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Iliman et al.

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[54] METHOD AND APPARATUS FOR LAYING DOWN THE FIBER HAIRINESS OF TEXTILE YARNS

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[52] **U.S. Cl.**.....**28/28,** 28/72.6

[51] **Int. Cl.**.....**D06c 29/00**

[58] **Field of Search**.....28/28, 72.6

[56] **References Cited**

UNITED STATES PATENTS

2,402,653	6/1946	Clark	28/28
2,795,839	6/1957	Seawell	28/28
2,996,785	8/1961	Suggs	28/28

FOREIGN PATENTS OR APPLICATIONS

574,448	3/1933	Germany	28/28

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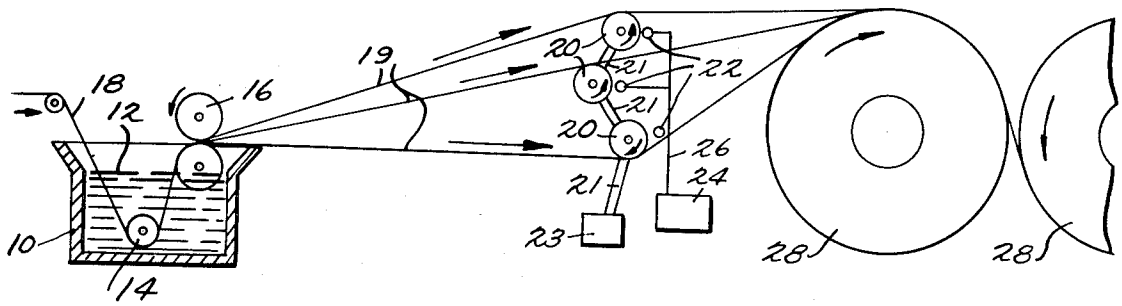
Attorney—Cushman, Darby & Cushman

[57] **ABSTRACT**

The surface hairiness, or fuzziness of staple spun yarn is reduced during a sizing operation by passing individual strands of the wet sized yarn through and in contact with the surfaces of the specially designed circumferential grooves in the surface of a cylindrical roller rotating in a direction opposite to the direction of the yarn's travel so that the higher linear speed of the roller exerts a strong opposing wiping, squeezing force on the yarn moving counter to the surface speed of the inner walls of the grooves of the roller.

Under certain circumstances, where modified performance is desired, the grooved roller may be rotated in the same direction as the yarn travels.

17 Claims, 13 Drawing Figures



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SHEET 1 OF 2

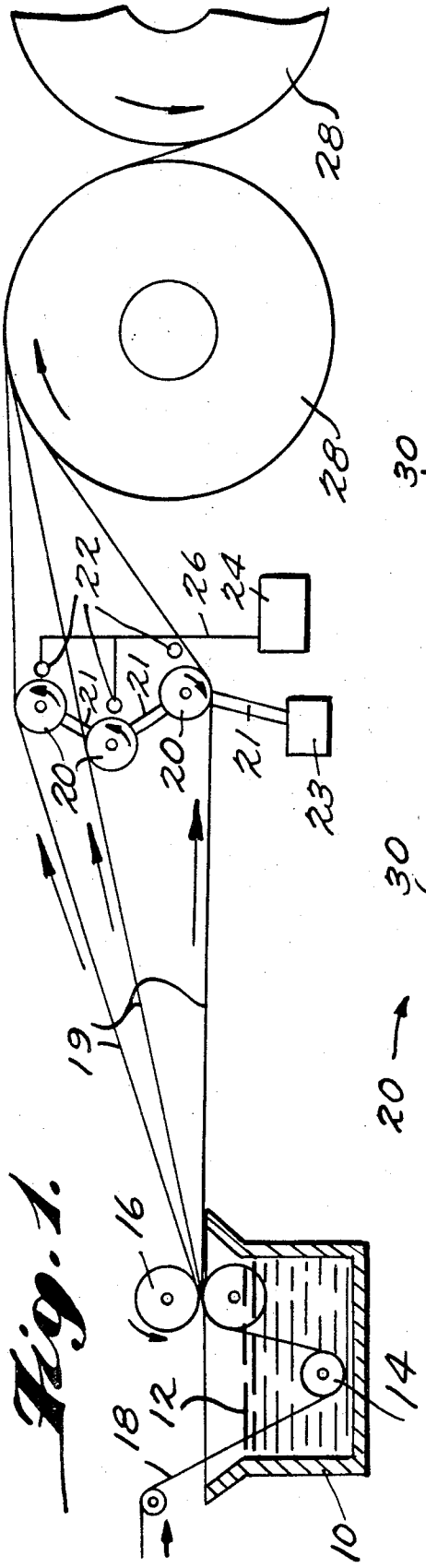


Fig. 1.

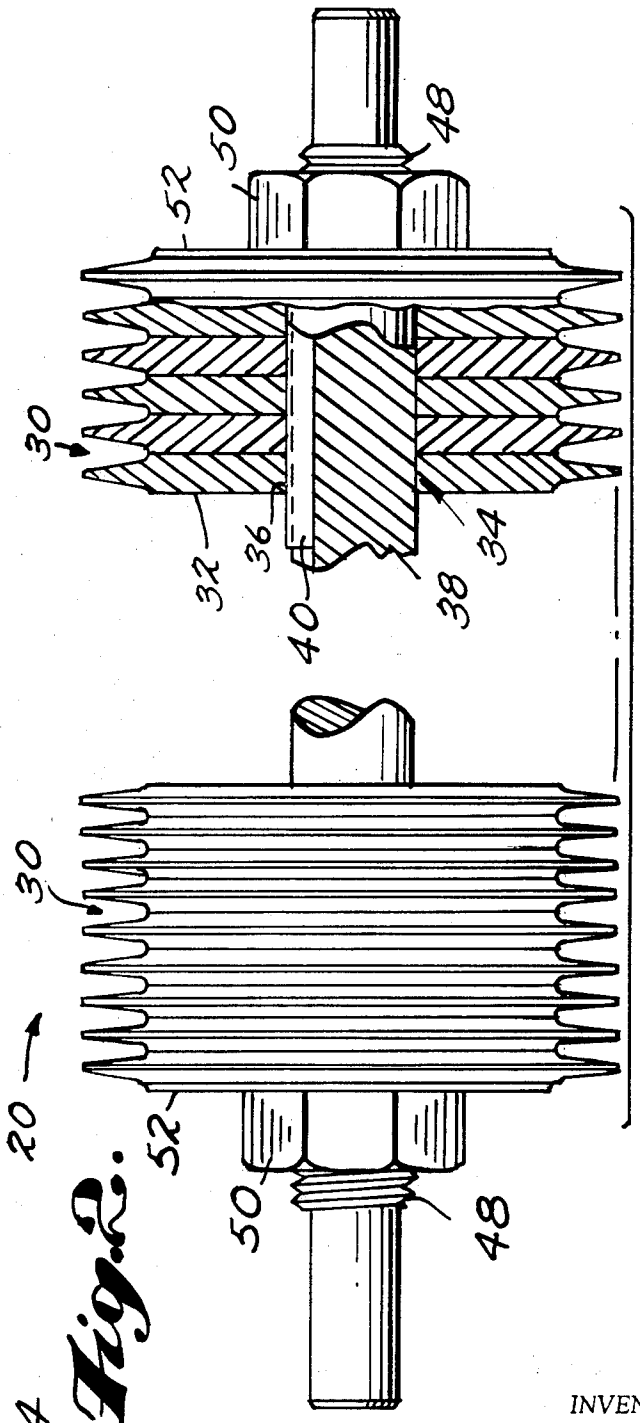


Fig. 2.

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Fig. 3.

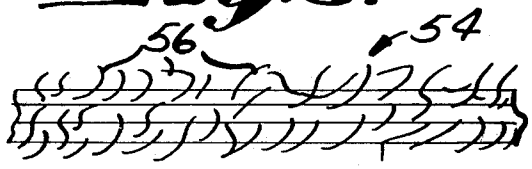


Fig. 4.

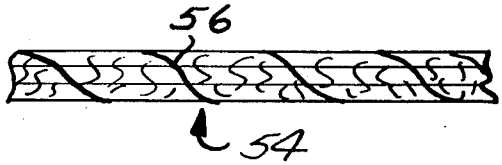


Fig. 5

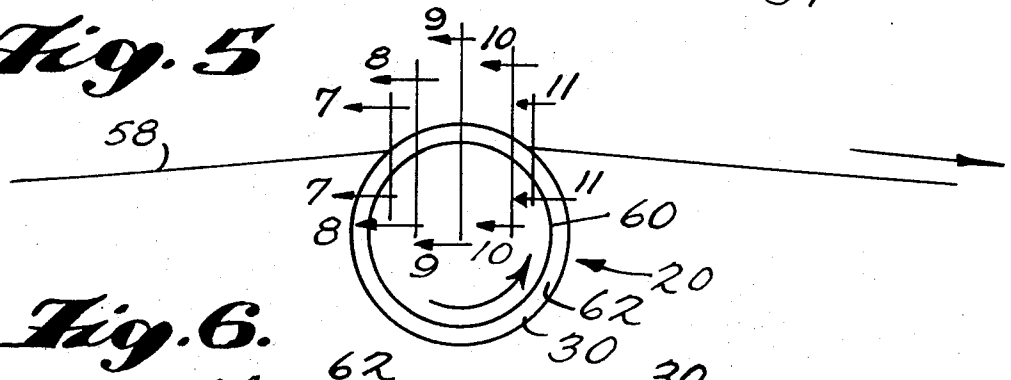


Fig. 6.

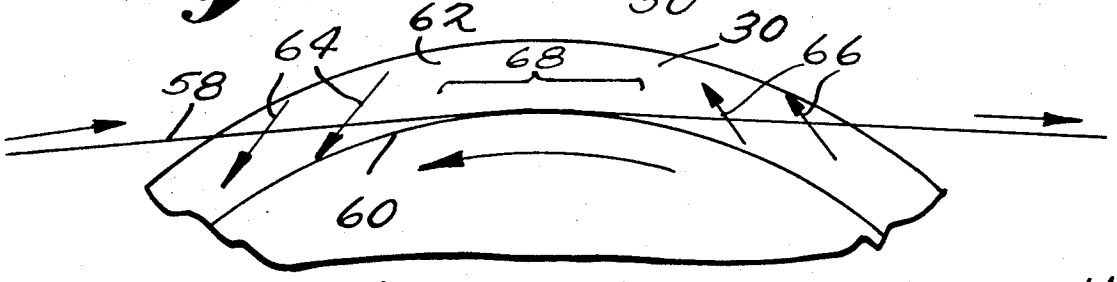


Fig. 7. Fig. 8. Fig. 9. Fig. 10. Fig. 11.

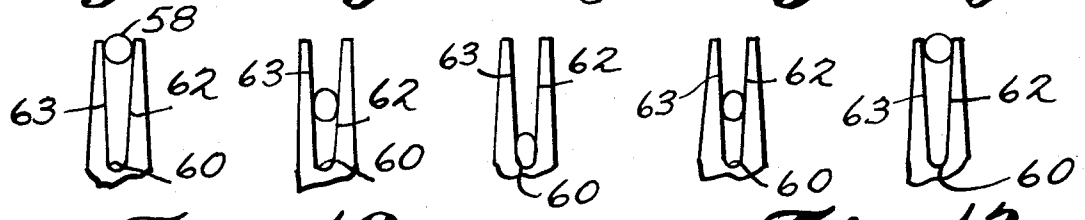


Fig. 12.

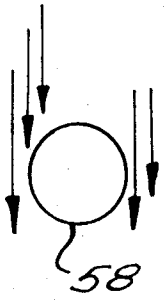


Fig. 13.



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METHOD AND APPARATUS FOR LAYING DOWN THE FIBER HAIRINESS OF TEXTILE YARNS

BACKGROUND OF THE INVENTION

A large variety of staple spun yarns which are used in textile weaving and knitting operations consists of a bundle of fibers which have been twisted together. Frequently, as is the case with staple spun yarns, the surface of the yarn is not smooth since a number of the component fibers adjacent to the periphery of the yarn surface project outwardly from the yarn's surface. This peripheral protrusion of the fibers from the surface of the yarns can adversely affect weaving and knitting performance as the protruding fibers tend to entangle with the adjacent yarn strands which can result in binding of adjacent yarns together as the yarns pass through various separate restricted openings encountered in knitting or weaving processing. As a consequence of the binding, yarn breakage can occur which necessitates stopping the associated knitting or weaving machine thus decreasing production efficiency and potentially creating a quality defect. The random projection of fibers from a yarn's surface can also result in objectionable dragging and clinging of the yarn as it is drawn through the various eyes and dents of a loom. As a result, undesirable abrading or hang-ups of the yarn can occur prior to and upon entry into these devices, further decreasing production efficiency and increasing the potential for reduced quality.

The advantages of laying down the peripheral fibers of a yarn in a direction opposite to that which the yarn advances through a loom have been long recognized and accepted. At the same time, (although up to now never accomplished with a practical mechanism) some have reasoned and observed that by causing the loose peripheral fibers to be helically wrapped around the body of the yarn strand the resulting sized warp yarn experiences the smoothest possible entry into the eyes and dents in its passage through the loom and is free of latching and clinging that can result in warp yarn breaks. Also undue loss of fibers from yarn is prevented.

It has also been reasoned and observed that if a sized warp yarn can have the size applied in some manner that permits it to be more uniformly distributed in the fiber bundle and on the yarn bundle's surface and if the voids and unevenness of distribution can be leveled out and more effectively positioned for optimum strengthening and protection of the yarn after the size has been dried, then, not only will better weaving yarn be obtained but less size need be applied to achieve this advantage.

In the warp yarn slashing art, it is the usual practice to feed a plurality of moving strands of yarn continuously from a supply source such as a warp section beam to a size box holding a sizing solution consisting of ingredients such as starch mixed with a wax. From the size box, the yarns may be fed to drying apparatus consisting usually of a number of heated cylinders. Other evaporative means may also be used. From the drying cylinders, the moving, dried, sized yarn strands are delivered by suitable guide mechanisms to a loom beam.

To obtain a smooth yarn surface, it has been suggested previously that rotating brushes, such as those disclosed in U. S. Pat. No. 972,760, or the guided manipulation of warp ends be utilized to rub the yarns against each other in a self-brushing action to lay down the peripheral fibers following the application of the sizing composition. However, both these arrangements have suffered from disadvantages in that the sizing solution tends to accumulate on the brushes or on devices that effect the wiping action on the sized yarn. Also, the breakage and doubling of yarns, when rubbed against each other, prevented the self-brushing system from receiving practical acceptance. In addition, the accumulation of sizing material on the brushes and wipers has required frequent stopping of the process to effect cleaning of these devices from hard dried size and collected fibers. Moreover, the use of brushes has been found to adversely affect the quality of the yarn since the brushes tend to remove fibers from the yarn bundle.

Other prior art references relating to the field of the present invention are the U. S. Patents to Still, No. 2,565,407 of Aug. 21, 1951, and Wood, No. 2,438,084 of Mar. 16, 1948.

The present invention avoids the foregoing disadvantages by the provision of a method and apparatus for treating yarn which achieves an improved surface smoothness of the yarn in a novel way and more efficiently than has heretofore been proposed.

Simultaneously the added advantage of size leveling action by virtue of a squeezing force is obtained which enhances the uniformity of placement of the size in and on the fiber bundle that composes the yarn strand.

Also the yarn smoothing and size penetrating capability is augmented by a practical way to avoid size or fiber accumulation in the operation.

SUMMARY OF THE INVENTION

The method of the present invention consists of applying a sizing solution to the yarns and then generally tangentially passing the yarns through the specially designed circumferential grooves of a roller which is rotated in a direction opposite, or under certain circumstances in the same direction, as the yarn travel so that the differential frictional forces built up between the surface of the yarn and inner wall surfaces of the groove cause a strong opposing, wiping and squeezing force to be exerted on the yarn moving through the groove.

With this method the differential forces built up between the rotating surface of a groove's walls and the linear movement of the sized yarn passing through the groove furnish a type of wiping action on the peripheral fibers projecting from the surface of the yarn strand so that they are caused to be drawn around the strand's circumference in the formation of a helical wrap. This placement of projecting peripheral fibers is superior to the common and familiar linear smoothing down of fibers on the yarn surface in a position parallel with the axis of the yarn strand.

The direction of rotation of a grooved roll may be in the same or opposite direction to the yarn passage. Both accomplish fiber lay, with the opposite direction roll rotation offering some preferred activity for certain applications.

One groove is provided about the circumference of the roller for each yarn strand being treated. Each groove has smooth, opposed, almost parallel side walls. The outermost part of the groove is slightly wider than the base of the groove. The slight "V" construction of the groove allows different diameter yarns to "self adjust" to the best depth of surface-wiping exposure. The

width of the grooves formed by the opposing walls may vary radially from 0 to 300 percent wider than the average diameter of yarn treated by the grooved roll device but preferably, the width near the base of each groove should be slightly less than the average diameter. The depth of each groove should be several times greater than the average diameter of those yarns that are to be treated by this device. In using this type of grooved roller, the peripheral fibers will be wrapped generally helically about the surface of the yarns with the longer fibers encircling the yarn strand. Simultaneously, the mild squeezing force assures a leveling or equalizing action of the size placement in and on the yarn.

Near the point of yarn and groove surface contact, a thin sheet of steam under pressure is directed onto the roller's surface to cleanse grooves and prevent accumulation of size and fibers on the roller. The steam is directed generally into the roller's grooves after the point where the sheet of warp yarns leaves the roller's grooved surface.

As an alternate to machining correctly proportioned grooves in roller material, the roller may be constructed from a plurality of plate elements which when assembled on a shaft and fixed in position form the respective grooves. In either case the material of the roller may be plastic or metal or a composite of suitable material that will be durable under constant use, resistant to corrosion and have high resistance to wear, yet be able to be machined to obtain smooth groove surfaces.

With the method and apparatus of the present invention the peripheral fibers are more securely locked about the yarn than when the fibers are laid down parallel to the longitudinal axis of the yarn. Moreover, by virtue of the helical wrapping of the peripheral fibers, yarn treated by the method of the present invention may be more easily fed through the eyes and dents of looms without concern for which direction the fibers have been laid down.

A principal object of the present invention, therefore, is to provide an improved method for smoothing the surfaces of spun yarns by helically wrapping outwardly projecting fibers about the yarns. Another object of the present invention is to provide a more efficient method of treating staple spun yarns so that the sizing material that has been applied to it will protect it more effectively from the abusive action of the loom. A further object is to provide a method wherein the grooved roller used for laying down the peripheral fibers of the yarn is maintained free from any accumulation of sizing material or fibers. Still another object is to provide a grooved roller device for effecting the helical wrapping of the peripheral fibers about the yarns.

Still another object of the present invention is to provide a grooved roller device for effecting an improved uniformity of size placement and distribution in and on the filamental structure of continuous multifilament yarns and to insure the uniform encasement of the surface size application on monofilament yarns.

At the same time, any undesirable broken fibers or filamental projections or filamental loops can be forced down onto the body of the fiber strand and be held there by the dried size. Other objects and attendant advantages of the present invention will become apparent as consideration is given to the following detailed description and accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of apparatus used in one arrangement for carrying out the method of the present invention;

FIG. 2 is a front view in elevation, partly in section and with parts broken away, of one embodiment and an alternate of the grooved roller of the present invention;

FIG. 3 is a greatly enlarged detail view of a portion of the conventional staple yarn prior to its treatment by the method of the present invention;

FIG. 4 is the same view of the yarn of FIG. 3 after treatment in accordance with the principles of the present invention;

FIG. 5 is a side view of a section of one of the grooves of the roller with a single strand of yarn passing therethrough;

FIG. 6 is an enlarged diagrammatic illustration of the wiping forces imparted to the peripheral fibers of the yarn strand as it passes through a groove of a roller;

FIGS. 7–11 inclusive are end views of a cross section of a strand of yarn as it enters, passes through and leaves a groove of the roller; and

FIGS. 12 and 13 are diagrammatic illustrations of the forces effecting the wrapping of the fibers about a yarn strand.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, there is illustrated in FIG. 1, in schematic form, an arrangement of a yarn-slashing apparatus which consists of a size box **10** containing a sizing solution **12**. An immersion roller **14** is located in size box **10** and serves to immerse running sheets or webs of yarn **18** into the sizing solution. A plurality of yarns may be fed from a suitable number of warp section beams (not shown) into the size box **10**. It should be understood, of course, that a plurality of treatment solutions may be utilized in sequence. From the immersion roller **14**, the webs are delivered to squeeze rolls **16**. The squeeze rolls **16** may be driven by gears or other suitable means of conventional design, while the immersion roller **14** may be free-running or driven. It will be understood that any desired number of yarns may be fed into the size box **10** in the form of a sheet of paralleled yarns as is conventionally done in the textile warp sizing process.

From the squeeze rolls **16**, the yarns may pass over a single grooved roller or may be divided into a plurality of incremental sheets **19**, each of which is then passed over the specially grooved rollers **20**. Each grooved roller is rotated by conventional means, such as belts **21** or gears driven by an electric motor **23**, preferably in a direction opposite to the direction of yarn travel. If found desirable, the grooved rollers may be rotated in the same direction as the direction of yarn passage through the grooves. In such circumstances the grooved roller would be revolved at a peripheral speed that would offer a differential between the linear speed of the groove's wall surfaces and the linear speed at which the yarn passes through the grooves of each roller. This differential in moving rates is necessary to establish the frictional wiping drag of opposing forces. This action, as with the roll rotated in a direction opposite to the direction of the yarn, is accompanied by a desirable squeezing force applied to the sized yarn passing through the grooved region.

Contact of the wet yarn with the grooves of each roller may tend to cause the wet size material and loose fibers to accumulate in a roller's grooves. To prevent such build-up and a resultant detrimental size condition being picked up on the yarn, slotted steam tube applicators **22** are positioned closely adjacent to each roller **20** to direct a jet of steam under pressure against an area of the roller's surface immediately following the region where the yarns are pulled out and away from the grooves. The steam jet should be directed generally into the grooves to deeply penetrate them to prevent size material and loose fibers from accumulating and developing into hard particles which might be detrimental if redeposited onto the yarn. The steam may be supplied from conventional means such as a steam generator indicated at **24** which is connected by suitable conduits **26** to the applicators **22.** To avoid undesirable steam condensation in the line, it will be necessary to provide suitable traps in the steam lines and insulation on these lines.

From the rollers **20,** the yarn sheets are passed over or through suitable drying means such as an appropriate number of rotary drying cylinders **28** of conventional design. In the FIG. **1** drawing, the drying phase is only suggested by showing yarns from different grooved rolls passing onto one accumulating drying cylinder. In practice, it is preferable to dry the sized and fiber lay roll treated yarn in a manner that allows the yarn from each grooved roller to be given the widest practical placement across the drying cylinder surface to assure that adjacent yarns avoid touching each other during the evaporative drying phase of treatment. Following the drying the yarn moves from the heated cylinders to take-up loom beams (not shown).

Referring now to FIG. **2,** there is illustrated a detailed view of one embodiment of the rollers **20** of the present invention. The rollers consist of a generally cylindrical body made from a suitable plastic, metal or composite material into the surface of which are machined a plurality of circular grooves, examples of which are generally designated at **30.** In an alternate embodiment as illustrated in the right-hand portion of the roller illustrated in FIG. **2,** the roller consists of a plurality of discs, one of which is indicated at **32,** which are formed with a central aperture as at **34** and provided with a notch **36.** With this arrangement, when the discs **32** are mounted on a shaft **38,** as illustrated in FIG. **2,** the adjacent tapered outer edges of each disc will define the grooves **30.** A key member **40** is utilized to firmly fix the discs on the shaft **38** for non-slipping rotation therewith.

The grooved rollers constructed with the desired number of grooves per inch of length are mounted on the shaft **38** and held in position on this shaft by retaining nuts **50** which are tightened on the shaft's two threaded surfaces **48.** Washers **52** may be interposed between the ends of the grooved roller and the retainer nuts **50.**

In still another embodiment, the machined grooved rollers may be made from round bar stock. A grooved structure can be formed with alternate washer-like wafers which are slipped onto a supporting shaft. By alternating washers with slight differences in diameter, a grooved formation can be obtained wherein the smaller diameter washers will form the base of the grooves with the adjacent larger diameter washers forming the adjoining side walls of the groove.

Utilization of segmented grooved rollers, in which the multiple segments (approximately **6** to **10** units) would be clamped together on a common shaft to assemble the full length grooved roller, or by using grooved rollers assembled from a series of disc segments clamped together to form the completed roller will avoid the necessity of replacing an entire roller in the event that one of the grooved portions becomes damaged. Additionally, the roller may be readily adapted to handle any yarns from very coarse to very fine dimensions simply by substituting appropriately dimensioned groove-forming elements on the supporting shaft as needed.

It is desirable that the material from which the grooved rollers are constructed be highly resistant to wear and structurally stable when subjected to heat, water and the chemicals used in the sizing solution, and yet be able to be machined or otherwise fabricated to produce smooth wall surfaces for the grooves. Acetal resin plastics, for example, have been found to perform effectively in the environment to which the present invention pertains.

Referring now to FIG. **3,** there is illustrated a section of conventional spun yarn **54,** a number of fibers of which project outwardly in a random manner from the peripheral surface of the yarn as at **56.** This is the condition of the yarn prior to its contact with the grooved rollers **20** of the present invention. In FIG. **4,** there is schematically illustrated the condition of the same piece of yarn subsequent to its treatment by the process and apparatus of the present invention. The outwardly projecting fibers **56** have been wrapped helically above the surface of the yarn strand and are securely held in place by virtue of the helical wrapping and the drying of the size material. It has been determined that the more rapidly the grooved roller is rotated, when the yarn is passing through the grooves in the direction opposite to the roller's rotating direction, the more transversely to the longitudinal axis of the yarn strand are the peripheral fibers **56** wrapped.

A description now will be given with the aid of FIGS. **5–13** inclusive, of the manner in which the rotating surfaces of a groove **30** effect the helical wrapping of the peripheral fibers about an individual yarn strand.

In FIG. **5,** a single strand of yarn **58** is being passed through a groove **30** which is a sectional view of one groove of the roller **20** with the line at **60** designating the base of the groove and the numeral **62** designating one of the walls of the groove, the opposite wall being broken away to more clearly show the position of the yarn in FIGS. **7–11** inclusive. FIG. **6** is a greatly enlarged illustration of the passage of the yarn strand **58** through a groove **30** with the arrows indicated at **64** representing the generally downwardly and backwardly directed wiping forces that are imparted to the peripheral fibers of yarn **58** during the initial stages of its passage through the groove **30.** The arrows indicated at **66** represent the generally upwardly and backwardly directed wiping forces imparted to the peripheral fibers by the side walls of the groove **30** as the yarn passes out of the groove and past the roller. It will be understood, of course, that in the region designated as **68** the wiping forces imparted by the surfaces of the groove **30** are generally backward and parallel to the direction of travel of the yarn. In FIGS. **7–11** inclusive, there are shown the progressive steps of the passage of the yarn through a groove when viewed into the cross section of

the longitudinal axis of the yarn strand **58**. In FIG. **7**, a section of the yarn begins entrance into the groove so that as the section of yarn passes to the position illustrated in FIG. **8**, the generally downwardly and backwardly directed wiping forces corresponding to the arrows **64** in FIG. **6** will predominate to lay down the peripherally projecting fibers. When the yarn section passes through the positions illustrated in FIGS. **8, 9** and **10**, not only does the wiping action of the grooved surfaces continue to lay down the peripherally projecting fibers, but the body of the yarn is subjected to a squeezing action enabling the size solution to be leveled uniformly throughout the yarn strand. In this embodiment, the inner half of the depth of the grooves gradually decreases in width from the midpoint of the groove which is equal to or slightly less than the average diameter of the yarn being treated. The squeezing action will displace any air pockets in the fibers and will effect more thorough and uniform penetration and placement of the size among the yarn's fibers. In addition, the excess size solution that is squeezed out of the yarn strand as the yarn strand passes through the positions illustrated in FIGS. **8–10**, will exert a dragging force due to its viscous and cohesive character on the peripheral fibers since the size solution will be acted on in one direction by the surfaces **62** and **63** of the groove, and in the opposite direction by the moving yarn strand itself. As a result, the projecting fibers on the top surface of the yarn **58** which would not come in contact with a portion of the groove surfaces will also be laid down on the surface of the yarn strand.

It has been found that with a roller having a three-inch radius which is rotated at **110** revolutions per minute and with the yarn passing in a direction opposite to the direction of rotation of the roller at a rate of 16 yards/minute, a satisfactory helical wrapping of the peripheral fibers is obtained. As illustrated in FIG. **12**, it is clear that as the yarn enters, the forces are generally downwardly and backwardly directed as represented by the arrows in FIG. **12**, and while the yarn leaves the groove of the roller, the forces would be in the opposite direction to the arrows shown in FIG. **12**. It is believed that the helical wrapping which is illustrated schematically by the arrows in FIG. **13** is achieved as a result of a whip effect imparted to the peripheral fibers in conjunction with the dragging force which results from the presence of the excess sizing solution. As previously noted, it has been found that the greater the speed of rotation of the grooved roller relative to the passage of the yarn through the grooves, the more transversely are the peripheral fibers wrapped about the body of the yarn strand.

It has also been found that when a warp of staple spun yarn strands are treated by the method and apparatus of the present invention, a more intimate bonding between the sizing solution and fibers of the yarn is obtained, thus affording improved protection of the yarn during subsequent weaving or other textile operations.

While the foregoing describes the preferred embodiments of the method and apparatus of the present invention it will be understood that various modifications may be made in the dimensions and arrangement of the parts without departing from the spirit of the invention or the scope of the appended claims. For example, although emphasis has been placed on rotation direction of the grooved rollers being opposite to direction of yarn passage, for certain reasons it may be more desirable to have the rollers turn in the same direction as the yarn, even if with lesser effectiveness in forcing peripheral fibers about the yarn's surface to be anchored in the size.

What is claimed is:

1. A method of treating spun yarn having a predetermined average cross-sectional diameter and composed of fibers at least some of which project in random fashion outwardly from the periphery of the yarn surface, said method comprising the steps of:

applying a sizing solution to the yarn,

generally tangentially passing the yarn through and in contact with the smooth surfaces of a groove formed about a circumference of a rotating roller, the width dimension of the groove being such that said yarn is subjected to a compressive force during at least a portion of the yarn's passage through the groove and the depth dimension of the groove being greater than the largest cross-sectional diameter of the yarn,

rotating said roller about its longitudinal axis at an angular velocity such that the surfaces of the groove move at a linear velocity that results in a differential between it and the velocity with which the yarn passes through the groove to impart a resistive drag to the projecting fibers whereby the randomly projecting fibers will be helically wrapped about the yarn's surface;

and subsequently drying the yarn.

2. The method as claimed in claim **1** including the step of rotating the roller in a direction opposite to the direction of travel of the yarn through the groove.

3. The method as claimed in claim **1** including the step of rotating the roller in a direction the same as the direction of travel of the yarn through the groove.

4. The method as claimed in claim **1** including the step of cleaning the groove surfaces by continuously directing a sheet of vapor, under pressure and substantially free of liquid condensate, against the roller's surfaces in a region following the point at which the yarn leaves the groove.

5. The method as claimed in claim **4** wherein said vapor is steam.

6. The method as claimed in claim **1** wherein a plurality of yarns are treated and a corresponding plurality of said grooves are provided on said roller.

7. The method as claimed in claim **6** including the step of providing a plurality of grooved rollers.

8. The method as claimed in claim **7** including the step of rotating each roller in a direction opposite to the direction of travel of yarns through the respective grooves.

9. The method as claimed in claim **7** including the step of rotating each roller in a direction the same as the direction of travel of yarns through the respective grooves.

10. The method as claimed in claim **8** including the step of continuously directing a stream of vapor under pressure and substantially free of liquid condensate against the surfaces of each roller in a region following the point at which the yarns leave their respective grooves to clean the respective groove surfaces.

11. In an apparatus for treating a plurality of spun yarns including size-applying means, yarn-drying means and means for transporting the yarns from said size-applying means to said drying means, said yarns being of the type having generally circular cross sec-

tions of a predetermined average cross-sectional diameter, the improvement comprising a substantially cylindrically shaped roller having a plurality of circumferentially formed, smooth-surfaced grooves evenly spaced along the longitudinal axis thereof, each groove having a depth greater than said diameter and width which varies uniformly from the base thereof to the rim such that at least a radially inwardmost portion of each groove has a width that is less than said diameter, said roller being disposed between said size-applying means and said drying means with its longitudinal axis generally transverse to the direction of travel of said yarns, and means for rotating said roller about its longitudinal axis.

12. The apparatus as claimed in claim **11** wherein said portion of each of said grooves having a width less than said diameter of said yarn extends from the base of each groove to approximately half of the depth thereof.

13. The apparatus as claimed in claim **11** wherein the depth of each of said grooves is between four and five times greater than said diameter of the yarn.

14. The apparatus as claimed in claim **11** wherein said roller comprises a plurality of circular plate segments each having a central aperture for receiving a shaft, each of said plate segments being formed with a central disc portion of predetermined radius, the surface portions of said plate segments beyond said disc portions being tapered toward each other so that when said plate segments are fixed on a shaft the spaces existing between said tapered portions will define said grooves of said roller.

15. In an apparatus for sizing a plurality of spun yarns including size-applying means, yarn-drying means and means for transporting the yarns from said size-applying means to said drying means, said yarns being of the type having generally circular cross sections of a predetermined average diameter, the improvement comprising a substantially cylindrically shaped roller having a plurality of circumferentially formed, smooth-surfaced grooves evenly spaced along the longitudinal axis thereof, each groove having a depth between four and five times greater than said average diameter of said yarns and a width which varies uniformly from the base thereof to the rim such that approximately the radially inward half of the depth of each groove has a width that is less than said yarn diameter, said roller being disposed between said size-applying means and said drying means with its longitudinal axis generally transverse to the direction of travel of said yarns, and means for rotating said roller about its longitudinal axis in a direction opposite to the direction of yarn travel.

16. The apparatus as claimed in claim **11** wherein a plurality of said rollers are provided disposed between said size-applying means and said drying means.

17. The apparatus as claimed in claim **16** wherein means are provided for directing a stream of vapor under pressure against the surface of each roller in a region following the point at which the yarns leave their respective grooves to clean the respective groove surfaces.

* * * * *