Nov. 21, 1961 KUNG-CHIH WANG 3,009,311

ELASTIC YARN

Filed March 13, 1957 2 Sheets-Sheet 1

Fig. 1

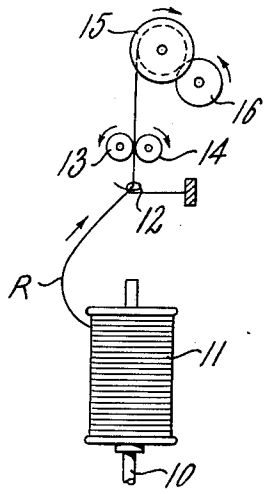


Fig. 4

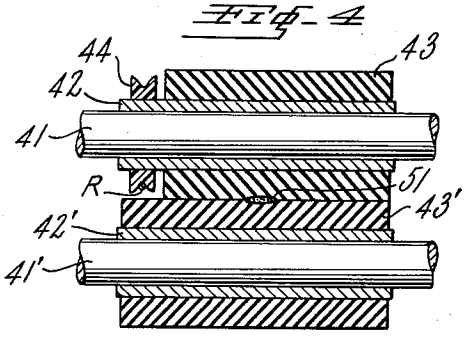


Fig. 5

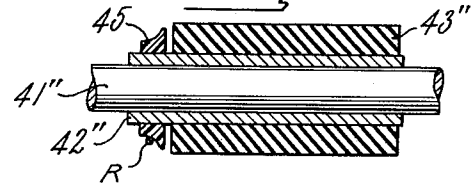


Fig. 6

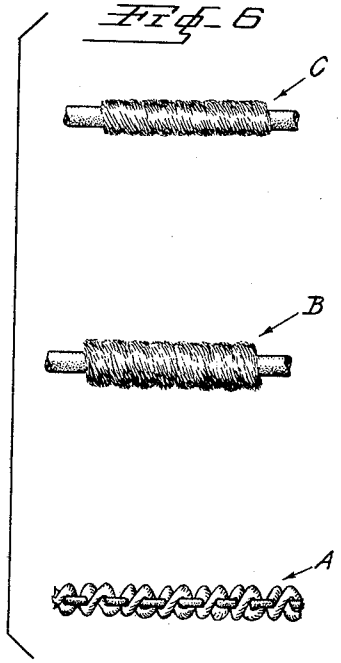
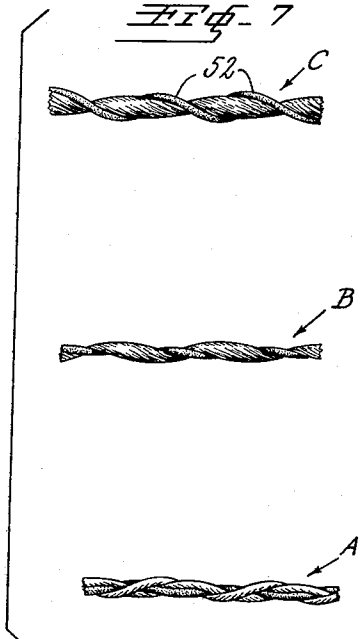


Fig. 7



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Nov. 21, 1961 KUNG-CHIH WANG 3,009,311

ELASTIC YARN

Filed March 13, 1957 2 Sheets-Sheet 2

Fig. 2

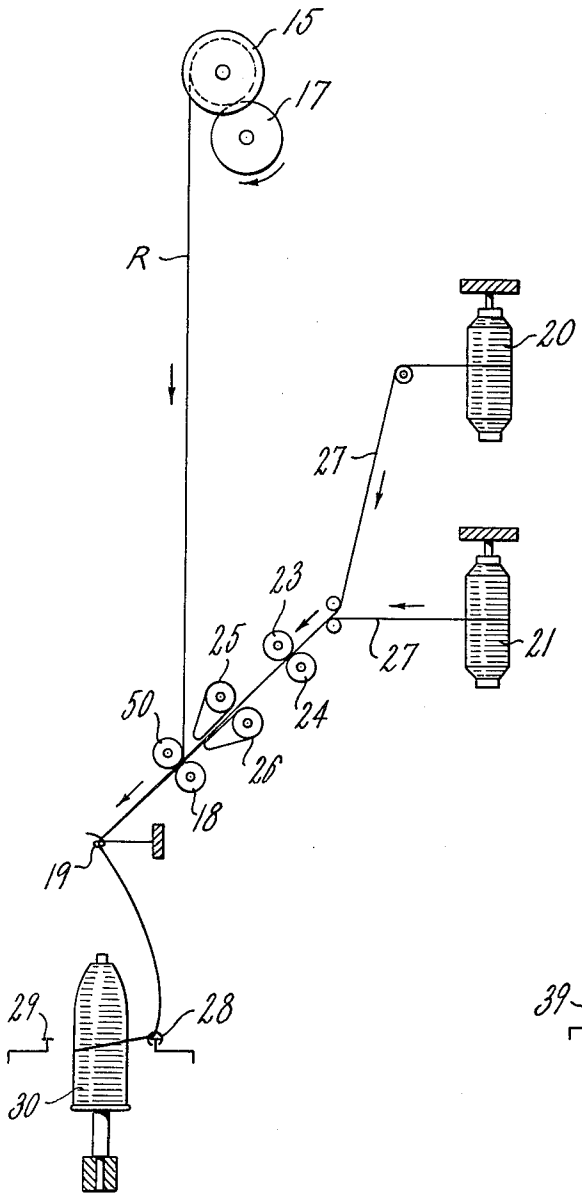
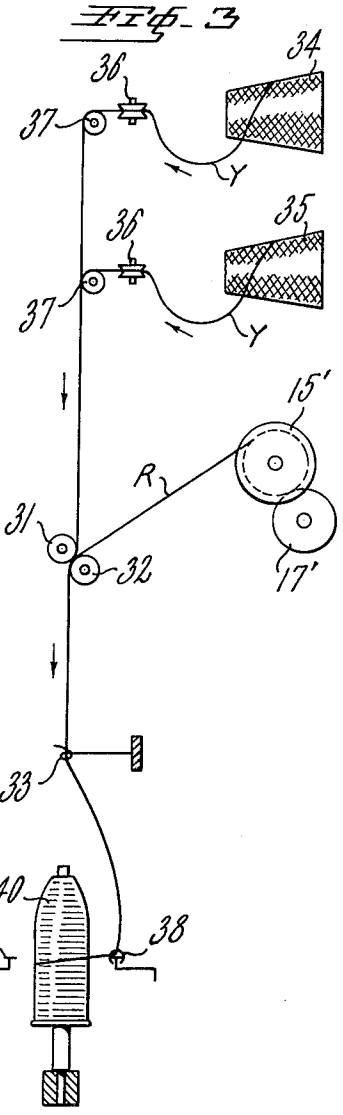


Fig. 3



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ELASTIC YARN

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2 Claims. (Cl. 57—152)

This invention relates to an improved single cover elastic yarn.

Single cover elastic yarns comprising a twisted rubber thread and a covering yarn or roving helically wrapped around the rubber thread have been produced for many years in accordance with the teachings of the Foster Patents 2,024,155 and 2,024,156 granted December 17, 1935. These yarns have been manufactured and used extensively, but they have not been used in all commercial fields where elastic yarns are used. For example, the yarns of this type which are produced commercially generally have an elongation falling in the limited range of from 120 to 160% elongation. These yarns generally are used only to produce low modulus, soft hand woven elastic fabrics such, for example, as the fabrics used in bathing suits.

Double cover elastic yarns consisting of an untwisted rubber thread having two yarns wrapped therearound in opposite directions have been manufactured and used widely for many years. Yarns of this type manufactured commercially have elongations falling in the range of from about 100 to 400% elongation, and they are made having either a high or a low modulus, as desired. Since these double covered yarns can be made to have either a high or a low elongation, or a high or a low modulus, as desired, the commercial applications in which they are used have not been limited as has the commercial applications for single cover yarns.

Elastic yarns of this general type, that is yarns comprising an elastic core, either twisted or untwisted and a fibrous cover sheating this core, either single or double, may be classified according to their elongations. Yarn with an elongation in the range of 100% or slightly greater is considered a low elongation yarn, and yarn with an elongation of approximately 400% or slightly less is considered a high elongation yarn. Yarn having an elongation of approximately 200% would be classified as an intermediate elongation yarn. Commercially the broad loom (weaving) trade uses large quantities of low elongation yarn, that is yarns having from 100–140% elongation, with a peak in the quantities of the yarns used falling at approximately 120% elongation; the knitting trade uses large quantities of intermediate elongation yarns, that is yarns having an elongation from about 180–220% elongation, with a peak in the quantities of yarns used falling at approximately 200% elongation; and the hosiery trade uses large quantities of yarns having a high elongation, that is yarns with an elongation from about 300–400% with a peak in the quantity of the yarns used falling at approximately 350% elongation.

In accordance with this invention balanced, well covered, single cover elastic yarns can be produced having an elongation falling anywhere in the expanded range of from about 115% to 350%, as desired. Consequently the new yarns will find applications in commercial fields the old single cover type yarns could not enter.

Furthermore, the new yarns are better covered than the old single cover type yarns. Although the single cover elastic yarns produced prior to this invention appeared to be well covered when viewed in their relaxed state, if the yarns were elongated it was found that ultimately the rubber thread would be displaced from the center of the yarn to the outside of the yarn, and the fibrous cover in turn would assume a central position. In this state the core had in fact reached or approached the condition of a cover which was helically wrapped about the fibrous element, and the latter, which was the cover, had approached a central location in the yarn as a core. This phenomenon is apparent to the eye under magnification, and it is apparent to the touch, for the yarn when elongated can be felt to have a greater "drag" or frictional force on the fingers if they are slid along the yarn, than when the yarn is relaxed, due to the presence of the rubber thread on the external surface of the stretched yarn.

It is a further object of this invention to provide a balanced, well covered, single cover elastic yarn in which the core is more nearly retained as a core, and the cover is more nearly retained as a cover on the core when the yarn is stretched to the extent anticipated in its use.

These objects are achieved by providing a balanced, well covered, single cover elastic yarn in which the ratio of the breaking length of core in a unit length of yarn divided by the length of cover in that given length of yarn falls below approximately 1.50 and preferably falls in the range from approximately 1.0 to approximately 1.50.

There is disclosed herein an improved method and apparatus for producing the new single cover elastic yarns.

In accordance with the method a twisted core and a fibrous covering strand are advanced to a covering point, and the fibrous covering is wrapped around the core in a manner such that the breaking length of the core in a given length of relaxed yarn divided by the length of cover in this given length of relaxed yarn falls in the range of approximately 1.0 to 1.50.

In a preferred embodiment of the method, the new yarn is produced by advancing the cover to the covering point through apparatus which grips the cover immediately prior to its reaching the covering point. A pretwisted, stretched core is advanced to this covering point, and immediately prior to reaching the covering point, the core is confined generally to a position adjacent the covering yarn, but the core is not gripped tightly at this point. This latter feature is an important feature of the method in accordance with this invention.

The apparatus may be the conventional spinning or twisting frame used heretofore to produce single cover elastic yarn but in which the frame has been modified in a manner which will be pointed out hereinafter. As is well-known, when a single cover elastic yarn is produced on these conventional frames, a rubber thread is first pretwisted. This twisted rubber core is then advanced at a controlled rate to the covering point.

In the apparatus heretofore, the core was advanced from a driven braked let-off package to and through a pair of nip rolls which were either the front draft rolls of a spinning frame, or the nip rolls of a twisting frame. The covering strand was also advanced through the nip of these rolls, and immediately after the rubber thread and covering strand left the nip rolls, the cover was wrapped about the core by the action of a traveller and a rotating spindle. In this earlier apparatus, the core was gripped by this pair of rolls, and was advanced thereby with the covering strand. Contrary to this practice, in accordance with the preferred embodiment of the apparatus of this invention although the core passes between this pair of rolls, the rolls are constructed so the core is not gripped in the nip of the rolls. Because of this arrangement, the rate of core feed is independent of the rate of cover feed to the covering point. In accordance with this invention, the rate of core feed, and the extent to which the core is stretched between the core supply package and the yarn take-up spindle, is controlled pri-

marily only by the yarn take-up spindle and the core let-off.

This is an important feature and contributes to the successful operation of the covering apparatus. Heretofore, the rate at which the core could be fed through these nip rolls was limited. If an attempt be made to run these nip rolls as used in the prior practice too fast, relative to the rate of delivery of core from the let-off package, the core would be stretched excessively between the let-off package and these nip rolls, and breakage of the core would occur in operations. Such excessive breakage does not occur when using the apparatus disclosed herein.

For a better understanding of the nature of this invention, reference should be had to the following detailed description of specific embodiments, when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic view illustrating apparatus for twisting rubber threads;

FIG. 2 is a schematic view illustrating apparatus for producing single cover elastic yarn by a spinning process;

FIG. 3 is a schematic view illustrating apparatus for producing single cover elastic yarn by the twisting process;

FIG. 4 is a cross-sectional view through the nip rolls showing their construction, and showing the relation of the core and covering strand;

FIG. 5 is a cross-sectional view of a modified nip roll that may be used in making the yarn of this invention;

FIG. 6 is a view of three yarns in the relaxed state, and

FIG. 7 is a view of the yarns of FIG. 6, but showing these yarns in the stretched condition.

Referring now to the drawings, there is illustrated in FIG. 1 a conventional upstroke twister that may be used to pretwist the rubber core for the single cover elastic yarn of this invention. The upstroke twister comprises a rotating twister spindle **10** carrying a package **11** of rubber thread. The rubber thread R advances from the package **11** in a balloon caused by rotation of the spindle **10** to a pigtail guide **12** and then through a pair of nip rolls **13, 14**. Between the package **11** and the nip rolls **13, 14** the rubber thread is twisted. From the nip rolls **13, 14** the rubber thread is led to a take-up spool **15** to be wound thereon for use in the covering process. The take-up spool **15** is driven by the customary take-up roll **16** usually having a cork cover which runs in contact with the rubber thread on the spool **15** to rotate this spool. As is well-known, the rotational speed of the take-up roll **16** and the nip rolls **13, 14** are adjusted to wind the rubber thread R on the spool **15** under the desired tension.

The apparatus described for twisting the core could, if desired, be incorporated with the covering apparatus to form a single step process.

In FIG. 2 there is illustrated spinning apparatus for covering the twisted elastic core, such as rubber thread, to produce the elastic yarn in accordance with this invention. The apparatus illustrated in FIG. 2 is conventional, but for the front draft rolls which will be described in detail hereinafter. As shown, this spinning apparatus comprises the rubber core let-off spool **15**, which has been transferred to the spinning apparatus from the twisting apparatus of FIG. 1. A let-off roll **17**, having the usual cork cover running in contact with the rubber thread on the spool **15**, has its rotational speed regulated to control the rotation of the spool **15** and thereby to control the speed at which the rubber thread R is let off from the spool **15**. This in turn controls the degree to which the rubber thread R is stretched as it leaves the package **15**. In the apparatus shown, the rubber thread R then is led between the front draft rolls **50, 18** to the customary pigtail **19**.

Roving **27** from the packages **20, 21** is led to the rear pair of drafting rolls **23, 24**. As the roving passes through the successive pairs of draft rolls **23, 24; 25, 26,**

and **50, 18** it is attenuated in the customary manner. As the roving **27** emerges from the front draft rolls **50, 18** with the rubber thread R, it is wrapped about the rubber thread as a fibrous covering sheath adjacent the rolls **50, 18** after it has travelled a short distance, typically less than one inch, e.g., ¾", from the front rolls. The covered rubber thread then passes through the pigtail **19** to the traveler **28** on the ring **29** to be wound on the rotating bobbin **30**. As is customary in the twisting and spinning methods of producing single cover elastic yarn, the bobbin **30** is rotated to wrap the cover about the core in a direction opposite to the twist in the pre-twisted core R, and consequently to remove some of the twist in the rubber core R during the wrapping operation.

Referring next to FIG. 3 there is shown apparatus for producing single cover elastic yarn in accordance with this invention by the twisting method. In the twisting method, the core is covered with a yarn rather than a roving. In the apparatus illustrated in FIG. 3, the rubber core let-off package **15'**, controlled by the let-off roll **17'** supplies the rubber thread R under tension. The rubber thread R advances from the let-off package **15'** through a pair of nip rolls **31, 32** to a pigtail guide **33**.

Covering yarns Y are supplied from packages **34, 35** about guides **36, 37**. The yarns Y advance to the nip rolls **31, 32** to pass therebetween. As the rubber thread R and the yarns Y leave the nip rolls **31, 32** the yarns Y are wrapped about the twisted rubber core to produce the single cover elastic yarn in accordance with this invention. The single cover elastic yarn then advances through the pigtail **33** to the traveler **38** on the ring **39** to be wrapped on the rotating bobbin **40**. As is customary in this method of producing single cover elastic yarn, the apparatus is operated to wrap the covering yarns Y about the rubber thread R in a direction opposite to the twist of the rubber thread R, and during this covering operation a portion of the twist is removed from the rubber thread R.

Referring now to FIG. 4 there is shown one embodiment of the modified nip rolls used in the apparatus. These are the nip rolls to be used at **50, 18** of the spinning frame illustrated in FIG. 2, and at **31, 32** of the twisting apparatus illustrated in FIG. 3. As shown, these rolls comprise shafts **41, 41'** that carry the sleeves **42, 42'** fixed thereto. There is wrapped about the sleeves **42, 42'**, the cots **43, 43'** of the usual resilient material such as rubber. These rolls are so positioned that the covering strand **51**, either the roving **27** or the yarns Y will be gripped in the nip of these rolls as shown to be advanced to the covering point as the rolls are rotated.

In the apparatus at least one of these rolls is constructed so that the rubber thread R may be led between the rolls yet it will not be gripped by the rolls. In the embodiment illustrated in FIG. 4, a portion of the cot **43** has been cut away, and a grooved pulley **44** has been mounted on the sleeve **4** so that the rubber thread R may be led through the two rollers in the groove of the pulley **44**, and the rubber thread is not gripped in the nip of the rolls.

An important feature of the apparatus is that the apparatus is constructed and arranged so that the advancing twisted rubber thread R and the covering material may be confined adjacent the covering point in close proximity to each other, yet the rubber thread R is not gripped at point where it is confined.

Referring next to FIG. 5 there is shown a further modified embodiment of one of the pair of nip rolls adapted to permit the rubber thread R to pass through the nip of the rolls without being gripped thereby. This roll comprises the shaft **41''**, carrying the sleeve **42''** which has the cot **43''** wrapped thereabout. As in the embodiment illustrated in FIG. 4, a portion of the cot **43''** is cut away and a disk **45**, in place of the pulley **44**, is carried by the sleeve **42''** in this cut away portion. As shown this disk **45** has one surface tapered toward the adjacent extremity of the shaft **41''** to provide a recessed bearing

surface on which the rubber thread R may rest without being gripped in the nip of the rollers. Conveniently the rubber thread is led to the disk **45** in such a direction as to hold the thread against the disk **45** and away from the end of shaft **41**".

The use of a pulley **44** or disk **45** having a smooth, yet tough abrasion resistant surface, has been found beneficial in advancing the delicate rubber thread without unduly chafing it. Advantageously the pulley or disk may be formed of nylon. However for some operations it may not be necessary to use such a device, and in that case the pulley or disk may be dispensed with.

To produce a yarn in accordance with this invention, the rate of core let-off is regulated relative to the rate of covering delivery to the covering point by the nip rolls as follows. The rates of delivery are adjusted to advance sufficient core and cover to the covering point so that the ratio of (*a*) the breaking length of core in a unit length of yarn divided by (*b*) the length of a cover strand in that unit length of yarn falls below approximately 1.50 and preferably in the range of from about 1.0 to 1.50.

The following specific embodiments of single cover elastic yarns, some of which are produced in accordance with this invention, show the structural characteristics of the yarns of this invention. In consideriny the data in these tables it is to be noted that the data were compiled from measurements on foot lengths or on a fraction of a pound of the elastic yarn, and consequently any slight error in measurement thereof may have been multiplied in the figures given in the tables. Nevertheless, the data are accurate within the tolerances recognized in the trade.

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A. Turns of cover in 1 foot of relaxed elastic yarn	640	589	605	743	1,042	1,175	612	1,360	1,366	1,249	510	(1)	(1)	(1)
B. Residual twist in core from 1 foot of relaxed elastic yarn	512	501	259	496	343	319	276	289	401	280	281	552	608	438
C. Inches of core in 1 foot of relaxed elastic yarn (core not shrunk in water)	6.5	6.3	9.6	6.7	9.5	10.5	9.7	10.5	9.8	8.9	9.7	6.4	6.2	8.1
D. Breaking elongation of core with residual twist (percent)	480	503	507	507	510	543	513	607	673	673	527	513	523	697
E. Breaking length of core from 1 foot of relaxed elastic yarn (inches)	37.7	38.0	58.9	40.7	58.0	67.4	59.5	74.2	75.8	68.8	60.8	39.2	38.6	64.6
F. Inches cover per foot of relaxed elastic yarn	29	30	34.9	36	39	40.5	44.3	53	55.3	60	29.5	29.6	29.5	29.2
G. Breaking length of core divided by inches of cover (each per unit length of relaxed elastic yarn)	1.30	1.27	1.69	1.13	1.49	1.66	1.34	1.40	1.37	1.15	2.06	1.32	1.30	2.22
H. Elongation of yarn—hand (percent)	120	120	175	165	250	255	260	320	330	350	140	140	105	140
I. Cover	[2] 2-36/1	[3] 2-36/1	[2] 2-36	[3] 3-36/1	[4] 1-40/1	[4] 1-40/1	[2] 2-36	[4] 1-40	[4] 1-70/1	[3] 1-36/1	[2] 2-36/1	[5] 2-6	[6] 1-2	[6] 2-2
J. Core size	75's	75's	75's	75's	90's	100's	75's	100's	100's	75's	75's	75's	75's	75's

[1] Roving cover. [2] Reverse twist cotton. [3] Regular twist cotton. [4] Nylon. [5] Hank 109B (du Pont synthetic fiber of the viscose type). [6] Hank cotton.

Item D is the length of the core at break (item E) less the relaxed length of the core when the bare core is completely relaxed but possesses the residual twist (item C), divided by the relaxed length of the core (item C) multiplied by 100.

Residual twist in item B is the twist retained by the core in the covered elastic yarn.

Item F was measured in the samples having a yarn cover (sample 1–11) by removing the cover from the core and measuring its length. In the samples having a roving cover (12–14) item F was calculated by determining the length of cover delivered by the front delivery rolls on the covering machine to that length of elastic yarn, because of the difficulty in removing and measuring the length of a roving, which has little twist, from the core. The "inches cover per foot of relaxed yarn" is the length of a single covering strand in this length of yarn; of course if desired the single cover elastic yarn can be produced, as shown in FIG. 2, using more than one strand in the cover. In such case this length is the length of any one of these strands.

The most significant data in the foregoing table is item G (item E divided by item F).

In the foregoing examples, this ratio in all examples with the exception of Examples 3, 6, 11 and 14 will be seen to fall below approximately 1.5, and specifically in the range from approximately 1.0 to 1.50. Items **11** and **14** will be found to be greatly in excess of this range, and they constitute single cover elastic yarns of the prior art and not in accordance with this invention. Items **3** and **6** will be seen to fall slightly above the upper limit of the invention. These yarns were made using the apparatus of this invention but they were made in such a way that they did not possess the advantages of a yarn in accordance with this invention; in general they are unsatisfactory.

Although as the ratio changes within the range of 1.0 to approximately 1.50, the characteristics of the yarns alter. As the ratio passes the limit of approximately 1.50 the core commences to move to the outside at the stretched condition of the yarn, and above this limit of approximately 1.50, the yarn is commercially considered to have the defects of the single cover elastic yarn of the prior art.

Other significant comparisons can be made. For example, comparing constructions **1** and **2** with construction **11**, it will be noted that constructions **1**, **2** and **11** have approximately the same length of cover per foot of yarn and approximately the same elongation. Yet it will be noted that construction **11** requires approximately 50% more core per foot of yarn than constructions **1** and **2**. Because of this excess of core the cover in construction **11** assumes a central position as a core, when the yarn is stretched, and the core is pushed to the outside as a wrap about the cover. Similar comparison might be made between constructions **3** and **4**, between constructions **6** and **7** and between constructions **12** and **14**.

Referring now to FIGS. 6 and 7 significant differences between the yarn in accordance with this invention and the yarn produced heretofore will become apparent. In these figures, yarn A designates a double cover elastic yarn produced heretofore. As will be seen by comparing FIGS. 6 and 7, this yarn remains well covered in the elongated condition.

Yarn C is a single cover yarn constructed as heretofore. It will be seen that this yarn appears to be well covered in FIG. 7, yet when it is stretched the rubber core comes to the outside of the yarn as a wrap at points such as point **52**. Yarn B is a yarn constructed in accordance with this invention. By comparing FIGS. 6

and 7, it will be seen that the yarn remains well covered even when elongated. The most significant comparison which should be made is a comparison of yarns B and C in FIG. 7 in the stretched condition.

Apart from the advantages in material saving in the new yarn, which are apparent from the foregoing, the new yarn possesses other most significant advantages. For example, assuming the same type and length of cover in both the new and the old yarn and the same elongation, the new yarn has a higher modulus because the core in the new yarn is at a greater stretched condition than in the old yarn. Further, since the core is retained as a core in the new yarn, a fabric made therefrom can be dyed better than a fabric made from the old yarn, because the rubber at the surface of the old yarn does not take the dye and hence gives the fabric a speckled appearance. Furthermore when these yarns are knitted or woven they are generally stretched; in the old yarn the core at the surface was not protected by the cover, hence it was chafed in the loom or knitting machine and damaged.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. A well covered, balanced, single cover elastic yarn having an elongation of at least 100%, comprising a twisted elastic core and a fibrous covering strand wrapped about said core, the ratio of the breaking length of core per unit length of covered yarn divided by the length of any given cover strand per unit length of covered yarn, being less than 1.50.

2. A single cover elastic yarn comprising a twisted rubber core, a fibrous strand wrapped about said core, said covered yarn being balanced and well covered and having an elongation in the range of 115–350%, the ratio of the breaking length of the rubber core per unit length of covered relaxed yarn divided by the length of cover strand per unit length of relaxed yarn being in the range of from 1.0 to 1.50.

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