibers of a sliver in a heated water during the back washing process which concurrently performs after a drafting and heating treatment, to thereby temporarily remove crimps from the fibers as the secondary effect of said back washing step, and thereafter in the subsequent respective steps of the spinning process, the resulting sliver is wound around a bobbin under tension. These steps are repeated in the spinning process of the prior art to produce a worsted wool "top". This "top" which is a long bundle of individual fibers wound in the shape of ball under tension is then stored for a prolonged time in a dark and cool place for ageing. It is by these complicated procedures that temporary setting of wool slivers is achieved in the prior art.

However, the aforesaid temporary setting of the wool sliver conducted according to the prior techniques was invariably weak such that the once lost crimps of the fibers would be recovered quickly by a mere increase in the temperature to which the fibers are exposed.

Therefore, especially when it is intended to take the "top" into a can, instead of winding the "top" in the shape of ball, for the sake of providing the "top" in a large package, or in case it is intended to omit the ageing process to shorten the production period, it could happen that the opportunity of conducting the temporary setting step of the fibers is lost. Because of these reasons, the heat treatment of the wool fibers of a sliver which is performed under tension to temporarily remove the crimps from these fibers has constituted a serious bottle neck in the rationalization of worsted spinning, requiring solution.

Also, it is known as a principle that the crimps of wool fibers can be removed either by the steps of heating, for a certain while, a wool sliver in a tensioned state when the sliver is wet, or by first moistening the fibers with water, then heating the same thereafter drying them under tension.

Japanese Pat. Publication No. 42–4301 discloses the techniques of setting the fibers to a crimpless state by passing steam through a container in which a worsted wool top is contained. However, according to this method, the stress to which the wool fibers are subjected is very low, being only 30–60 g at most per gram/meter of the sliver. Moreover, this method has a further disadvantage that it cannot be performed in a continuous mode of operation.

Now, for the sake of reference, hereunder will be mentioned below the method of evaluating the state of crimps of wool fibers which has been worked out by the inventors. More specifically, a length of wool sliver test piece depending downwardly in relaxed state was nipped between two nippers of a tensile tester. These nippers were positioned at an interval corresponding substantially to the mean length of the fibers constituting this sliver. Then, the test piece was elongated by these nippers so that a stress-elongation curve was depicted on the chart. The crimp stretchability (C.S.) of this test piece was calculated from the value obtained from the chart, as follows: C.S. = (Length of test piece at Tension T_2 (g)) − (Length of test piece at Tension T_1 (g))/Length of test piece at Tension T_1 (g) × 100 percent

wherein: $T_2\ (g) = (aX/d/9000)\ [1 - (L/l)]$

$$T_1\ (g) = 1/10\ T_2\ (g)$$

$$7 \times 10^{-3}\ (g) \qquad X \qquad 14 \times 10^{-3}\ (g)$$

a represents the weight of the test piece per unit length (g/m);

d represents the mean fineness (denier) of the fibers constituting this sliver;

L represents the distance between the nippers before the test was started; and

l represents the mean length (cm) of the fibers constituting this sliver.

In Table 1 is shown the crimp stretchability (%) of a wool "top" obtained from the method taught by said Japanese Pat. Publication No. 42-4301 as compared with that of the wool "top" which has not been subjected at all to the setting treatment intended to remove the crimps from the fibers.

TABLE 1

	Fibers placed in dry atmosphere	Fibers left for 4 hr. in atmosphere of RH 80% at 25°C
Worsted "top" obtained from ordinary process	2.11	3.21
Worsted "top" obtained after setting by method of Japanese Patent Publication No. 42-4301	1.54	3.15

As is noted from the above Table 1, the worsted "top" which is obtained from the method disclosed in said Japanese Patent Publication is such that the crimps of the fibers are certainly straightened in the stage immediately after the setting treatment. However, such a

"top" is hardly any different from the "top" which has not received this setting treatment when this "top" is placed in a high humid atmosphere, and therefore, it is difficult to term such a "top" as having stable loss of crimps continuously throughout the entire worsted spinning process. Thus, this method taught by the Japanese Pat. Publication fails to provide a really desirable setting effect.

As stated previously, it is usual in the known ordinary worsted spinning process to have a step of removing the crimps of the wool fibers which form a sliver. For example, prior to the "top" or the "roving" being wound around a bobbin, the sliver is subjected to drafting while gathering the fibers of the sliver together more tightly by giving the sliver a false twist through a rotating flute. Another example is that a wool sliver is passed between twp sets of nipping rollers which are arranged so that the distance between the respective sets is smaller than the mean length of the fibers contained in the sliver, and only the crimps of the fibers are straightened without causing sliding movement between the fibers, i.e., without causing the phenomenon of draft to take place.

The present invention has been worked out by adroitly combining these known techniques.

SUMMARY OF THE INVENTION

It is, therefore, a primary object of the present invention to solve the aforesaid various problems encountered in the efforts being paid to rationalize the conventional worsted spinning processes stated above.

Another object of the present invention is to provide a method and an apparatus for heat setting of wool sliver under tension so that the thus removed crimps of the fibers of the sliver will never be recovered even when the sliver is placed under non-restrained condition throughout the entire spinning process but will be recovered only by subjecting the fibers to a crimp recovering treatment which is given after the fibers have been spun into a yarn or after the yarn has been processed into a fabric.

Still another object of the present invention is to provide a method and an apparatus of the type described above, which is a unique and novel combination of known techniques used in the conventional worsted spinning processes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a chart showing the stress-elongation characteristic curves of wool fibers.

FIG. 2 is a chart showing the relationship between the heating time and the crimp stretchability which is the effect of the setting.

FIG. 3 is an illustration showing the changes in the state of a wool fiber which this fiber exhibits during the setting process.

FIG. 4 is an explanatory schematic illustration showing an example of the apparatus used in putting the method of the present invention into practice.

FIG. 5 is a perspective view showing a false-twister of the apparatus shown in FIG. 4.

FIG. 6 is a sectional view of same.

FIG. 7 is a perspective view showing the behavior of the sliver when the latter is being nipped by a set of nipping rollers of the apparatus shown in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

One aspect of the present invention concerns a method for continuously setting wool sliver during the manufacture of a "top" in a worsted spinning process. This method is characterized by the successive performance of the following three steps: (1) heating the wool sliver which is being given an appropriate amount of moisture; (2) giving the resulting sliver false twist and draft simultaneously for a certain length of time in a heated atmosphere; and (3) then drying this sliver under weak tension at a temperature lower than that in the preceding step.

Description will hereunder be made on the operations and the behavior of the fibers in the respective steps of the method according to the present invention.

The aforesaid step 1 is intended to give the wool sliver an appropriate amount of moisture and to heat the moistened sliver. In this step, an appropriate amount of moisture is given the wool sliver and the moistened sliver is heated at the same time by keeping the sliver in a relatively relaxed state prior to being false twisted and drafted. More specifically, by either steaming the sliver or by heating the moistened sliver, the wool fibers in the sliver become sufficiently swollen and are thus plasticized to render the crimps as well as the fibers themselves to a state of being easily stretched in the subsequent draft step. FIG. 1 shows cruves representing the relationship between the stress and the elongation of the fibers. In FIG. 1, A represents the state of wool fibers held at the temperature of 25°C and the humidity of 15 percent. B represents the state of those wool fibers which are held at the temperature of 100°C and the relative humidity of 22 percent. This chart shows that in order to obtain an equal elongation, the fibers B can be drafted under a tension of one half or less of that required for the wool fibers A. Thus, it will be understood that it is extremely effective, in making uniform and smooth straightening of crimps, to give the wool fibers an amount of moisture of 20–20 percent and to heat them at a temperature of 70–110°C prior to being subjected to the drafting step.

Next, the wool sliver having been steamed is fed to the twisting zone formed by a false twister. In this zone, the fibers contained in the sliver are gathered together more tightly as the sliver is twisted progressively. Thus, the sliver proceeds through a heated atmosphere of this zone under a tension, during which period the fibers are restrained so as not to slip and to be displaced from their initial positions in the sliver and accordingly not to receive uneven draft. During this travel of the sliver, the inherent crimps of the wool fibers are straightened so that the fibers are rendered substantially rectilinear in shape. The wool fibers are thus heat-set in this rectilinear shape.

The relationship between the length of time of heating and the effect of setting, with respect to the aforesaid crimp stretchability, is mentioned in FIG. 2. In this chart, the characteristic curves of wool fibers subjected to heat treatment for different lengths of time are shown for comparison as follows. The curve C represents the crimp stretchability relative to heating time exhibited by the wool fibers immediately after the fibers were set by the drying step. D represents the same relation at the end of four (4) hours during which pe-

riod the fibers set by the drying step were left in a high temperature and humid atmosphere of 25°C and RH of 80 percent under relaxed state. E represents the same relationship at the end of one (1) minute during which time the sliver obtained from C is left in normal pressure and in saturated steam atmosphere under relaxed condition. The wool fibers treated in these respective modes of treatment of C, D and E have been given false twist of 25 T/m and drafted by 30 percent from the initial lengths of the wool fibers. As will be understood from these data, in order to obtain a satisfactory effect of setting, it is necessary that the heating time be set at least 0.5 minute. However, when the feed speed of the wool sliver is set at 6 m/min. in view of the actual productivity in the operation, the length of the twisting zone of the apparatus for carrying out said setting will require at least three (3) meters. If however, it is intended to prevent fibers from slipping relative to each other in the sliver when pulled between two sets of nipping rollers without giving any twist to these fibers, the distance between the two sets of nipping rollers has to be arranged smaller than the average length of the fibers. This in turn will give rise to the need for the provision of very many sets of such rollers. Thus, the apparatus per se will become very complicated in structure and large in scale, which is difficult to put into practice.

Accordingly, by relying on the method of the present invention, namely, by performing the heating and drafting of wool fibers of a sliver while giving false twist thereto, the aforesaid difficulty can be effectively eliminated. It should be understood that, in order to produce a resistance in the fibers against the force to cause the slipping of these fibers relative to each other in the sliver, the appropriate turns per meter of false twist to be given the sliver is set at 15–40 T/m.

In succession to the aforesaid heating and drafting step, the sliver will be caused to proceed to the rotary section of the false twister, then to the untwisting zone, and then to the nipping rollers and is delivered therefrom in the non-twisted state again. This untwisting zone is arranged to have a length smaller than the average length of the wool fibers contained in the sliver and this untwisting is performed under tension and heat to lift the preceding twist set which was given the fibers together with the crimp stretching set in the twisting zone to set the fibers in such a way that only the crimp straightening set remains in the fibers.

Thereafter and in succession to the aforesaid step, the sliver is dried at a temperature lower than that of the steam in the preceding zone and under a condition which will not cause the crimps of the fibers in the sliver which have been straightened to recur, i.e., under a stress of about $0.19/d$ or less.

FIG. 3 shows the state of wool fiber which is exhibited under each condition of treatment. In the chart, F represents the state of the fiber when it is given only moisture and heating. G represents the state in which the fiber obtained in F has been drafted. H represents the state in which the drafted fiber has been dried at the aforesaid temperature under a tension substantially the same as that of the draft. I represents the wool fiber which has been dried at the said temperature under such a weak tension as will not cause recovery of the once lost crimps of the fiber. The method of the present invention includes the step of performing a sufficient crimp removing set on the wool fibers of a sliver by drying it at a temperature lower than that of the preceding steaming section under the condition stated in I. If, on the contrary, this drying step is conducted under a high tension such as stated in H. there will arise such inconveniences and disadvantages as will be described below.

In order that the sliver be maintained, during the drying step, under a tension similar to that applied during the drafting, it will be necessary to perform this drying step by keeping the sliver under such a tension as will not cause slipping of fibers relative to each other in the sliver as is so in the case of drafting. However, if the false twisting step is to be provided during this drying step, this will mean that undesirably another twist set is given to the sliver, even though the mutual slipping of fiber may be prevented. For this reason, this drying step requires to be performed under such a weak tension as will not cause the once lost crimps to recover. To this end, it is desirable to perform this step in such a way as is done by a known cylindrical drier. On the contrary, if the drying step is performed under such a tension similar to that employed in drafting, the amount of actual elongation to which the wool fibers per se are set will increase (corresponding to the length S shown in FIG. 3). Therefore, when the fibers are subjected later to a crimp recovering treatment in the finishing step after the fibers have been spun into a yarn or after the spun yarn is processed in to a fabric, it will occur that, along with the recovery of the once lost crimps, the amount of elongation (meaning the length S in FIG. 3) which the wool fibers themselves have developed will also be shortened again due to the shrinking of the fibers. Such wool fibers will exhibit, when spun into a yarn, a hand which is different from that of known worsted yarn, and thus it is impossible to obtain the desired set of wool sliver of the present invention.

As stated above, the present invention contemplates the carrying out of continuous setting of wool slivers by adroitly utilizing the behavior of wool slivers. The feature of this invention lies in the effective combination of treatments in a series of steps of performing mainly provisional crimp-removing set on wool fibers. Above all, there are obtained the following four advantages from the method of the present invention:

i. by performing the moistening and heating step of wool fibers in the relaxed state of the fibers, there is secured satisfactory infiltration of heat and moisture into the wool sliver so that uniform heating of the fibers in the sliver can be accomplished;

ii. the wool sliver having undergone the preceding step is then passed through a nipping point in the second step and arrives at the false twisting and heating zone where the sliver is intensively drafted while being twisted and while the fibers are thus restrained relative to each other in the sliver. At such drafting, the appropriate moistening and heating which were given the sliver in the preceding first steaming step will take effect so that the fibers are rendered to the state in which their crimps are ready for being easily straightened to a sufficient extent, and then these crimps are thus effectively straightened;

iii. by performing the untwisting of the sliver in the untwisting section under a heated and tensioned condition, the twist set on the wool sliver oer se which has been given in the preceding twisting and heating treatment can be removed completely in such a way that

only the twist set of the sliver excluding the crimp-removing set is lifted; and

iv. in the subsequent drying step which is performed at a temperature lower than that of the preceding steam, the intensive shrinking property peculiar to wool fibers is controlled so that the sliver is dried and substantially quenched by this lower temperature under a weak tension to thereby suppress only the tendency of recovering the lost crimps. Thus, no stretching of the wool fibers is performed but only the crimp removing set can be effected.

By these four successive treatments, it is possible to attain the aforesaid objects of the present invention.

Hereunder will be described the present invention more concretely with respect to an embodiment by referring to the accompanying drawings.

In FIG. 4, reference numeral **1** represents a wool sliver. **2** and **2'** represent feed rollers for feeding the wool sliver **1** to a steaming chamber **5** at an appropriate speed. **3***a*, **3***b* and **3***c*, **3***d* represent a pair of sliver inlet members and a pair of sliver inlet members and a pair of sliver outlet members, respectively, of the steaming chamber **5**. Each of these inlet and outlet members is constructed to cooperatively form a sort of nozzle so that the gap between the upper and the lower inlet members thereof decreases progressively in the direction of travel of the wool sliver **1**. This steaming chamber **5** is continuously supplied with saturated steam of normal pressure and filled with this steam. The steam contained in this chamber **5** is discharged partly to the outside of the chamber **5** through the small opening between the inlet members **3***a* and **3***b*, and the remaining steam is discharged to the adjacent heating chamber **5'** through the small space between the outlet members **3***c* and **3***d*. This heating chamber **5'** is assigned for keeping the wool sliver **1** which has been heated in the steaming chamber **5** at substantially the same temperature as that of the latter chamber **5**. In this heating chamber **5'** is provided a steam pipe P so that a heat zone is formed by the use of this steam pipe P to serve as the heat source.

In the aforesaid heat zone defined by said heating chamber **5'** are provided a first nipping roller unit **4** and a false twisting section **6** which are arranged in the direction of the travel of the wool sliver **1**. In between this heating chamber **5'** and its next adjacent drying member **9**, there is provided a second nipping roller unit **7**, so that this second nipping roller unit **7** serves to couple the heating chamber **5'** to the drying chamber **9**.

Said first nipping roller unit **4** is comprised of two bottom rollers **4***a* and **4***c* arranged at an appropriate interval relative to each other and a top roller **4***b* positioned above these two bottom rollers at a position intermediately of these two. The top roller **4***b* is pressed downwardly by an appropriate pressure source not shown such as air cylinder to form a set of nipping elements for the wool sliver. Each of these three rollers **4***a*, **4***b* and **4***c* is rotated positively at the same peripheral speed.

As shown in FIGS. **5** and **6**, the false twisting section **6** comprises a hollow cylinder **61** which is rotated positively, and a ring **62** which is mounted circumferentially of this cylinder **61** on a notch **61***a* formed on this circumference. The wool sliver **1** which is fed through the hollow cylinder **61** is led out from this notch **61***a* to the outer side of the ring **62** and then the sliver **1** is again guided into the hollow cylinder **61** to impart false twist to the sliver **1**. In FIG. **5**, numeral **63** represents a bearing of a supporting member for rotating the hollow cylinder **61** about the axis represented by the direction of travel of the sliver **1**. **64** represents a chain sprocket for imparting positive rotation to the hollow cylinder **61**. This rotation force is transmitted from an appropriate drive source not shown.

In FIG. **4**, the second nipping roller unit **7** is comprised of two bottom rollers **7***a* and **7***c* which are arranged at an appropriate interval therebetween and a top roller **7***b* overriding these two bottom rollers at an intermediate position between the two as in the case of the first nipping roller unit **4**. The top roller **7***b* is pressed downwardly by an appropriate pressure means not shown such as air cylinder, to form a pair of nipping elements for the sliver. It should be understood also that each of these three rollers **7***a*, **7***b* and **7***c* is rotated positively at the same peripheral speed.

The second nipping roller unit **7** is arranged so that it is rotated at a peripheral speed which is appropriately greater than that of the first nipping roller unit **4**. The interval between these two sets of nipping roller means serves as the draft zone. Also, the distance of travel of the sliver between the contact point P_1 at which the wool sliver **1** contacts the ring **62** and the first nipping point P_2 of the second nipping roller unit **7**, and the distance of travel of the sliver between said first nipping point P_2 and the second nipping point P_3 of the second nipping roller unit **7** are both arranged to be smaller than the average length of the wool fibers consituting the sliver, namely, smaller than about 60–70 mm, in order to be sure that there will not occur any slipping between the fibers in the sliver in the stage the twisted sliver **1** is untwisted.

The drying chamber **9** positioned posteriorly adjacent to the second nipping roller unit **7** comprises a plurality of drying rollers **8***a*, **8***b*, **8***c*, **8***d* and **8***e* each containing a heater therein which are arranged in zig-zag fashion as shown so that the wool sliver **11** delivered from the second nipping roller unit **7** will travel from one roller to another by following a zig-zag course. These drying rollers are rotated at a peripheral speed which increases progressively in the direction of travel of the wool sliver **1**. Accordingly, as the sliver **1** passes around these respective rollers one after another, the sliver is pulled at a progressively increasing but appropriate draft ratio, so that the sliver is adapted to be dried under a relatively weak tension.

Also, this drying chamber **9** is constructed in such a way that dry air having a temperature not higher than and desirably lower than the temperature of the steam provided in the preceding chamber **5'** is introduced into this chamber **9** from a dry air inlet **10** which is provided at one upper end portion of the chamber **9** and is discharged to the outside of this chamber from an air outlet **11** which is provided at the opposite lower end of the chamber **9**.

Between this drying chamber **9** and the heating chamber **5'** is provided a gap **12**. Heated air is blown into this gap **12** to create the action of air curtain by this heated air to prevent the steam which fills the space in the heating chamber **5'** from flowing into the adjacent drying chamber **9**. In FIG. **4**, numerals **13** and **13'** represent a pair of upper and lower delivery rollers for guiding the already set wool sliver discharged from the drying chamber **9** to the subsequent step or to an appropriate take up means such as a can.

An embodiment of the invention by which the method of the present invention is carried out is of the foregoing arrangement. Description will hereunder be made on the manner in which the wool fibers of the sliver are set provisionally.

A wool sliver **1** which is to be set is introduced into the steaming chamber **5** via the feed rollers **2** and **2'**. By utilizing the steam pressure (which is 0.05–0.1 kg/cm² by gauge pressure), the steam is allowed to be discharged under pressure from the space between the inlet and outlet members **3***a* and **3***b* so that the air contained in the sliver **1** is driven out from this space with this outflowing stream of steam. Because of the arrangement of these members **3***a* and **3***b* to form a progressively narrowing space therebetween as these members extend deeper into the steaming chamber **5**, the aforesaid air driving-out effect is increased all the more. As a consequence, it is possible to maintain a stable, constant steaming condition without causing air to be introduced into the wool sliver **1** located in the steaming chamber **5** and into this chamber **5** itself. In this way, the temperature of the wool sliver **1** is raised up to the temperature (about 100°C) within the steaming chamber. At the same time with this, the moisture is caused to be absorbed by the wool fibers in the sliver as the steam is condensed progressively. According to our calculation, the moisture content of the sliver will be as follows. Let us now suppose that the wool fibers before being introduced into the apparatus had a moisture content of 15 percent. When these wool fibers have a specific heat $C = 0.414$ Kcal/kg°C, and when the saturated moisture of normal pressure has an enthalpy $i'' = 100.04$ Kcal/kg, and when the normal pressure saturated steam whose dryness degree of 0.98 has an enthalpy $i' = 633.80$ Kcal/kg, and the temperature of the wool fibers before steaming is 20°C, the increase in the moisture content of the sliver will be:

$$[(100-20)°C \times c\ \text{Kcal/kg°}C]/[(i''-i')\text{Kcal/kg}] \times 100$$
$$= (80°C \times 0.414\ \text{Kcal/kg°}C)/633.80 - 100.04\ \text{Kcal/kg})$$
$$= 0.0614$$

Thus, the total moisture content which is calculated will be 21.14 percent. However, actual measurement gives the figure of 22 percent. Therefore, a mositure which is necessary and sufficient for performing the setting is obtained. On the other hand, by subjecting the sliver to a sufficient amount of this moistening and heating treatment in relaxed state of fibers prior to being drafted, it is possible to materialize quick lifting of the strain which has been given to the sliver before the latter is introduced into the method of the present invention. This treatment will thus have a good effect on the subsequent steps.

The wool sliver which has thus been subjected to an increase in the temperature and which has been impregnated with moisture is then nipped to a sufficient extent by the first nipping roller unit **4**. Since the rollers of this unit are positively driven at the same peripheral speed, there occurs no shuffling or like phenomenon or uneven displacement of the fibers relative to each other, and the progressively fed sliver is nipped smoothly and continuously. That portion of the sliver located in the drafting section is twisted by the twister in the false twisting section **6**. When the sliver is fed under normal and constant condition, the sliver gains always a twist of a constant pitch. This is brought about by the fact that, owing to the frictional resistance exterted by the ring **62** intended for imparting a contact angle to that portion of the sliver located in the false twisting section **6**, if the hollow cylinder **61** is rotated in the direction of, for example, the arrow T as shown in FIG. **6**, that portion of the sliver not having reached the ring **62** will be twisted counter-clockwise relative to the direction of travel of this sliver.

During this period of operation, a length of fresh sliver which has never been twisted at all is delivered from the first nipping roller unit **4**. At the same time, the already twisted sliver passes by the ring **62** for a length corresponding to the length of said freshly introduced sliver.

The wool sliver **1** which has passed by the ring **62** is completely untwisted. Thus, so long as the wool sliver **1** is fed at a constant speed and so long as the hollow cylinder **61** in the false twisting section **6** is rotated at a constant speed, the number of turns which are applied to the sliver between the first nipping roller unit **4** and the ring **62** will be maintained constant.

As stated above, under stable conditions, the wool sliver **1** which is drafted between the first nipping roller unit **4** and the ring **62** is in the state of having been twisted at a constant pitch. Therefore, there will arise no slipping between the fibers in the sliver when the sliver is pulled during the drafting. In this way, it is possible to perform continuous drafting of the sliver which is formed with a number of staple fibers without causing any uneven draft and breakage of the sliver itself. A desired draft ratio may be obtained by increasing, to an appropriate extent, the peripheral speed of the second nipping roller unit **7** in excess of that of the first nipping roller unit **4**. A desirable draft ratio will be 10–40 percent. At this drafting site, the condition of the wool fibers has progressed from its "yield" region to its "after-yield" region. Therefore, the fibers in the sliver are rendered to a state in which they can be elongated sufficiently. Thus, the fibers are elongated uniformly. Up to the stage after the sliver **1** has passed by the ring **62** in the false twisting section **6** till it reaches the nipping point P_2, the wool sliver **1** is in the state of being untwisted. Also, at the second nipping roller unit **7**, the sliver **1** is in the state of having been untwisted. In view of the fact, however, that the distance between P_1 and P_2 and between any two nipper rollers of second nipping roller unit **7** is 60–70 mm at the most, there will never occur slipping between the fibers in the sliver **1**. Also, as stated previously, the respective component rollers of the second nipping roller unit **7** are rotated positively at the same peripheral speed. Accordingly, there will occur no uneven displacement between the fibers in the sliver as stated previously, and the sliver which is fed progressively is nipped smoothly and continuously. During this part of operation, the wool sliver **1** which is now in its untwisted condition is rendered to a tensioned state. Therefore, at the time the sliver is twisted and drafted, the fibers of this sliver are subjected to crimpless setting. At the same time with this, the twist set which has been applied progressively to the sliver is relieved, so that only the crimp-removing set progresses.

Then, the wool sliver **1** which enters the drying chamber **9** is subjected to setting as it is dried under a weak tension by the drying rollers **8***a*, **8***b*, **8***c*, **8***d* and **8***e* which each contains a heater therein. The wool sliver **1** which has thus been set is discharged progressively by the delivery rollers **13** and **13'** under non-restrained

state and without causing the once lost crimps to be recovered.

As stated above, according to the method of the present invention, the wool sliver is given, during the entire worsted spinning process, an appropriate amount of moisture and heat, and then the sliver is drafted in a warm atmosphere by false twisting treatment without causing any slipping between the fibers in the sliver, thereafter untwisting the sliver under tension, and finally the sliver is dried under a weak tension and at a temperature lower than the temperature of the preceding treatments, thereby setting the fibers contained therein. Thus, according to this method of the invention, the sliver as well as the individual fibers therein receive a very high amount of provisional setting which remains stable and unchangeable when the sliver is exposed to a high humid atmosphere, and this is especially so throughout the worsted spinning process. This method, therefore, eliminates the need of taking up the sliver around a bobbin under a tensioned state to thereby pull the crimps of the fibers and to thus restrain the fibers, as has been the case with the prior art. Accordingly, by relying on the method of the present invention, it becomes quite possible to take the sliver into a can. Besides, the present method allows the omission of the step of subjecting a bobbin of "top" to ageing.

In the embodiment stated above, the wool sliver was passed through saturated steam during its travel from the first nipping roller unit **4** to the second nipping roller unit **7.** It should be understood that if the sliver is passed through an atmosphere which is capable of keeping the sliver in substantially the same condition as that in the preceding step where the sliver has been impregnated with an appropriate amount of moisture and held at an increased temperature by steaming, then there can be obtained a substantially equal effect of setting. Also, the number of turns which the sliver receives at the time of drafting should be selected so as to keep the sliver in a stable condition by taking into consideration the speed of travel at the time of drafting, and the rotation speed of the false twister members. It is necessary to select the appropriate number of turns of twist which will not cause slipping of fibers relative to each other in accordance with the size of the wool sliver and with the draft ratio applied. Therefore, it will be effective to select the number of turns so that the pitch of the respective turns is smaller than the average length of fibers for the distance of travel covered by the sliver from said nipping point to said false twisting point. Furthermore, in case the region of tension to which the sliver is subjected when it is in the untwisted state is insufficientl by the use of only the second nipping roller unit members *7a*, *7b* and *7c*, it is also possible to provide the nipping roller members in multiple stages to prolong the time of drafting.

Hereunder will be shown some examples of provisional setting obtained according to the method of the present invention and also some examples of the effect brought about by this setting. The evaluation of the condition of the crimps of wool fibers was conducted by relying on the aforesaid crimp stretchability (CS %).

EXAMPLE 1

By the use of a wool "top" made of 100 percent merino wool fibers whose quality number is 64^s and having a size of 30 g/m and which was made by the known worsted "top" manufacturing process and which thereafter completed the ageing of 3 weeks in "top" bins in the known manner, and by the use of the same kind of wool "top" having experienced the same process excepting the ageing process but having been given a provisional set according to the setting conditions of the present invention, i.e. a draft ratio of 20–40 percent, a number of turns of 30 T/m in the false twisting step, and a draft and restraining time of 30 seconds, their respective crimp stretchability were sought. Furthermore, a batch of these two kinds of "tops" was left in a high humid atmosphere of 25°C and RH 80 percent in the non-restrained state and another batch was given steaming at 100°C in the non-restrained state. The crimp stretchability of these two kinds of batches is shown also in Table **2.**

TABLE 2

	Immediately after "top" making	Left for 4 hr at 25°C & RH 20%	Steamed
Known Method			
Ageing done:	2.11	3.21	5.11
Method of This Invention			
Drafted about 20%:	1.18	1.50	5.11
Drafted about 30%:	1.14	1.41	5.04
Drafted about 40%:	1.05	1.20	4.80

As is clear from this Table **2,** the wool "tops" which have experienced ageing according to the prior art show a substantial amount of crimp recovery in a high humid atmosphere under non-restrained condition and do not necessarily show a stable setting effect during the spinning process. In contrast thereto, those "tops" set according to the method of the present invention exhibit satisfactory loss of crimps after the setting, and present a stable effect of setting such that the once lost crimps hardly become recovered when the sliver is subjected later to a high humid atmosphere under non-restrained state. Furthermore, by steaming the thus set sliver under non-restrained state, crimps were recovered to such an extent as was substantially the same with those "tops" which experienced ageing. The set according to the invention hardly recovered the initial state even in nonrestrained state throughout the entire spinning process. It will be noted that this set is one which is able to recover the initial state only in the final treatment after the fibers have been spun into a yarn or after the spun yarn has been processed into a fabirc. been processed into a fabric.

EXAMPLE 2

By the use of wool tops made with 100 percent merino wool fibers whose quality number is 64^s of 30 g/m in size which have been given the known wool spinning process and which have experienced 3 weeks of ageing in "top" bins in known manner, and by the use of similar "tops" not subjected to ageing but subjected to the provisional setting according to the present invention, namely, under the conditions: a draft ratio of 30 percent, a number of turns of false twist of 30 T/m and a draft and restraining time of 30 seconds, these two were subjected to the spinning process up to finisher-bobbiner under substantially the saem conditions. Crimp stretchability was sought on these two. Furthermore, a batch of these two kinds of "tops" was left in a high humid atmosphere at 25°C and RH 80 percent

under non-restrained state. Another batch was subjected to steaming under non-restrained state. These three were compared with respect to crimp stretchability and the result is shown in Table 3.

TABLE 3

	Immediately after finisher-bobbiner	Left for 4 hr at 25°C & RH 80%	Free steaming
Received ageing but no setting (conventional method):	1.58	2.54	4.84
Received setting (present invention):	1.11	1.32	5.05

The test pieces having the aforesaid properties were spun, respectively, on spinning frames. The draft ratio, the number of yarn breakages during the spinning process and the shrinkage at boiling water of spun yarns are shown in Table 4. The spindles of the spinning frames were rotated invariably at the rate of 10,500 r.p.m. and the count of fineness of the spun yarns was invariably 50^s (by metric count).

TABLE 4

	Draft ratio on spinning frame	Number of yarn breakages	Shrinkage at boiling water
Received ageing but no setting (conventional method):	12	20/Frame	0.8%
No ageing, but received setting (present invention):	17	12/Frame	0.8%

As will be clear from these Tables, by giving the setting, the crimps of the fibers can be removed satisfactorily and stably. Moreover, because of the good parallel disposition between the fibers, it was possible to enhance the draft ratio on the spinning frames, and to reduce the number of yarn breakages and also to elevate the productivity of the spinning frames and to stabilize the operation. In addition, the shrinkage at boiling water of the yarns spun from the "tops" which received the setting according to the present invention did not show any great difference as compared with yarns of the prior art. Thus, these wool yarns did not present any problem of quality at all from the viewpoint of hand peculiar to wool fibers.

We claim:

1. A method for continuously setting wool sliver during the manufacture of a "top" in a worsted spinning process, comprising the steps of:

1. heating the wool sliver in its state of containing moisture;
2. steaming the resulting wool sliver under tension while imparting the sliver false twist by first twisting and then untwisting said resulting sliver, and
3. drying the resulting sliver under a weak tension at a temperature lower than that of said steaming.

2. A method according to claim **1,** in which said step 1) is performed by steaming the sliver under the conditions that the content of moisture of the sliver is held at 20–30 percent and that the temperature is held at 70–110°C.

3. A method according to claim **1,** in which the false twist imparted to the sliver in the step 2) is in the range of 15–40 turns per meter of the sliver.

4. A method according to claim **2,** in which the false twist imparted to the sliver in the step 2) is in the range of 15–40 turns per meter of the sliver.

5. A method according to claim **3,** in which the step 2) is performed for at least 0.5 minute.

6. A method according to claim **4,** in which the step 2) is performed for at least 0.5 minute.

7. A method according to claim **1,** in which the untwisting of the sliver in the step 2) is performed by keeping the length of that portion of the sliver being untwisted smaller than the mean length of the individual fibers constituting the sliver.

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