

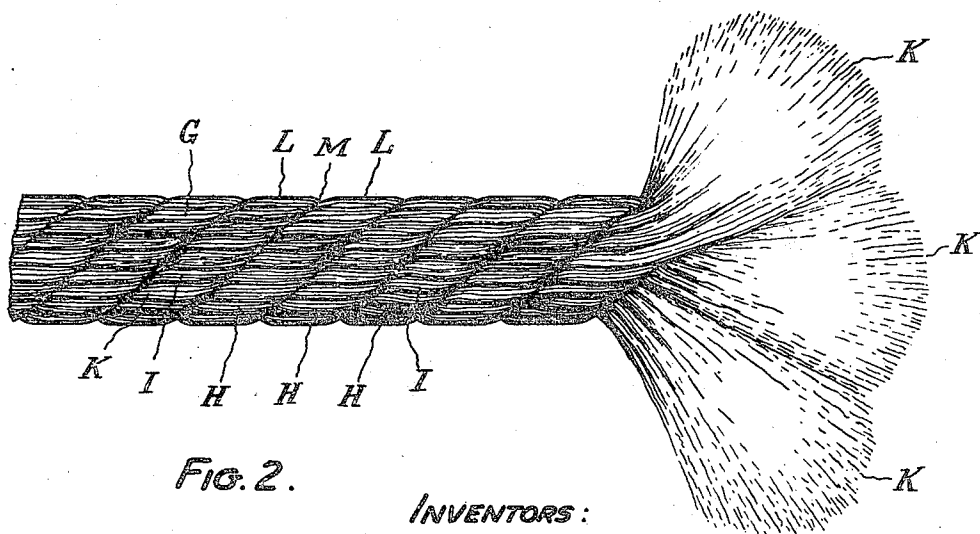
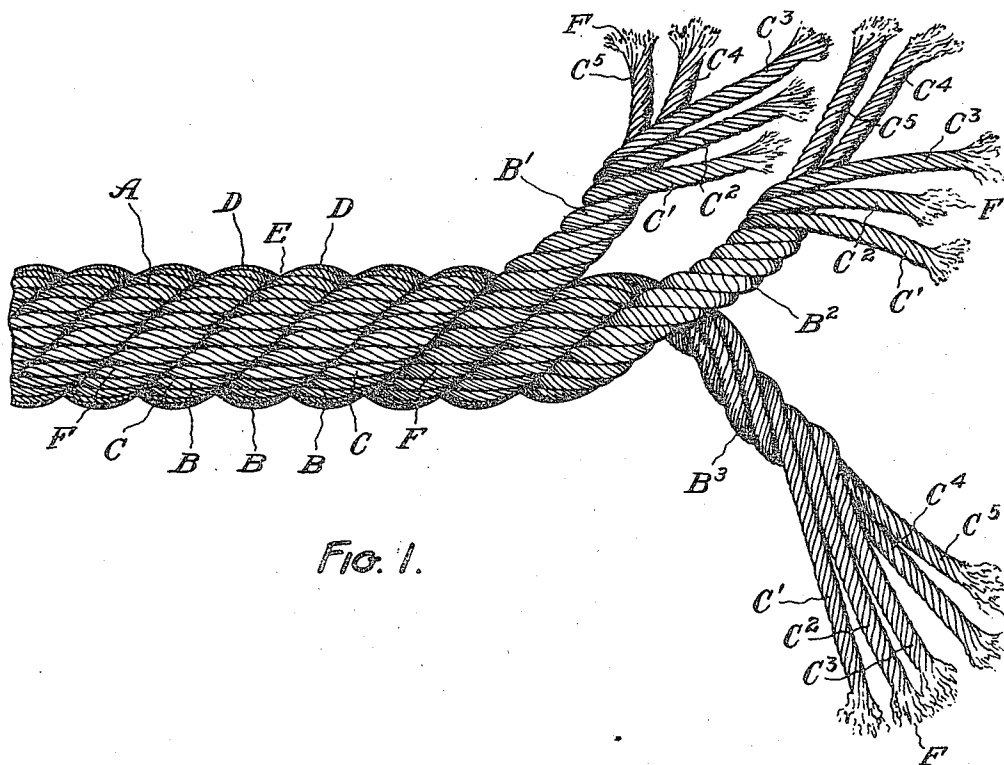
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TEXTILE CORD AND PROCESS OF MAKING IT

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TEXTILE CORD AND PROCESS OF
MAKING IT

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This invention relates to improvements in textile threads and cords and processes by which they are made. While cords made according to our invention may be used for many purposes, they are especially adapted for use under conditions where strength, prescribed elastic characteristics and durability are prerequisites. Our cords are particularly well adapted for use in pneumatic tire carcasses, power transmitting and material handling belts and other reinforced rubber articles.

Some of the objects of our invention are the provisions of:

Textile thread and cord having valuable qualities and advantages superior to any of those of threads or cords heretofore made of which we have knowledge.

Textile thread and cord made of staple fibers in which the inherent strength and flexibility of the individual fibers are utilized to a greater extent than heretofore they have been utilized.

Textile thread and cord having high heat resisting qualities and relatively high tensile strength while hot.

A process of making textile thread or cord having the above stated features and advantages.

Our process is especially valuable in the manufacture of cords from cotton or other natural or artificial staple fibers, or from blends of different kinds of staple fibers. In certain features, our invention is an improvement on the invention which is the subject of U. S. Patent 1,747,533 issued Feb. 18, 1930, to Frank L. Sessions.

Specifically, by our invention textile staple fiber thread and cord may be made in which the fibers in the yarns in the threads incorporated in the finished cord have substantially no twists about the axes of the yarns in which they are embodied. While our invention has many advantages some of which will be further disclosed herein, one of the greatest advantages is the practically complete elimination of torsional shearing stresses which unavoidably are developed in the twists in the fibers in the high twisted yarns heretofore universally incorporated in finished textile staple fiber cord.

By our invention the original singles yarns are twisted initially only enough to hold the fibers intact while the yarns are being twisted into thread. In the subsequent twisting operations the yarn twists are so substantially eliminated as to cause only negligible, if any, torsional shearing stresses and twist contractions in the yarns.

In the accompanying drawings which are drawn greatly oversize to illustrate what the microscope

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discloses, Fig. 1 shows the appearance of a finished cord made by the heretofore generally used process; and Fig. 2 shows the appearance of a finished cord made by our process.

Throughout this specification and in the appended claims the English or Hank numbering system for cotton is used; direction of twist is indicated by the letter S, when the twist helixes are like those of a left hand screw thread, and by the letter Z, when like those of a right hand screw thread; and the abbreviation T. P. I. means twists per inch.

In the heretofore known processes of manufacturing cord from textile staple materials, the staples of suitable grade and length are carded or combed and spun under draft into yarn of the desired size and twist pitch; a plurality of such yarns are plied into thread; and a plurality of such threads are twisted into cord.

The three structures, yarn, thread and cord resulting from the three twisting operations required to make a textile staple cord are all formed out of the same basic, structural material—staple fibers. The form, weight, dimensions, strength and physical characteristics of each structure result from the combination and coaction of innumerable, very small diameter, staple fibers. Initially twisting them together is the only known, practical method for holding them intact while they are being further manipulated and combined for making successively stronger structures such as yarn, thread and cord. The breaking of yarn, thread or cord, ultimately must result from either the separation of the yarn staple fibers from one another by slipping or by their breaking. Any improvement in the yarn, thread or cord made from the same kind, grade, size and quantity of material can be effected only by changes in the treatment, arrangement or manipulation of the staple fibers either before or after they are twisted into yarn.

Unplied singles yarn has its maximum tensile strength when it has a certain optimum number of twists per inch (twist pitch) to make the fibers interlock and reduce slippage but not develop too great torsional shearing stresses in the individual fibers when the yarn is subjected to tensile stress.

For this reason the construction of textile staple cord, as heretofore it customarily has been made, has been based on the theory that in order to impart the maximum breaking strength to the cord, the staple fibers should have the same twist pitch and be disposed in the yarns in the threads in the cord substantially as they have to be disposed in

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the original, unplied singles yarns to give the yarns maximum breaking strength.

High twist in cord and its component parts as heretofore made gives it flexibility and permits knee action but increases the torsional shearing stresses in the helical coils of the fibers in the twisted yarns and robs the cord of breaking strength.

Since the fibers in the yarns in the threads in cords made by our invention have substantially no twists about the yarn axes, the cords and threads may have relatively higher actual twist to give them greater flexibility and permit greater knee action without subjecting the fibers to injurious torsional shearing stresses, than is possible under the heretofore generally used process.

The yarn fiber twists are tiny, microscopic, helical springs which, when stretched, develop destructive, torsional, shearing stresses. By our process these twists are untwisted, straightened out, and the fibers rearranged in lines substantially parallel to the yarn axes, thus increasing the ability of the cord to withstand repeated flexings. This permits the yarn fibers to be more closely compacted than they could be if they were twisted.

It also makes possible the use of heavier and less expensive singles yarns for making cord having greater strength than staple fiber cord of like diameter heretofore made of the same or lighter weight singles yarn. Except for their natural shapes and chance arrangement, the fibers in our cords extend generally longitudinally of the yarns and all are bent around the axes of the threads in which they are embodied. Since there are substantially no twists in the yarns, the only helical coils in the fibers are of the same pitch as that of the thread twist. The twist contraction of the fibers is therefore much more nearly equal in all of the fibers, than it is in the twisted yarns embodied in the threads in finished cords as heretofore generally made.

Cord embodying such twistless yarn has the recognized advantages of smaller size, smaller diameter, higher strength, lower stretch, less slipage, greater durability, greater flexibility, greater elasticity, and greater tensile strength while hot, all per cross sectional area, than finished cords embodying twisted yarns of the same grade, kind, size and quantity of staple fibers. Progressive overloading and breaking of the fibers seldom occur in cords embodying such twistless yarns.

Careful observation and comparison of the "breaks" in cords made by our process and "breaks" in cords made by the heretofore generally used process, strikingly disclose the difference between the arrangement and coaction of the fibers in the two types of cords. Our drawings faithfully portray our observations. The following definitions of the expressive terms "pop break" and "1-2-3 break" are found in Haven's "Mechanical Fabrics," 1932, page 435:

"When all the plies break simultaneously—a desirable condition—the rupture is generally denoted as a 'pop break.' More often there is some corkscrew in the ply and the skein strands break one at a time. Such a rupture is called a '1-2-3 break'."

In the drawings, Fig. 1 illustrates a typical "1-2-3 break" of a cord made by the heretofore generally used process. In this figure an undisturbed portion of the finished cord is shown at A. The large helical twists, B, represent the threads, three of which form the cord. Each of these

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threads being composed of five high twist yarns C, have retained much of their finished roundness and form helical ridges D, with valleys, E, between them, around the cord A. The narrow helical twists C represent the yarns, and the almost microscopic fibers which form the twisted yarns are indicated conventionally by the fine lines F extending in helical coils around the yarns. At the break both the cord and threads appear to be untwisted, and the ends B¹, B², B³, of the threads, C¹, C², C³, C⁴, C⁵, of the yarns to extend different distances from the cord and threads respectively. The fibers F, form ragged, separated ends on the yarns.

Fig. 2 illustrates a typical "pop break" of a cord made by our process. An undisturbed portion of the cord is shown at G. H represents the threads, three of which form the cord. Each of these threads H is composed of five, substantially twistless yarns whose fibers are so compacted and blended that the yarns cannot be distinguished by the naked eye. They are indicated conventionally at I, and their longitudinally extending fibers are indicated at K, by fine lines paralleling the yarn axes.

At the break, the cord is untwisted only enough to permit the ends of the highly compacted fibers to expand upon the release of the transverse components of the fiber stresses in the cord. The broad spread of the tufts is evidence of these forces. It will be noted that the "break" appears to have occurred simultaneously in all of the yarns in all of the threads substantially in the same transverse plane.

The finished cord is substantially cylindrical, the tops of the threads being flattened as shown at L, and the valleys M, around the cord between the threads H, are much shallower than the valleys E, in the cord shown in Fig. 1. The substantially smooth cylindrical surfaces of our cords do not produce the "sawing" action between contiguous cords or contiguous layers of cords in the tire carcass, transmission belt or other structure which they reinforce. Cords, as heretofore they have been made, having relatively high surface ridges such as those shown in Fig. 1, are known to develop this destructive "sawing" action in tire carcasses particularly when the tires are underinflated.

PROCESS

The following descriptions of our process and directions for making our thread and cord are based upon the use of cotton staple fibers. We prefer cotton because of its known superior tensile strength, especially when its fibers are straight.

Preferably, combed, fairly long staple (about 1½" to 1¾"), Sea-Island or Peeler cotton, or their equivalent should be used, but we do not limit ourselves to any specific kind of material or length of staple.

We shall describe our process first in terms applicable to the making of any textile staple cord, and then describe its use in the manufacture of 22/5/3 cord.

We prefer to use wet twisting but dry twisting may be used for selected steps if its use does not result in giving the cord undesired characteristics.

While wetting, twisting and stretching operations are best performed progressively upon yarns, threads and cords while they are traveling at normal production speeds, we have found it convenient to compute and express all data concerning them in terms of a specified Unit Length

of the original singles yarns before the operation of twisting them into thread was started. For example, instead of saying the finished thread or cord has or shall have a given number of twists in a specified portion of its own length, such as an inch, we shall say that it has or shall have a given number of twists per a specified Unit Length of the original singles yarns that are or shall be embodied in the finished thread or cord. Thread and cord made of yarn embody exactly the same staple fibers the original singles yarns embodied, hence, the length of the yarns, thread and cord and the numbers of their twists may be stated with reference to a specified Unit Length of the original singles yarns. We believe that the expression of all length and twist data in terms of such a specified Unit Length simplifies computations and makes our process easily understood.

It will be observed that any specified length of the original singles yarn but preferably of no other element may be chosen as the Unit Length. Accordingly, the term Unit Length as used herein, means a specified length of original singles yarns before they are plied into thread or cord.

TWISTING

Since there are unavoidable and incalculable variations in the number of twists per inch throughout the length of textile yarn, it is impossible to know exactly how nearly the yarns in threads or cords made by our process are twistless. We have found that a number of actual twists per inch in either direction not greater than the square root of the yarn number of the singles yarn embodied in finished cords made by our process do not develop harmful torsional shearing stresses or twist contraction, and therefore are ineffective and negligible. Therefore, it will be understood that the terms twistless, substantially twistless, eliminated, substantially eliminated, or the like, as used herein may include singles yarns having a number of twists per inch in either direction not greater than the square root of the original singles yarn count.

A plurality of original singles yarns, each having the same direction of twist and the same total number of twists in a specified Unit Length are plied together to form a thread by twisting them, in the opposite direction to that of the original singles yarn twists, a greater temporary total number of twists per said Unit Length than the number of twists the original singles yarns had per said Unit Length.

A plurality of such finished threads made precisely as above described are plied together to form a cord by twisting them in the same direction as the original singles yarns were twisted, a number of twists per said Unit Length equal to the number by which the temporary total number of twists per said Unit Length each of the finished threads had, exceeds the number of twists per Unit Length each of the original singles yarns had.

Except for the unavoidable and incalculable variations, above mentioned, which may occur in the manipulation of textile fibers, the results of the foregoing twisting operations are:

(1) The finished cord will be considerably shorter than the length of the original singles yarns but will embody all of the staple fibers that were in them.

(2) The helical twists of the fibers about the axes of the original singles yarns will have been substantially eliminated or made ineffective by

having been effectively untwisted; or, in other words, the fibers will have substantially no twists about the axes of the yarns in which they lie and will extend in direction substantially parallel to those axes.

(3) Each of the threads will have the same final number of actual twists as the original singles yarns had, but the twists will be in the opposite direction.

(4) The cord will have a total number of twists equal to the number by which the temporary total number of twists the finished threads had exceeded the number of twists the original singles yarns had and the cord twists will be in the same direction as those of the original singles yarns.

In carrying out our process the direction of the original manufacturing twists given yarns, threads and cords respectively may be S Z S or Z S Z. In the following illustration of the use of our process for making 22/5/3 cord the original yarns will be assumed to be S twisted, the plied yarns (threads), Z, and the plied threads (cord), S.

If the yarn twists be not entirely eliminated in the plying operations, direction of the actual twists of the yarns, threads and finished cord, respectively, might be S Z S or Z S Z or Z Z S or S S Z. But, if the yarns as they lie in the finished threads and cord be twistless, the ideal condition as they lie in the finished cords, the directions of the actual twists may be respectively either zero, S Z or zero, Z S.

EMPIRICAL RULES FOR PREDETERMINING CORD, THREAD AND YARN TWISTS, AND FOR MAKING 22/5/3 CORD

An empirical "Unit Length" of 100 inches of original singles yarn is convenient as it facilitates percentage computations and it will be used in the following description of the use of our process in making 22/5/3 cord.

Cord twists

The total number of manufacturing twists to be given the cord per Unit Length of 100 inches of the original singles yarns may be computed by multiplying the square root of the equivalent yarn number of the yarns, which are to be embodied in the cord, by an empirical twist factor the choice of which depends upon the strength and flexibility that it is desired the cord shall have. We have found that a twist factor range up to 1200 is generally satisfactory, but above 1200 the cord twisting may prove to be too high. Raising the twist factor increases the flexibility and decreases the breaking strength of the cord, while lowering the twist factor decreases the flexibility and increases the breaking strength.

In this instance for making 22/5/3 cord having S twist, we shall use a twist factor of 1000. Thus:

$$1000\sqrt{1.466}=1000 \times 1.208=1208 \text{ S}$$

The finished cord therefore, should have 1208 S manufacturing twists per unit of 100 inches of length (Unit Length) of the original singles yarn embodied in the cord.

Thread

Starting with given yarns the temporary total number of manufacturing twists to be given the thread per the chosen Unit Length, may be computed by multiplying the square root of the equivalent yarn number of the yarns which are to be embodied in the thread by an empirical twist factor ranging up to 1200.

In this instance for making 22/5 thread having Z twists we shall use the same twist factor, 1000, that we used for the cord. Thus:

$$1000\sqrt{4.4}=1000 \times 2.098=2098 \text{ Z}$$

The threads therefore, should have 2098 temporary total Z manufacturing twists per Unit Length of 100 inches of the original singles yarns to be embodied in the thread and cord.

Yarn

Having determined the number of finished cord twists, and the temporary total number of thread manufacturing twists the number of temporary manufacturing twists the original singles yarn should have per 100 inches of its own length is computed by subtracting the total number of finished cord twists, from the temporary total number of thread manufacturing twists.

In this instance, subtracting the total number, 1208 S finished cord twists from the temporary total number 2098 Z thread manufacturing twists leaves 890 Z twists as the temporary original singles yarn twists.

It will be understood that the initial or manufacturing twist given the yarn prior to incorporation into a thread will be sufficient to enable the yarn to withstand the tension and handling to which it is subjected in subsequent operations. We have found that initial or manufacturing yarn twist not substantially greater per inch of length than the square root of the original singles yarn count multiplied by a twist factor not greater than three will give satisfactory results in the manufacture of tire cords or the like from staple cotton fibers in accordance with our invention.

ALTERNATIVE METHOD OF COMPUTING THE TEMPORARY TOTAL NUMBER OF THREAD TWISTS

Having singles yarn with a given number of manufacturing twists per 100 inches of its own length, the temporary total number of manufacturing twists to be given the thread per unit of length of 100 inches of original singles yarn length in a direction opposite to that in which the original singles yarns were twisted, may be computed by adding together the given number of original singles yarn twists to the computed or desired number of twists per Unit Length of 100 inches of original singles yarn length which the finished cord should have.

WETTING, TWISTING, STRETCHING AND DRYING

We have found that the following wetting, twisting, stretching and drying operations, performed in the order given, untwist, compact and straighten the fibers, make the cord dense and of small over-all diameter, facilitate its production, augment its normal and hot breaking strengths and its elasticity, and control the amount of elongation left in the cord. It should be understood that the nature, order, number and extent of such wetting, stretching and drying operations may be changed without departing from the scope of our invention. For instance, one or more of the operations may be omitted and the stretching and length setting be done in whole or in part after the final twisting of the cord.

DETAIL INSTRUCTIONS FOR MAKING 22/5/3 CORD

(1) Five original 22s singles yarns each having 890 S manufacturing twists per 100 inches of its own length (Unit Length) are saturated and twisted into a thread having 2098 Z temporary total manufacturing twists per said 100 inches

of length of the original singles yarns (Unit Length.)

(2) The thread while saturated is stretched to a length approximately 87 per cent of the length of the original singles yarns before they are embodied in the thread. For each 100 inches of original singles yarn lengths embodied in it the thread would therefore be stretched to a length of approximately 87 inches. This stretch reduces twist contraction and makes the twist pitches of both yarns and thread more uniform throughout their lengths.

(3) The thread may be dried while maintained at its stretched length and when dried it will be set at that length. This operation of drying gives the thread a definite set length and prepares it for storing or for further operations.

(4) Three threads formed as above, each measuring approximately 87 inches in length, per 100 inches of original singles yarn length (Unit Length) and having 2098 temporary total Z manufacturing twists per 100 inches of original singles yarns length (Unit Length) are saturated and twisted together 1208 S twists per Unit Length to form a cord.

(5) The cord while saturated is stretched to a length of approximately 85 per cent of the length of the original singles yarns (Unit Length) before they were embodied in the thread.

For each 100 inches of original singles yarn lengths embodied in it the finished cord would, therefore, be stretched to approximately 85 inches in length.

(6) After being stretched the cord is maintained and dried at its stretched length where it becomes set at that length, which is 85 per cent of the original singles yarn length or 85 inches per Unit Length. This is the finished length of the cord.

The amount of residual stretch in the finished cord may be varied by varying the percentages of stretch given in paragraphs (2) and (5), also by varying the number of the thread or cord twists.

While the five singles yarns are being twisted 2098 Z temporary total manufacturing twists per Unit Length to form thread as described in paragraph (1) they first elongate because their original 890 S twists per Unit Length are being untwisted. This indicates that the S twist contractions of the yarns are being given up faster than the Z twisting of the thread takes effect. When the thread Z twists begin to take up length faster than the yarn S twists yield it, the length of the thread becomes progressively shorter. After the original 890 S twists of the yarn per Unit Length have been substantially eliminated or rendered ineffective by having been given an equal number of Z twists in the first part of the thread twisting operation, the threads embodying the yarns are Z twisted 1208 additional twists per Unit Length all of whose contractions tend to shorten the thread. The thread now has a temporary total of 2098 Z twists per Unit Length.

During the twisting of the threads 1208 S twists per Unit Length, to form cord, as described in paragraph (4), both the threads and the singles yarns give up their corresponding Z twists and their resulting contractions which tends to lengthen the cord, but the cord's 1208 S twist contractions per Unit Length absorb more length than is yielded by the 1208 Z twists, per Unit Length of both the yarns and threads, hence the cord contracts.

This analysis shows that the finished cord length after the described final stretching and drying operations is approximately 85 per cent of the original singles yarn length, (Unit Length), hence the true yarn number of the finished cord is

$$\frac{22}{15} \times \frac{85}{100} = 1.25$$

The actual gauge of this finished cord is .030", its stretch at ten pound load is 5.5 per cent and 10 per cent at break.

Those skilled in the art will understand how to correlate the longitudinal speed of the five singles yarns plies and the revolutions of the twister so as to twist the yarns continuously at such a rate that every Unit Length will be formed into thread having 2098 Z twists in it, spaced uniformly within manufacturing tolerances. They will also understand how to correlate the longitudinal speed of the three thread plies and the revolutions of the twister so as to twist the thread plies continuously at such a rate that a cord will be formed having 1208 S twists per Unit Length.

The steps of our process lend themselves to the convenient arrangement of the twistors, the receptacles for the saturating liquids, and the devices for stretching, tensioning, drying and winding the traveling strands.

Our process in no way prevents the use of water, penetrants, solutions of latex, or of mercerizing or other treatment of the yarns, threads or cords in any desired way either during or after their manufacture.

We claim:

1. Textile staple fiber cord composed of a plurality of yarns plied into threads and threads plied into cord in which the staple fibers composing the yarns as they lie in the finished cord are substantially parallel to the axes of the yarns in which they are embodied.

2. An article made of rubber or other flexible material reinforced with textile staple fiber cords made of yarns plied into threads and threads plied into cord, the staple fibers composing the yarns as they lie in the finished cord, being substantially parallel to the axis of the yarn which they compose.

3. The process of making textile staple fiber cord which includes plying together a plurality of original singles yarns each of the same known length and having the same known direction and known number of twists a greater number of twists than said known number and in the reverse direction to said known direction to form thread; and twisting together in said known direction a plurality of threads so formed from said known lengths of said original singles yarns a number of twists substantially equal to the number of twists by which the number of said plying twists exceeds said known number of twists to form a cord in which the singles yarns as they lie in the cord are substantially twistless.

4. The process of making textile staple fiber cord which includes twisting textile staple fibers into original singles yarn having a number A, of known direction twists per inch throughout its known length; plying a plurality of said original singles yarns by twisting them together in the reverse direction of said known direction a number B, twists for each inch of said known length of said original singles yarn to form thread; and plying a plurality of such threads by twisting them together a number C, twists in said known

direction for each inch of length of said original singles yarn to form cord; the number A, being equal to the product of the square root of the original singles yarn count multiplied by a twist factor not greater than 3; the number C being equal to the product of the square root of the equivalent yarn count of the plurality of original singles yarns that are to be embodied in the cord multiplied by a twist factor not greater than 12; and the number B being equal to the sum of A plus C; the singles yarns as they lie in the finished cord being substantially twistless.

5. The process of making textile staple fiber cord which includes twisting the fibers into original singles yarn having a number, A¹, of known direction twists per inch throughout its known length; plying a plurality of said original singles yarns each of the same known length by twisting them together in the reverse direction to said known direction a number, B¹, twists for each inch of said known length of said original singles yarn to form thread; and plying a plurality of such threads by twisting them together in said known direction a number, C¹, twists for each inch of said known length of said original singles yarns to form cord; the number A¹ being equal to the number by which B¹ exceeds C¹; the number B¹ being equal to the product of the square root of the equivalent yarn count of said plurality of original singles yarns embodied in said thread multiplied by a twist factor not greater than 12; and the number C¹ being equal to the product of the square root of the equivalent yarn count of the plurality of original singles yarns that are to be embodied in the cord multiplied by a twist factor not greater than 12; the single yarns as they lie in the finished cord being substantially twistless.

6. The process of making textile staple fiber cord which comprises twisting together in a given direction a plurality of singles yarns, all of the same length and each having the same given number of twists distributed uniformly throughout its length a number of twists greater than said given number and in the opposite direction thereto to form thread; stretching said thread to a length not less than 85% or more than 96 per cent of said same length and giving it a set while so stretched; twisting together in said given direction a plurality of such threads a number of twists substantially equal to the number by which said greater number exceeds said given number to form cord; and stretching said cord to a length not less than 85% or more than 96 per cent of said same length and giving it a set while so stretched.

7. The process of making textile, staple fiber cord which comprises twisting together in a given direction a plurality of saturated, original singles yarns, all of the same length and each having the same given number of twists distributed throughout its length, a number of twists per said given length of original singles yarn greater than said given number and in the opposite direction thereto to form thread; stretching said thread while saturated, to a length not less than 85% or more than 96 per cent of said same length of said original singles yarns; drying said thread while maintained at its stretched length; twisting together in said given direction a plurality of such threads, a number of twists substantially equal to the number of which said greater number exceeds said given number to form cord; and stretching said cord while saturated to a length not less than 85% or more than

96 per cent of said same length of said original singles yarns; and drying said cord while maintained at its stretched length.

8. A cord composed of a plurality of threads helically surrounding the cord's axis each of said threads being composed of a plurality of yarns helically surrounding the thread's axis, each of said yarns being composed of a multiplicity of staple fibers which are substantially twistless relative to said yarn's axis.

9. The process of making cord from staple fibers which includes twisting the fibers into original singles yarn of known length, a number, A^2 , of known direction twists per inch throughout its length; plying a plurality of said original singles yarns each of said known length into thread by twisting them a number, B^2 , twists for each inch of said known length of said original singles yarn but in the opposite direction to said known direction, the number, B^2 , being larger than the number, A^2 ; and plying a plurality of said threads into cord by twisting them in said known direction a number, C^2 , twists for each inch of said known length of said original singles yarn; the number, A^2 , being equal to the product of the square root of said original singles yarn count multiplied by a twist factor not greater than 3; the number, B^2 , being equal to the product of the square root of the equivalent yarn count of said plurality of said original singles yarns multiplied by a twist factor not greater than 12, and the number, C^2 , being equal to the difference between the numbers, A^2 and B^2 ; the twists of the singles yarns as they lie in the cord being substantially eliminated.

10. The process of making textile staple fiber cord which includes plying together a plurality of original singles yarns each of the same known length and having the same known direction and known number of twists a greater number of twists than said known number and in the reverse direction to said known direction to form thread; and twisting together in said known direction a plurality of threads so formed from said known lengths of said original singles yarns a number of twists substantially equal to the number of twists by which the number of said plying twists exceeds said known number of twists to form a cord in which the singles yarns as they lie in the cord are substantially twistless; stretching said cord to a length not less than 85 per cent or more than 96 per cent of said known length of said original singles yarns to straighten and compact the fibers; and giving the cord a set at its stretched length.

11. The process of making textile staple fiber cord which includes twisting textile staple fibers into original singles yarn having a number A, of known direction twists per inch throughout its known length; plying a plurality of said original singles yarns by twisting them together in the reverse direction to said known direction a number, B, twists for each inch of said known length of said original singles yarn to form thread; and plying a plurality of such threads by twisting them together a number, C, twists in said known direction for each inch of said known length of said original singles yarn to form cord; the number A, being equal to the product of the square root of the original singles yarn count multiplied by a twist factor not greater than 3; the number C being equal to the square root of the equivalent yarn count of the plurality of original singles yarns that are to be embodied in the cord multiplied by a twist factor not

greater than 12; and the number B being equal to the sum of A plus C; stretching the cord so formed to a length not less than 85 per cent or more than 96 per cent of the length of said original singles yarns to straighten and compact the fibers; and giving the cord a set at its stretched length; the singles yarns as they lie in the finished cord being substantially twistless.

12. The process of making textile staple fiber cord which includes twisting the fibers into original singles yarn having a number, A^1 , of known direction twists per inch throughout its known length; plying a plurality of said original singles yarns each of said same known length by twisting them together in the reverse direction to said known direction a number, B^1 , twists for each inch of said known length of said original singles yarn to form thread; and plying a plurality of such threads by twisting them together in said known direction a number C^1 , twists in said known direction for each inch of said known length of said original singles yarns to form cord; the number A^1 being equal to the number by which B^1 exceeds C^1 ; the number B^1 being equal to the product of the square root of the equivalent yarn count of said plurality of original singles yarns that are to be embodied in said thread multiplied by a twist factor not greater than 12; and the number C^1 being equal to the product of the square root of the equivalent yarn count of the plurality of original singles yarns that are to be embodied in the cord multiplied by a twist factor not greater than 12; the singles yarns as they lie in the finished cord being substantially twistless; stretching said cord to a length not less than 85 per cent or more than 96 per cent of said known length of said original singles yarns to straighten and compact the fibers; and giving the cord a set at its stretched length.

13. The process of making cord from staple fibers which includes twisting the fibers into original singles yarn of known length, a number, A^2 , of known direction twists per inch throughout its length; plying a plurality of said original singles yarns, each of said known length, into thread by twisting them a number, B^2 , twists for each inch of said known length of said original singles yarns but in the opposite direction, to said known direction, the number B^2 being larger than the number A^2 ; and plying a plurality of said threads into cord by twisting them in said known direction a number, C^2 , twists for each inch of said known length of the original singles yarns; the number A^2 being equal to the product of the square root of said original singles yarn count multiplied by a twist factor not greater than 3; the number, B^2 , being equal to the product of the square root of the equivalent yarn count of said plurality of said original singles yarns multiplied by a twist factor not greater than 12; and the number, C^2 , being equal to the difference between the numbers A^2 and B^2 ; the twists of the singles yarns as they lie in the finished cord being substantially eliminated; stretching said cord to not less than 85 per cent or more than 96 per cent of said known length of said original singles yarn and giving it a set at its stretched length.

14. The process of making textile staple fiber cord which comprises saturating and wet-twisting together in a known direction a plurality of original singles yarns, each of the same known length and each having the same known number of twists, a greater number of twists than said

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known number, and in the reverse direction to said known direction to form thread; saturating and wet-twisting together in said known direction a plurality of said threads, a number of twists substantially equal to the number by which said greater number exceeds said known number to form cord; stretching said cord while saturated to a length not less than 85 per cent or more than 96 per cent of said same length of said original singles yarns and drying said cord at its stretched length, the twists of said singles yarns as they lie in the finished cord being substantially eliminated.

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