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METHOD OF PRODUCING FIBROUS COVERING FOR ELASTIC THREAD

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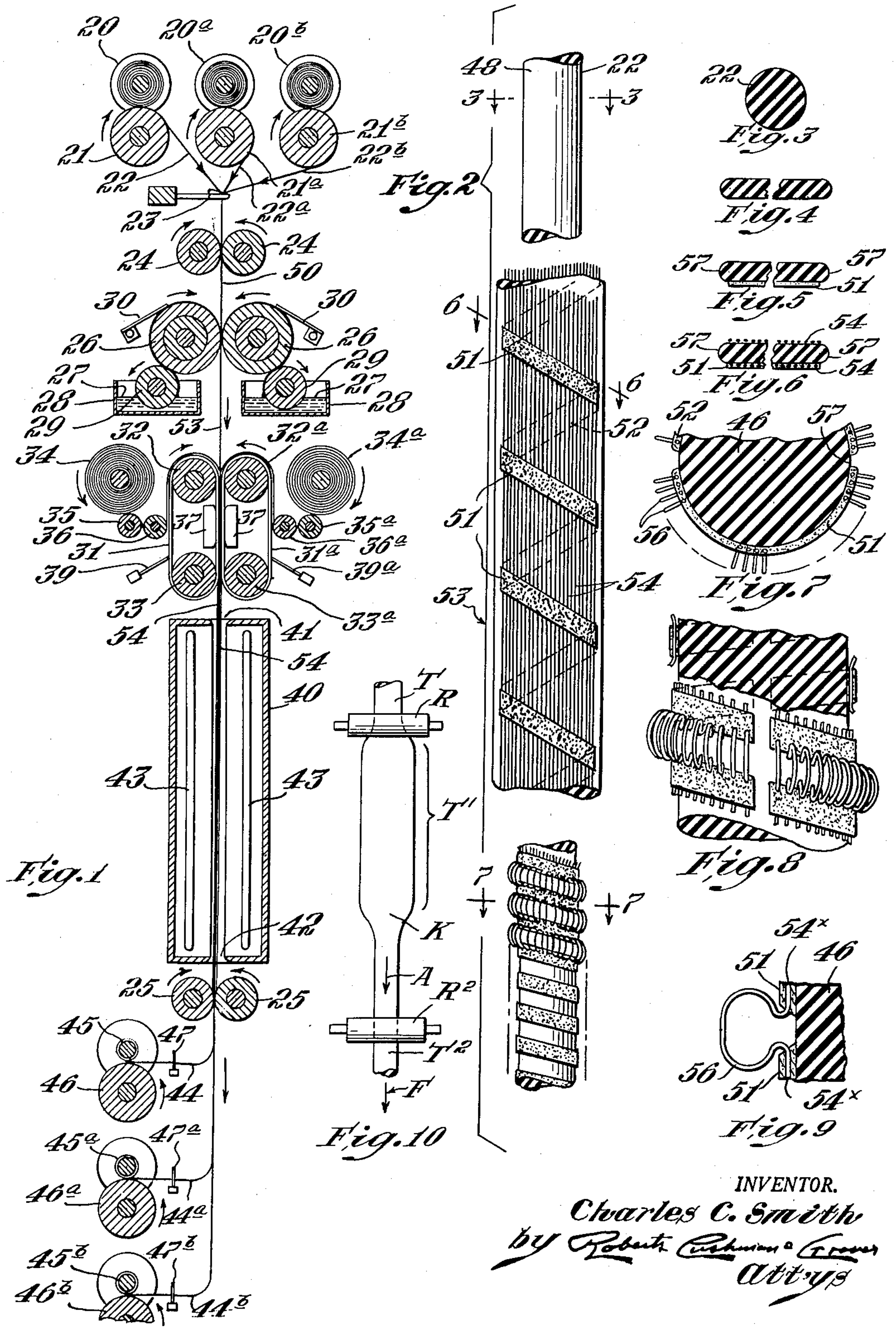

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METHOD OF PRODUCING FIBROUS COVERING FOR ELASTIC THREAD

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This invention relates to covered rubber elastic thread and to a method of making it. As contrasted with customary prior practice wherein a rubber elastic core thread is encased in a helical wrapping or wrappings of textile yarn, the present invention provides a covered elastic thread wherein the covering or jacket consists of a multitude of independent fibers or filaments arranged substantially parallel to each other without twist and extending lengthwise of the core to which each fiber or filament is attached at two or more spaced points in its length so as to provide, between adjacent points of attachment, a free length of the fiber which forms a bight or loop, the projecting bights or loops collectively forming a soft jacket or covering which is longitudinally stretchable with the core.

Objects of the invention are to provide a covered elastic thread which is soft to the hand, so that it may be worn next to the human body without harsh chafing of the delicate body tissues; to provide a series of softly enclosed air cells adapted to absorb body exudation, and to provide for heat or cold insulation; to provide a core with soft parallelized covering fibers, free at certain intervals, to permit the garment made from the thread to accommodate itself to minute body movements, without excessive sliding; to provide a method for the manufacture of such covered thread; and other objects which will become clear and evident as the specification of the selected embodiment proceeds.

In contradistinction to customary prior practice, the present invention provides for covering the elastic core with parallel fibers such, for example, as are obtained by carding, combing or drawing staple length fibers such as cotton, wool, rayon, nylon or the like, or by cutting synthetic filaments into staple lengths, or with independent, continuous synthetic filaments which have not been twisted together and which are, in this form, known in the trade as "tow."

Any length of fiber, or a blend of various fiber lengths or continuous filaments may be employed in the covering operation, as may be desired or convenient.

According to a preferred embodiment of the invention a continuous or unbroken layer of substantially parallel fibers, either staple or continuous, is anchored at intervals to the elastic core.

However, the fibers employed should be longer than "flock" fibers and, in fact, the majority of the fibers should be long enough to be attached to the core at two points, at least, separated from one another by a predetermined distance so as to permit the fibers, when the thread is relaxed after covering, to form bends or bights projecting from the core, such bends or bights being shaped, for example, more or less like the Greek letter omega. These projecting bights or bends collectively form a soft, continuous covering or jacket for the core.

By "staple" fibers is meant natural fibers, for example like cotton, in which there is considerable variation

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in fiber length. For example, in what is known as 1/16 inch American cotton, the fiber length will vary from about 1/16 of an inch up to about 2 inches, with only about 35% of the fibers having a length of 1 3/16 inch.

Short fibers, say about 1/4 inch or shorter, are sometimes known as "flock," particularly when they have been separated, as by combing for example, from the longer fibers.

Synthetic "staple" fibers may also have considerable length variation in the fiber length array. However, as a general rule, the manufactured staple fibers are more uniform in length than the natural staple fibers.

For some products, a substantially uniform length staple is desired, while in some other cases a substantial variation in fiber length will result in the optimum product. The ratio of length to diameter of the fibers should be very substantial. In staple fibers, it is preferable to use lengths of about from say 65 to 25,000 times the diameter of the fiber. When continuous filaments are used, the length to diameter ratio is almost infinite.

A single relatively short staple fiber will form but a few omega-like loops, for instance only one, while a longer staple fiber or a continuous filament may form a larger number of loops, depending on the length of the fiber and the size of loop.

Since the fiber lengths are not always, and in fact, seldom are exact multiples of the lengths necessary to form a single bight or loop, free ends of many of the fibers will project, being interspersed among the loops, and will impart something of a velvet or flocked effect to the covering.

In the process of manufacture the core (round, square or of any other convenient cross-sectional shape) is first flattened and simultaneously tensioned to elongate it to the desired degree. Then while the core is tensioned, a series of properly spaced, transverse or diagonal lines are printed on diametrically opposite sides of the elongated core while the latter is flattened to form a thin ribbon. The printing fluid is of an elastic and adhesive nature and the parallel fibers are pressed into the printed lines so that on curing, the fibers become permanently fastened to the core at the printed lines while being free from the core between adjacent printed lines. When the covered core is relaxed the free portions of the covering fibers project out from the core to form the bights or loops above mentioned, successive bights of a given fiber longitudinally of the thread normally substantially contacting.

In accordance with the present invention, the possible elongation of the covered yarn is entirely independent of the presence or absence of pre-stresses in the core. In the prior art product the elongation of the covered yarn is directly related to and is a function of the pre-stresses in the core.

In prior practice, wherein the core is covered with a helical wrapping, the core is always pre-stressed to elongate it to a predetermined percentage of its maximum safe elongation (elongation to the elastic limit) while the wrapping is being applied. From its normal relaxed condition, the covered yarn is only capable of elongation in response to a load greater than that necessary to stretch the core to said predetermined percentage elongation and furthermore, since the core, in the relaxed yarn, is held under radial compression, the relaxed yarn is stiff and has a harsh feel.

For example, in the prior art, a spirally wound core, for example the base core, may be elongated to about its maximum, consistent with safety, and a number of spirally wound covering coils wound tight on the elongated core. The number of coils per unit length is so regulated as to permit the fully elongated core to relax partially in length. Assuming, for example, that in the prior art, the elastic core has a maximum safe elongation of 600%, and a 150% elongation is desired in the covered product, then such a number of covering convolutions is wound on the elongated core as to permit it to recover only 150% out of the 600% elongation. In such case the elastic core is longitudinally pre-stressed at 450% and prevented from further contraction by the convolutions wound thereon.

According to the present invention the core of the relaxed covered yarn may have any desired elongattion from zero to the maximum safe elongation. The covered yarn may be made to begin to respond in stretching to any load which would stretch the uncovered core or to begin to stretch in response to the application of any predetermined greater load up to that which would produce maximum elongation, and correlatively, to contract, after extension, to any predetermined percentage of its maximum elongation. Moreover, since in the relaxed covered yarn the core is not under radial compression, the yarn is very pliable and has a soft, pleasant feel.

In the practice of the present invention, the core is widened by compression while being stretched longitudinally. For specific example, if a resilient core has a safe total cubical displacement factor equal to the cubical displacement resultant from a 600% longitudinal elongation alone, and it is desired that the covered yarn have a length wide elongation of 150%, and at the same time have a soft feel and good pliability, the core may be widened, by transverse compression to provide 450% of the permissive cubical displacement and simultaneously stretched longitudinally to provide the remaining 150% of the permissive cubical displacement. The filaments or fibers are then anchored to the stretched and flattened core by transverse bands of adhesive with such spacing between adjacent bands as will permit the core to contract transversely to the equivalent of 450% of the permissive cubical displacement and simultaneously to contract in length the equivalent of 150% of the permissive cubical displacement. In such a case, the core of the covered yarn will have 0% transverse and 0% longitudinal pre-stress. In other words, it is fully relaxed. For further example, with proper spacing of the fiber anchoring bands during application of the fibers, the relaxed covered yarn may begin to stretch upon application of a very small load, but stretch may be limited, by the straightening of the fiber bights, at a point where the core has been stretched only 150% as compared with a possible 600% stretch of the uncovered core.

Again, with proper spacing of the fiber anchoring bands, the action of the bands may be such that in the relaxed thread the core will have a predetermined elongation, for example 150% of its maximum elongation and thus a substantial load must be applied before the covered yarn begins to stretch. The stretch is limited, as in the preceding case, by the straightening of the fibers, for example, at a point where the core has extended to 400% of its maximum elongation.

As above suggested, the permissive elongation of the covered core is controlled by printing the anchoring lines of adhesive closer or farther apart or by elongating the flattened ribbon more or less preparatory to printing. Thus, for example, if a 150% elongation be desired in the finished product, the flattened ribbon is elongated about 150% while being printed. If a 400% elongation be desired, then the ribbon is elongated to 400%, while being printed. Alternatively, by printing the anchoring lines of adhesive on a core which has been stretched substantially to its elastic limit, with a spacing so dimensioned as to permit a 150% of a 400% recovery in the completed thread, there will be produced a pre-stressed core such that the thread will have a greater load-carrying capacity before elongation starts than in the former case, which results in a softer acting thread. Thus any desired elongation may be provided for the finished covered thread. It may be noted that the knitting trade prefers an elongation of about 350% while the weaving trade prefers about 150% elongation. The present invention permits any of these various desired elongations or recovery from maximum elongation within the capacity of the elastic core.

The printed and covered core will resume its original cross-sectional shape when the tension is relaxed and thereafter will retain that original shape during normal use. On such recovery the covering fibers attached to the diametrically opposite faces of the core, while it was flat, will be substantially uniformly distributed, peripherally, about the outer surface of the relaxed core, the projecting bights forming a low pitch helix coaxial with the core.

In the accompanying drawings:

Fig. 1 is a diagrammatic, vertical section illustrating one desirable form of apparatus for use in the practice of the invention;

Fig. 2 is a greatly enlarged, fragmentary elevation of a rubber elastic core thread showing various steps in the process of covering it;

Fig. 3 is a transverse section on the line **3—3** of Fig. 2, illustrating a core of circular normal section;

Fig. 4 is a transverse section through the core as it appears when flattened preparatory to the application of adhesive;

Fig. 5 is a transverse section illustrating the diagonal, sticky areas on one side of the flattened core resultant from the printing operation;

Fig. 6 is a transverse section, substantially on the line **6—6** of Fig. 2, showing the parallel covering fibers partially embedded in the sticky area on one side of the flattened core, the fibers on the opposite side being free from the core;

Fig. 7 is a transverse section, to very large scale, substantially on the line **7—7** of Fig. 2, showing the core after the tension has been partly relaxed and indicating the uniform peripheral distribution of the covering fibers puffed out into radial bights or loops;

Fig. 8 is a fragmentary elevation partly in section and to very large scale, showing one of the rows of bights as they appear in the relaxed thread;

Fig. 9 is a greatly enlarged, longitudinal, fragmentary section, showing one of the omega-like bights or loops and the way in which it is anchored to the core; and

Fig. 10 is a diagram illustrative of a principle made use of in the practice of the present invention

In accordance with the present invention, use is made of a phenomenon observed in the stretching of a rubber elastic thread which is illustrated in Fig. 10. In this view the character T represents a relaxed rubber elastic thread of circular transverse section which is passed between a pair of rigid rollers R, one of which is shown. For purposes of illustration it may be assumed that the rollers R do not turn but that they are spaced apart a distance such that the thread squeezed between them, is widened and flattened so that at this portion its width exceeds the diameter of the original thread T.

Assuming that initially a length of the thread has been passed between the rollers, for example by turning them, so as to provide a portion T^2 to which tension may be applied in the direction of the arrow A by a force F, and that this tension has been increased until the combined transverse and longitudinal displacement of the molecules of the rubber, due to the compression of the thread between the rolls and the application of longitudinal tension, substantially equals the cubic displacement which would result from the application of stress, longitudinally only, up to the elastic limit of the thread, the thread will begin to flow from between the stationary rollers R. Assuming that the point K is the point in the thread which was being gripped by the rolls at the instant the tension F reached the above intensity, the thread will emerge from the rolls as a ribbon T^1, the point K advancing and all of the thread between the point K and the rollers R being flat, while all of the thread below the point K will remain of its initial circular transverse section. If the force F for advancing the thread be applied by passing the thread through a second pair of rolls R^2, driven at the proper speed, the entire length of thread between the two sets of rolls, after the point K has passed the rolls R, will be flat, but as the thread emerges from between the rolls R^2 it will resume its initial circular section. By the use of this principle, it is possible to subject a portion of a normally circular thread to a treatment which ordinarily could be applied only to a flat ribbon, but the result of such treatment, as compared to its application to a normally flat ribbon, will be modified when the thread resumes its normal circular section.

The above principle, that is to say the retention of its flattened condition in response to the concomitant application of flattening pressure and tension, is applicable to rubber elastic threads of any initial transverse section and even to the covering of elastic sheet material, on one or both sides, but for most purposes its utility is directed to its application to threads of initially regular transverse section, that is to say threads of circular or regular polygonal section, and when hereinafter reference is made to a thread of "regular transverse section" such term is intended to apply to threads of any regular polygonal section and also to threads of circular transverse section.

Referring to Fig. 1, which illustrates a selected mechanical embodiment of means for use in the practice of the invention, a plurality of core-supporting spools (three such spools being shown by way of example) are indicated at **20**, **20**^{a} and **20**^{b}, these spools being driven by a conventional uniform surface speed drive mechanism comprising the drive rolls **21**, **21**^{a} and **21**^{b} by means of which the relaxed elastic core yarns **22**, **22**^{a} and **22**^{b} are unwound from the spools or supply packages and are fed through guide eyes **23** (only one of which is shown) into the nip of a pair of feeding and tensioning means **24**, **24**. These rolls **24**, **24** are positively driven at a uniform, peripheral speed and are adjustably supported in a manner conventional in the art so that any desired space may be provided between them at the nip point. Since the means for driving and adjusting the rolls **24**, **24** may be conventional they have not been herein illustrated. The nip rolls **24**, **24** are of a length such as to grip a substantial number of core threads simultaneously. The eyes **23** guide the longitudinally spaced elastic core yarns from the several supply packages **20**, **20**^{a}, **20**^{b}, etc. so that they enter the nip rolls in spaced, side-by-side relation. Any number of core yarns may be covered simultaneously but to facilitate the operation it is preferable to space the core yarns so that there are from four to sixteen core yarns per inch of length of the nip of the rolls **24**, **24**, depending on the size of the core yarns.

The core yarns are drawn through the mechanism by a second pair of nip rolls **25**, **25** spaced a suitable distance from the rolls **24**, **24**. The rolls **25**, **25** are driven at a higher peripheral speed than the rolls **24**, **24** thereby to elongate the core threads to the desired degree with the zone at which the actual covering operation is performed. The desired elongation may be produced (within the capacity of the elastic material) by adjusting the peripheral speed of the rolls **25**, **25** relatively to that of the rolls **24**, **24**, any convenient means being provided for adjusting the speed of either one or both of the pairs of rolls **24**, **24** or **25**, **25**. The linear speed difference between the nip rolls **24**, **24** and **25**, **25** shall be such as to provide the necessary balancing tension, on that portion of the transversely elongated core which is located between these two sets of nip rolls, to prevent the premature recovery of the transverse displacement. No speed-adjusting mechanism is here illustrated since such mechanism is well known in the art and may be conventional.

The printing, fiber deposit and curing and setting of the adhesive anchoring material are all performed within the space between the two sets of rolls **24**, **24** and **25**, **25** and simultaneously at diametrically opposite sides or faces of the flattened and tensioned elastic core.

Any desired design, including lines, dots, etc., may be printed on the faces of the core while the latter is flattened by the action of the engraved printing rolls **26**, **26** (these rolls being at opposite sides of the core). The printing rolls are supplied with suitable printing compound **27** held in containers **28**, **28** from which it is carried up by the feed rolls **29**, **29** and deposited on the undersides of the engraved printing rolls **26**, **26**. This printing compound is of a type which, when first applied, is sticky or tacky but which sets when properly treated so as to be retentive of the fibers which may be placed in contact with it while in its tacky condition. The adhesive material is also of a nature such that when it has set it is elastic so that it is capable of elongating with the elastic core without separating from the latter. The excess printing compound is removed by doctor blades **30**, **30** of conventional design. The printing rolls **26**, **26** and the feed rolls **29**, **29** are suitably driven in the direction indicated by the arrows in Fig. 1, by any conventional type of drive mechanism, not shown.

The printing rolls **26**, **26** are relatively adjustable thereby to permit contacting of the flattened core at the printing point and any appropriate conventional means may be provided for driving and adjusting the printing rolls.

After the adhesive has been printed onto the core the fibers are delivered for contact with the printed areas. As here illustrated the fibers or filaments are applied to the core by means of a pair of endless belts or blankets **31** and **31**^{a} suitably supported and driven by rollers **32**, **33** and **32**^{a}, **33**^{a} which may be supported on a frame (not shown) of any suitable construction. These rolls are driven in the direction indicated by the arrows (Fig. 1) and are preferably arranged so that the rolls of one pair may be moved relatively to the rolls of the other, thereby to keep the belts taut.

The endless belts or blankets **31**, **31**^{a} are, usually, made of wool, felt, fine cotton duck, canvas or similar material to which the fibers will tend to cling and so as to be carried thereby, and which have a comparatively smooth surface with which to press the fibers into the printed anchoring places. The fibers for use in making the covering are supplied as a pair of packages **34** and **34**^{a}. These packages may be rolls of carded or combed staple fiber in sliver form or a continuous filament tow, the constituent fibers or filaments being substantially parallel. Any other convenient arrangement may be used for supplying the fibers to the belts **31** and **31**^{a}. The fibers are delivered to the belts **31** and **31**^{a} by a set of feed rolls **35** and **36**; **35**^{a} and **36**^{a} (one pair for each belt), driven in any conventional manner. The belts **31** and **31**^{a} are provided with pressure plates **37**, **37** each located between corresponding belt-supporting rollers and each being adapted yieldingly to bear against the inside run of the corresponding belt so as to provide the necessary pressure to press the fibers against the sticky areas formed on the core by the printing rolls. These pressure plates **37** may be yieldingly urged toward each other in any suitable way, for example, by springs or weighted levers (not shown).

The pressure plates **37**, **37** may be mounted on electrically insulating standards (not shown) and electrically grounded (not shown) so as, in effect, to constitute a tribo-electric magnetic condenser plate, resiliently to hold the fibers onto the belt or blanket.

Such a tribo-electric magnetic condenser plate is fully described in a copending application, Serial No. 250,531, filed on October 9, 1951.

The fibers form a thin layer on the belts or blankets **31** and **31**[a] and as the belts travel in the direction of the arrows the sticky areas of the core will pick up all of the fibers from the surfaces of the belts which can be embedded in the adhesive material by the pressure plates **37**, **37**. Any excess fiber not thus picked up continues to follow the belts **31** and **31**[a]. The speed of the feed rollers **35**, **36**, when properly adjusted, is such as to deliver only enough fibers to the belts to replenish the supply on the latter. Combs **39** and **39**[a] are arranged to even up the fibers on the belts or blankets **31** and **31**[a]. The linear speed of the printing rolls **26**, **26** and the linear speed of the belts or blankets **31** and **31**[a] are so relatively adjusted as to coincide with the linear speed of the core thread at the particular elongation determined by the speed difference between the rolls **24**, **24** and **25**, **25**.

After the fibers have been deposited and adhesively attached to the sticky areas of the core thread, the covered thread is drawn through a drying, curing or vulcanizing device **40** provided with inlet and outlet openings **41** and **42** respectively. If the adhesive employed is such as becomes set by exposure to a high temperature, the apparatus **40** may be provided with heating elements **43**, **43** of any desired type and adapted to dry, cure or vulcanize the printed compound. If the adhesive material is such as becomes set by exposure to a gaseous or other fluid medium, then the device **40** may be provided with means for exposing the covered thread to such a fluid medium on its way through the device **40**. Obviously if the sticky material be of a self-curing nature, such that it sets quickly upon exposure to the air, or if it be a thermoplastic material which sets upon cooling, the device **40** may be dispensed with.

The covered and cured elastic thread passes between the rolls **25**, **25** and as soon as the tension is relaxed it resumes its original cross-sectional shape which it had before it entered the rolls **24**, **24**. Thus if the normal section of the elastic thread was round before entering the rolls **24**, **24**, it will resume its round shape after leaving the rolls **25**, **25**. Likewise a square thread will become square, a triangular thread will become triangular and so on, it being noted that the flattening action which the core undergoes during the operation of attaching the fibers results in no permanent deformation, assuming, of course, that the elastic thread has such a normal elasticity as to cause it to resume its original cross-sectional shape. However, as has been stated, the discharge nip rolls **25**, **25** have a higher peripheral speed than the feeding nip rolls **24**, **24** so that the portion of the core body, located between these pairs of rollers, will be under the desired longitudinal stress which shall be of such magnitude as to balance the transverse stresses and thus hold the core body in a transversely attenuated condition.

The covered and relaxed threads **44**, **44**[a] and **44**[b] are wound on suitable cores **45**, **45**[a] and **45**[b] driven by drums **46**, **46**[a] and **46**[b] respectively, at a uniform surface speed in a conventional manner, the drums turning in the direction indicated by the arrows. Distributing fingers **47**, **47**[a] and **47**[b] may be provided for distributing the completed elastic thread longitudinally of the cores, these distributing fingers being moved back and forth in a conventional way.

The various parts of the apparatus are supported on appropriate frame members (not shown) and the driving means for the various rotating parts may comprise conventional gears, belts, chains or the like which receive their motion from a suitable power source (not shown).

Referring to Fig. 2, one of the elastic core threads is shown to greatly enlarged scale. In the upper part of the figure the core thread **22** is shown in its normal or relaxed form, this core being of round or circular section, as shown at Fig. 3. As the core thread passes between the rolls **24**, **24** and later through the rolls **25**, **25** it is flattened by the rolls **24**, **24** to form a thin ribbon and by virtue of the tensioning effect of the rolls **25**, **25** this flattened core will retain its ribbon-like cross section throughout the portion intervening between the rolls **24**, **24** and **25**, **25**, as illustrated, for example, at the central part of Fig. 2 and in the transverse sections of Figs. 4, 5 and 6. It is preferred to flatten the thread sufficiently to produce a 10 to 50% transverse enlargement in the width of the flattened section, as compared with the normal relaxed diameter of the thread, while at the same time, by the tensioning action of the rolls **24**, **24** and **25**, **25** the flattened portion is elongated to result in a reduction in thickness of 50 to 90% of the original diameter of the relaxed cylindrical thread. For example, if a round thread having a relaxed diameter of 0.020 inch is used, it may be so flattened and tensioned that the flattened portion of the thread will be about 0.022 inch wide and about 0.002 inch thick at the point at which the adhesive is printed on.

In printing this flattened ribbon-like thread the so-called "lake" printing process may be used. According to this process the printing rolls have engraved cavities which become filled with the printing compound, the excess being removed by a doctor blade. As the printing rolls press against the flattened thread these small lakes of printing compound will adhere to the face of the flattened thread and will be pulled out of the cavity in the rolls, thus depositing a predetermined measured quantity of compound on the thread. As suggested, the printing compound is such as the produce sticky areas on the core thread. Usually the printing compound will be adhesive when applied and capable of setting when subjected to appropriate treatment. In the particular illustration shown in Fig. 2, the flat surfaces of the core thread have been printed with diagonal bands **51** on one side and **52** on the opposite side. The printed section, as a whole, is designated by the numeral **53**. The diagonal lines **51** may be so arranged as to form a substantially unbroken helix when the elastic thread is subsequently relaxed. Obviously any other design may be printed on the core, if preferred.

The covering fibers stick to the printed areas as the core passes between the belts **31** and **31**[a]. These fibers indicated at **54** (Figs. 2 and 6) are straight and substantially parallel with each other and extend longitudinally of the elastic core thread. The initial spacing of adjacent sticky bands **51** or **52** determines the height of the omega-like bights or loops which the covering fibers form when the thread is relaxed; that is if the initial distance between adjacent bands **51** or **52** is made long, the omega-like loops will be high, that is to say they will project a substantial distance from the core when the latter is relaxed. If the distance between adjacent bands **51** is short, the loops will be low; thus the thickness of the jacket or covering material may be controlled as desired. For purposes of illustration a relaxed thread having a diameter of 0.020 inch may be provided with bands **51** or **52** spaced from 0.015 to 0.02 inch apart. Such spacing will produce a loop height of approximately 0.005 to 0.007 inch measured radially out from the periphery of the core. Such omega-like bights or loops are indicated at **56** on the relaxed core (Figs. 2, 7, 8 and 9).

Since the anchoring bands **51** and **52** are printed on the diametrically opposite, flattened faces of the core, a small gap **57** (Fig. 6) will be left near each edge of the flattened section. As a rule these gaps are of a lesser thickness than that of the flattened core. By reducing the viscosity of the printing compound so that it flows around the edges of the flattened core these gaps may be eliminated. However for ornamental purposes such gaps may be retained or even made purposely wider.

Referring to Fig. 9, one of the omega-like loops **56** and also parts of two adjacent printed bands **51** are shown in a part of the relaxed core **46**. The space between adjacent bands **51** (as shown in Fig. 2) has shortened as the core contracted so that the bands **51** in Fig. 9 are much closer together than those in Fig. 2. Those portions **54**x of the fiber which have become embedded in the adjacent bands **51** remain substantially parallel to the axis of the core while the intervening loose portion of the fiber buckles out to form the loop **56** (Fig. 9). This projecting loop with the portions **54**x which may be referred to as the "legs" of the loop, forms a figure suggestive of the Greek letter omega. However, it may be observed that if the spacing of the bands **51**, as applied to the tensioned core, is substantially less than that illustrated in Fig. 2, the resultant loops or bights, when the core is relaxed, may be of a shape less closely resembling the Greek letter omega and, in fact, may more nearly approach the shape of the letter U.

In passing through the curing device **40** of the leg or foot portions **54**x of the loops are permanently anchored to the core by the setting of the adhesive. The projecting portions **56** of the loops collectively form the peripheral surface of the core cover or jacket in the completed thread, it being noted that the parallel fibers are quite close together peripherally of the thread and that successive bights of any given fiber may be very close together and substantially touch when the core is fully relaxed.

Since the bands **51** of rubber adhesive are applied to and cured (and thus in fully relaxed condition) while the core is tensioned, the relief of core-tensioning stress tends to compress each band axially of the core and thus, collectively, the resistance of the bands **51** to such compression may limit contraction of the core to a predetermined amount, dependent upon the initial spacing and width of the bands **51**.

When the covered thread prepared as above described is elongated during use, each of the loops **56** will, at full extension of the thread, become a straight continuation of its leg or foot portion **54**x. If the thread is stretched to any substantial further degree the fibers will rupture and the core will thereafter break. The extensibility of the complete thread may be so calculated that the fibers **54** and the core **46** will rupture simultaneously or practically so. For most uses such a simultaneous break of the covering and core is desirable. However for certain specific purpose it may be desirable to provide a construction such that the fibers **54** will break while the core **46** is still capable of substantial further elongation before reaching its elastic limit. On the other hand, it may sometimes be desirable to construct the covered thread so that the core **46** will rupture first and the fiber covering will rupture only on further elongation. However, the greatest tensile strength of a given covered thread is obtained when the rupture of the core and covering is substantially simultaneous.

The improved covered theread, according to the present invention, has a very soft, lofty covering or jacket providing a wholly different feel from that of a thread covered by the usual spiral windings of the prior art. Furthermore, the improved thread of the present invention is capable of elongation to a very substantial degree without exposing the core whereas threads covered with spiral coverings, according to usual prior practice, can only be elongated to a limited extent before the core thread is exposed. Moreover, by the present procedure the core is adequately covered by the use of a substantially less amount of fibrous covering material than is necessary when other prior methods of covering are employed.

The term "rubber elastic" is herein employed as a convenient expression to denote a material having the elastic stretch characteristics similar to those of natural India rubber and is to be understood as inclusive of all such other materials, among them the synthetic rubbers, as have similar physical characteristics.

While as herein specifically described the fiber is at-

tached to the elastic thread by the use of adhesive, usually a material different from that of the thread, it is contemplated as within the scope of the invention, particularly when the elastic thread is of a synthetic material, that the adhesion of the fiber may be obtained by causing the thread itself to become temporarily adhesive as, for instance, by the use of a volatile solvent or by the application of heat in any convenient way.

While a desirable embodiment of the invention has herein been illustrated and described by way of example it is to be understood that the invention is broadly inclusive of any and all modifications falling within the scope of the appended claims.

I claim:

1. The method of encasing a rubber elastic core thread in a jacket of fiber which comprises as steps, stretching the thread, attaching fibrous material at intervals spaced longitudinally of the thread, and relaxing the thread.

2. That method of covering a rubber elastic core thread with projecting bights of fibrous material which comprises as steps, stretching the thread longitudinally, while it is stretched assembling elongate fibers with the thread so as to extend longitudinally of the latter, attaching each fiber to the thread at spaced points and thereafter allowing the thread to relax.

3. That method of covering a rubber elastic core thread with projecting bights of fibrous material which comprises as steps, compressing the thread transversely and stretching it longitudinally, while it is stretched disposing a multitude of elongate fibers to lie substantially parallel to the thread and closely adjacent to its peripheral surface, attaching each fiber to the thread at points spaced longitudinally of the thread and allowing the thread to relax.

4. That method of encasing a rubber elastic core thread in a jacket of fibrous material which comprises as steps, compressing the thread transversely and concomitantly stretching the thread longituidnally, providing fibers of staple or greater length disposed in substantially parallel relation, disposing said fibers to contact the peripheral surface of the stretched thread and to extend longitudinally of the latter, attaching each fiber to the thread at intervals regularly spaced apart longitudinally of the fiber, and relaxing the thread.

5. That method of covering rubber elastic core thread with fibrous material which comprises as steps, compressing the thread between rigid parts so as to flatten it and applying tension to the thread sufficient to cause it to flow between said parts, applying a substantial continuous helix of adhesive having spaced turns to the stretched thread, associating elongate fibers with the stretched thread so that spaced portions of each fiber are adhesively gripped by the adjacent turns of the adhesive helix, and allowing the thread to relax whereby the portions of each fiber intervening between adjacent turns of the helix take the form of projecting bights.

6. That method of encasing a rubber elastic core thread in a jacket of fibrous material which comprises as steps, flattening the thread and stretching it, providing tow consisting of parallel filaments of synthetic textile fiber, arranging said tow to extend lengthwise of the stretched thread, attaching the tow at spaced points in its length to the stretched core thread, and allowing the thread to relax whereby portions of each filament of the tow project from the thread as omega-shaped bights.

7. That method of covering rubber elastic core threads with fibrous material which comprises as steps, compressing the thread between opposed parts to flatten it and tensioning the thread to cause it to flow between said parts, applying adhesive to the stretched thread at longitudinally spaced areas, disposing elongate fibers to extend longitudinally of the thread and so that portions of the fibers are embedded in the spaced areas of the adhesive, setting the adhesive and allowing the thread to contract whereby those portions of the fibers intervening between adjacent areas of adhesive take the form of open bights.

8. The method of encasing a rubber elastic core thread in a jacket of fiber which comprises as steps, concomitantly flattening and stretching the thread, printing it at regularly spaced intervals with a medium which provides temporarily sticky areas to which fibers adhere, applying fibers to the sticky areas of the thread so that the fibers adhere to said sticky areas, and relaxing the thread.

9. That method of encasing a rubber elastic core thread in a jacket of fibrous material which comprises as steps, concomitantly flattening and stretching the thread, printing spaced bands of adhesive upon the surface of the stretched thread, and printed-on bands of adhesive, extending transversely of the thread, causing fibrous material to adhere to said bands of adhesive, and relaxing the thread.

10. The method of encasing a rubber elastic core thread in a jacket of fiber which comprises as steps, flattening the thread, stretching the flattened thread, arranging a thin sheet of fibers substantially parallel to each of the flat faces of the thread, the fibers extending longitudinally of the thread, attaching each fiber to the thread at points spaced lengthwise of the fiber, and relaxing the thread.

11. The method of encasing a rubber elastic core thread in a jacket of fiber which comprises as steps, flattening the thread, stretching the flattened thread longitudinally while printing its flat faces with adhesive at spaced areas of its length, assembling the fiber with the stretched thread so that portions of the fiber adhere to the adhesive areas, setting the adhesive, and relaxing the thread.

12. That method of covering a rubber elastic core thread with projecting bights of fibrous material and which comprises as steps, flattening the rubber elastic thread and while it is flat, stretching it and to each of its wider flat faces applying longitudinally spaced, parallel bands of adhesive, associating with the flattened thread substantially parallel fibers extending lengthwise of the thread adjacent to each of its flat faces, the fibers being of a length such that each fiber contacts at least two adjacent bands of adhesive, setting the adhesive and allowing the thread to relax whereby those portions of the fibers which intervene between adjacent bands of adhesive form projecting bights.

13. The method of encasing a rubber elastic core thread in a jacket of fiber which comprises as steps, flattening the thread, stretching the flattened thread while printing the flat faces of the thread with a medium which provides temporarily sticky areas, said areas being spaced longitudinally of the thead and extending diagonally across its flat faces, the diagonal areas at opposite faces sloping in opposite directions and being so aranged that after the thread has been relaxed and has resumed its original cross-sectional shape the adhesive areas collectively form a substantially unbroken helix, applying fiber to the flat faces of the thread so that portions of the fibers adhere to said sticky areas, and allowing the thread to relax and resume its original cross-sectional shape.

14. The method of encasing a rubber elastic core thread in a jacket of fiber which comprises as steps, flattening the thread, stretching the flattened thread while printing the flat faces of the thread with a medium which provides temporarily sticky areas, said areas being spaced longitudinally of the thread and extending diagonally across its flat faces, applying fibers to said flat faces so that portions of the fibers adhere to said sticky areas, and relaxing the thread.

15. That method of encasing a rubber elastic core thread in a jacket of fibrous material which comprises as steps, flattening the thread, printing the flatened thread with adhesive while stretching it so that opposite flat faces of the thread are provided with spaced sticky areas, said sticky areas extending diagonally of the thread and being so arranged that when the thread has been relaxed and recovers its normal transverse section, said adhesive areas collectively form a substantially unbroken helix, applying fibrous material to the adhesive areas of the flat faces, treating the adhesive to cause it to set, and relaxing the thread.

16. The method of encasing a rubber elastic core thread in a jacket of fiber which comprises as steps, flattening the thread, stretching the flattened thread while printing the flat faces of the thread with a medium which provides temporarily sticky areas, said areas being spaced longitudinally of the thread and extending diagonally across its flat faces, the diagonal areas at opposite faces being so arranged that when the thread is relaxed and resumes its original cross-sectional shape the adhesive areas collectively form a substantially unbroken helix coaxial with the thread, disposing elongate, substantially parallel fibers so that they extend longitudinally at each of said flattened faces of the thread, said fibers being of lengths exceeding the distance between adjacent sticky areas of the thread, pressing the fibers into contact with said sticky areas whereby spaced portions of the fibers adhere to the thread, and relaxing the thread whereby those portions of the fibers, intervening between the points of adhesion, project as bights from the surface of the thread.

17. That method of treating a rubber elastic thread which comprises as steps subjecting the thread to transverse deforming pressure thereby to widen and flatten it while concomitantly subjecting it to longitudinal tension such as to prevent the flattened portion from resuming its initial transverse sectional contour, applying material to at least one of the flat faces of the thread and thereafter relaxing the tension to permit the thread to resume its initial transverse sectional contour.

18. That method of treating a rubber elastic thread of an initially regular transverse section which comprises as steps passing the thread between rigid presser elements which flatten and widen it while simultaneously subjecting the thread to longitudinal stress by means of a pair of tensioning rolls spaced from the pressure-applying elements, the tensioning rolls being driven at a linear speed such as to cause the thread to flow from between the pressure elements and to retain its flattened condition until it escapes from between the tensioning rolls, and treating at least one of the flat faces of that portion of the thread intervening between the presser elements and the rolls.

19. That method of treating a rubber elastic thread according to claim 18 wherein the pressure-applying elements are rolls turning at a lesser linear speed than that of the tensioning rolls.

20. That method of preparing a covered elastic yarn which comprises as steps, subjecting a rubber elastic thread, of regular transverse section, to transverse pressure thereby to flatten it, and concomitantly applying longitudinal tension sufficient to prevent the flattened thread from resuming its initial transverse section, applying covering material to at least one of the flat faces of the thread, and relaxing the tension to allow the thread to resume its initial transverse sectional contour.

21. That method of preparing a covered rubber elastic yarn according to claim 20 wherein, in applying the covering material, an adhesive is first deposited on the flat face of the thread and then a fibrous substance is caused to cling to the adhesive.

22. That method of preparing a covered elastic yarn according to claim 20 wherein, in applying the covering material, a rubber adhesive is first deposited on one, at least, of the flat faces of the thread, textile fibers are caused to cling to the rubber adhesive, and the latter is then cured before the tension is relaxed.

23. That method of treating a rubber elastic thread of initially circular, transverse section which comprises as steps squeezing the thread between opposed, rigid, pressure-applying parts thereby to flatten it and increase its width while concomitantly tensioning it until it flows from between the pressure-applying parts whereby the thread emerging from between said parts continues to retain its flattened shape until relieved of tension, printing

material onto the flat faces of the thread, and thereafter relaxing the tension to allow the thread to resume its initial transverse section.

24. That method of treating a rubber elastic thread according to claim 23 wherein, the printing is applied as spaced, diagonal stripes of opposite pitch at opposite sides respectively of the flattened rubber thread.

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