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B. H. FOSTER

2,804,745

ELASTIC YARN AND METHOD OF MAKING SAME

Filed Dec. 16, 1953

2 Sheets-Sheet 1

Fig. 1

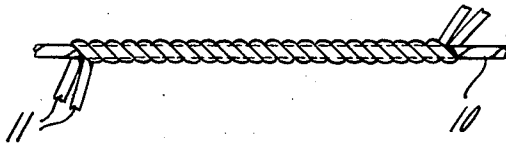


Fig. 2

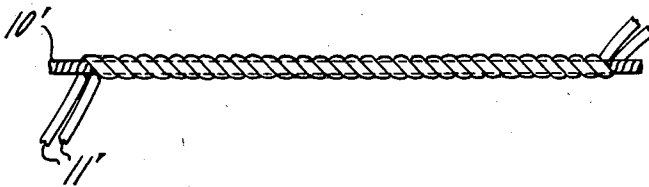


Fig. 3

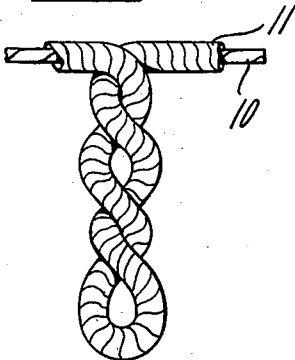


Fig. 4

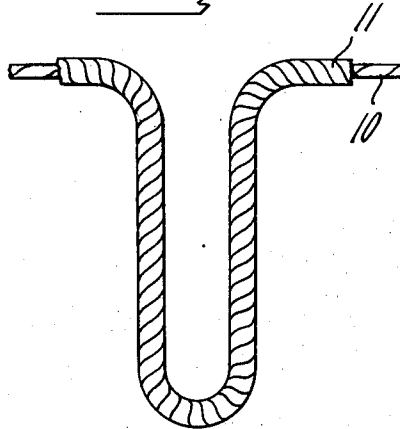
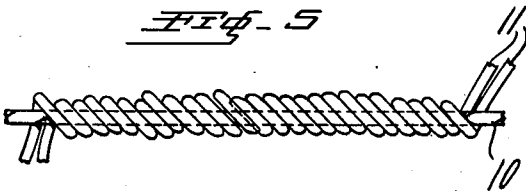


Fig. 5



INVENTOR.
BOUTWELL H. FOSTER

BY *David B. Miller*

ATTORNEY

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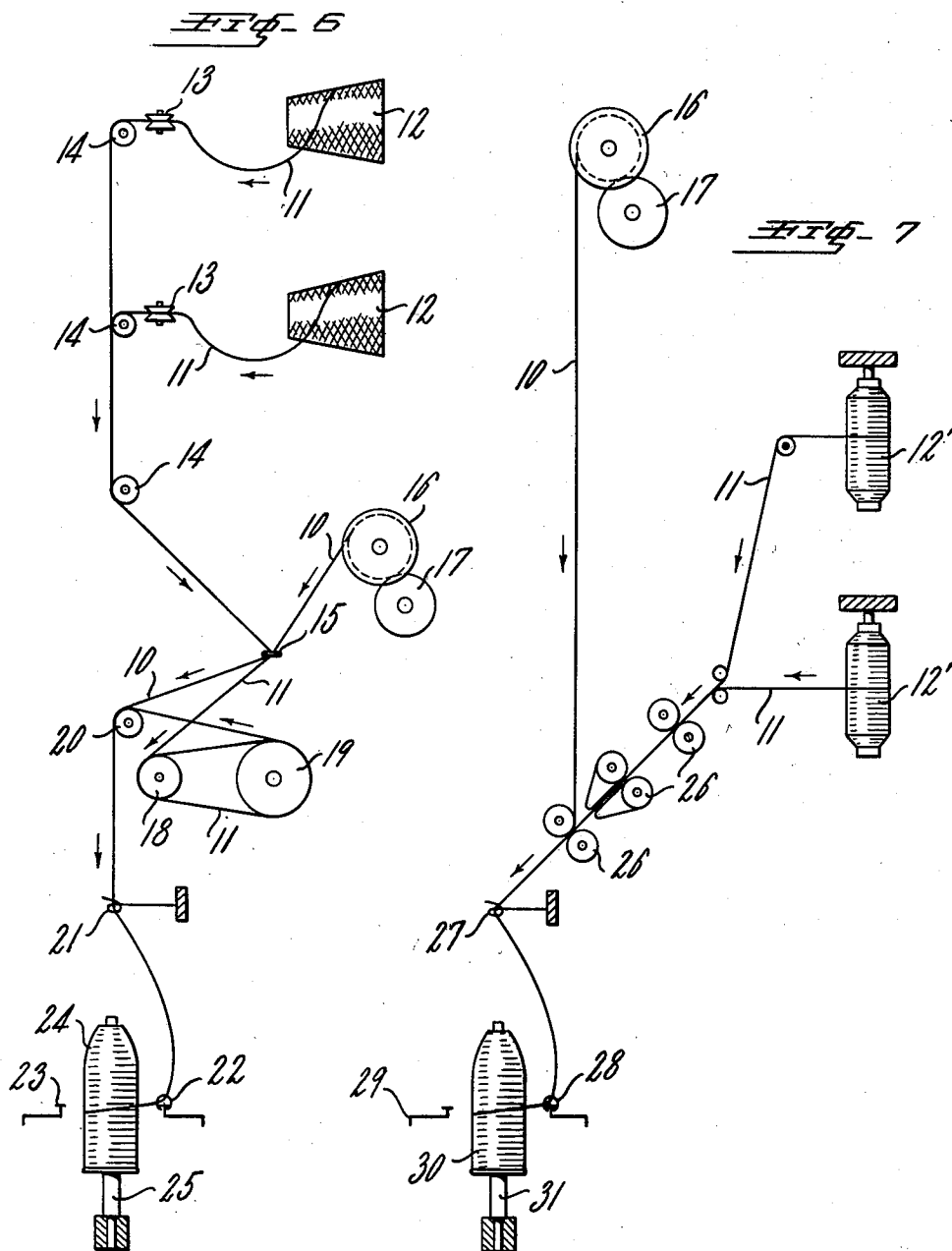
B. H. FOSTER

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2 Sheets-Sheet 2



INVENTOR.
BOUTWELL H. FOSTER

BY *David B. Miller*

ATTORNEY

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ELASTIC YARN AND METHOD OF MAKING SAME

Boutwell H. Foster, Maplewood, N. J., assignor to United States Rubber Company, New York, N. Y., a corporation of New Jersey

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8 Claims. (Cl. 57—152)

This invention relates to an elastic yarn and to a method of making this yarn. More particularly, it relates to an elastic yarn in which an elastic core is sheathed in a fibrous covering of thermoplastic textile material and to a method of making this yarn.

In Patents 2,024,155 and 2,024,156, granted to me on December 17, 1935, there are disclosed elastic yarns which are formed by applying to a stretched and twisted elastic core a single fibrous sheath in the form of either a relatively twist-free roving or a twisted yarn. The yarns made in accordance with the teachings of these patents are well balanced and well covered yarns of great extensibility, and these yarns have met with great success in the industry.

It is a primary object of the present invention to provide improved elastic yarns of this general character which can be produced more cheaply than the yarns heretofore made, and which can be made having a greatly increased extensibility over that possessed by the yarns heretofore made.

If an elastic yarn is to be satisfactory for use in the textile industry, it must not only be extensible and have good appearance, but it must also be well balanced, that is, it must be free from any substantial tendency to twist or kink when it hangs slack. In yarns of the type referred to above, the elastic core is pretwisted in one direction, and the cover is wrapped about the core in the opposite direction, so in the resulting yarn the untwisting torque of the core just exactly counterbalances the untwisting torque of the cover.

Heretofore if a well balanced yarn of this type was to be produced, it was necessary to pre-twist the elastic core to a very great extent. The precise amount of this pre-twist depends on a number of factors, one of which is the ultimate extensibility desired in the elastic yarn. The core while being covered must be stretched to the maximum amount desired in the covered yarn, for thereafter the covering will prevent the core from stretching beyond the length to which it was stretched at the time of covering. But when a core is stretched during the covering operation, the number of turns per inch in the stretched core is less than the number of turns per inch in the relaxed core. Consequently, the core must be pre-twisted enough to have the requisite number of turns per inch to balance the cover when the elastic yarn is in a relaxed state. A second factor which governs the amount of pre-twist necessary in the core is the number of wraps of cover applied to the core. The greater the number of wraps per inch of cover in the yarn, the greater must be the number of turns per inch of the core to counterbalance the torque of the cover. There is a minimum number of turns per inch of cover which can be used in applying the covers heretofore used in elastic yarns. This number varies with core and yarn sizes, but it must be high enough to wind the cover about the core so that it will not appear loose or tend to bunch when the yarn is relaxed.

When the elastic yarn is formed by a process in which the core and cover are twisted together to cover the core,

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still a third factor appears which governs the amount of pre-twist necessary in the core. When this method is used, the twisted core and the covering strand are twisted together in a direction opposite to the core pre-twist and thus one turn of twist is removed from the core for each turn of the cover. Hence, the core must have been pre-twisted enough that it will retain sufficient twist to counterbalance the torque of the covering after the core has been partially untwisted in this operation.

Pre-twisting of these cores is costly; the greater the pre-twist the greater the cost. It is an object of this invention to produce a balanced elastic yarn of the type described which requires substantially less pre-twisting of the core than has heretofore been necessary.

As described above, the greater the extensibility required in the yarn the greater the core must be stretched in covering. But the more the core is pre-twisted the less it can be stretched without breaking excessively in production during the covering operation. In practice, this has meant that yarns of this type have been limited in their extensibility to a maximum of about 200%. Yarns having this extensibility are generally satisfactory for use in woven fabric where the stretch desired is in the range of 75 to 150%. But yarns of this general character have been excluded from use in many knitting applications, and particularly in the hosiery field, where the stretch required of a yarn is 250% or more.

Since a yarn produced in accordance with the present invention requires substantially less pre-twisting of the core than do the yarns of this type heretofore made, it is possible to make yarns in accordance with this invention which have an extensibility of at least 250%, and yarns having an extensibility of 300% or greater can be produced commercially. Accordingly, it is an object of this invention to provide an elastic yarn of the type described which has a much greater extensibility than has been possessed by similar yarns of this type heretofore made.

The elastic core of yarns according to the present invention may consist of any suitable core of elastic material, but it is preferred to use a core formed of rubber. A round rubber core made directly from a rubber latex, such as a rubber thread made by the process described in the patent to Hopkinson et al., 1,545,257, granted July 7, 1925, is preferred. As is well known in the rubber industry, the rubber latex may be compounded with various ingredients to improve its physical properties, such as resistance to aging, etc., if desired. Although a round rubber thread of this type is preferred for the core, other kinds of rubber thread, such as the well known cut rubber thread, may be used.

In accordance with this invention this elastic core is sheathed in a covering strand or strands of thermoplastic textile material which are wrapped around the elastic core. Many thermoplastic textile materials suitable for the covering of the yarn according to this invention are well known in the industry. Examples of such materials are "Rhovyl" and "Fibravyl," yarns made of oriented polyvinyl chloride; "Vinyon," an oriented copolymer of vinyl chloride (88%) and a small proportion of vinyl acetate (12%); "Vinyon N," an oriented copolymer of vinyl chloride and acrylonitrile; "Vinyon NOZZ," which is produced by stretching "Vinyon N" at elevated temperatures; dynel, a staple form of "Vinyon N"; "Dacron," an oriented superpolyester resin; oriented saran, an oriented copolymer of vinylidene chloride; nylon, a synthetic linear superpolyamide, etc.

These and other thermoplastic materials are readily available to the industry in fibrous form as required by this invention. They may be used in their continuous, filamentary form, or they may be used in their staple form wherein the filaments are severed into short lengths and drawn and spun into yarn or roving. Or the staple

thermoplastic material may be mixed with any of the well known non-settable textile fibers, such as cotton, and formed into strands to produce blended strands having known setting properties. It is only necessary that the covering be capable of being formed into strands which can be wrapped around the core and set on the core.

To produce an elastic yarn according to this invention, a strand or strands of thermoplastic covering is wrapped about the stretched elastic core by any of the suitable methods which are well known in the art, such as by spinning the two strands together, or by advancing the core through a hollow rotating spindle which carries a package of the covering material and wraps it around the core, to produce an unbalanced elastic yarn. In accordance with the method of the present invention, before being combined with the settable covering material the core is pre-twisted to a much lesser amount than is necessary to produce an elastic yarn which is well balanced when it is doffed after the covering stage. Consequently, the elastic yarn at this stage is badly out of balance in the direction of the cover twist. This unbalanced yarn is next subjected to heat to set the thermoplastic material in the covering. This setting of the thermoplastic covering relieves the stress in the cover, and hence it reduces the untwisting torque exerted in the yarn by the covering. In this manner, the unbalancing torque exerted by the cover is relieved so that the core exerts enough torque to balance the yarn, and the finished elastic yarn is well balanced after the heat treatment.

It is preferred to use heat shrinkable thermoplastic covering materials for this covering, for these materials have the property of contracting upon the application of heat thereto. Heretofore it has been necessary to control the covering operation closely in producing elastic yarns so that the yarn as it was doffed had a good appearance in which the cover was tight and free of bunches. However, if heat-shrinkable thermoplastic yarns are used for the covering material, this control need not be so close, and the yarns may be doffed having a loose cover and poor appearance in addition to being out of balance. When these yarns are heated to balance them, the heat shrinkable covers will be shrunk into snug, even engagement with the core to produce a yarn having a good appearance.

Accordingly, it is a further object of this invention to produce a balanced well covered elastic yarn in which the covering is shrunk into snug engagement with the elastic core.

The amount of pre-twist to be given the core in practicing the present invention will vary with the particular materials used in covering the core, and with the core, yarn size, stretch and other properties desired in the finished product, but for any given yarn which is produced, the amount of pre-twist necessary in the core is greatly reduced in the present invention from the amount necessary to produce a balanced yarn by the methods heretofore used. Although this core pre-twist will vary, it has been found that balanced yarn having a good appearance can be produced in accordance with this invention in which the amount of core pre-twist is as little as one-half or less than one-half of the core pre-twist necessary in the yarns heretofore made.

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

Fig. 1 is a view of a length of yarn made in accordance with the present invention;

Fig. 2 is a view similar to Fig. 1 of a heretofore existing yarn of this type;

Fig. 3 is a view showing the manner in which an unbalanced yarn twists and kinks when hung slack in a loop;

Fig. 4 is a view showing the disposition of a well balanced yarn when hung slack in a loop;

Fig. 5 is a view of a length of yarn according to this invention after the core is wrapped in a heat shrinkable thermoplastic cover but before the yarn has been subjected to a heat treatment;

Fig. 6 is a schematic view showing a method of covering a core employing a ring twister which may be used to form the yarns of this invention, and

Fig. 7 is a schematic view illustrating a method of covering a core to form the yarn of this invention which utilizes a spinning frame.

Referring now to the drawings, there is shown in Fig. 1 a length of yarn made in accordance with the present invention wherein a rubber core 10, such as the type produced in accordance with the above mentioned Hopkinson et al. patent, is covered with strands of thermoplastic textile material 11. It will be observed that the core 10 is twisted in a direction opposite to the direction that the cover is wrapped about this core, so that the core balances the covering to produce a balanced yarn. Although the cover shown in this figure consists of two strands 11 of fibers, the covering can consist of a greater or lesser number of strands as is well known in the industry.

In Fig. 2 there is shown a comparable length of yarn of the type made heretofore. This yarn consists of a core 10' and cover 11' and, as will be observed from a comparison of Figs. 1 and 2, the core 10' is twisted to a much greater extent than the cover 10 in order that it may balance the covering 11' of this old yarn.

Referring next to Fig. 4, the good balance of a finished yarn in accordance with this invention is illustrated. In this figure there is shown a length of yarn which is hung in a loop from its ends. This yarn hangs in substantially a U-shape with little or no tendency to kink or twist one leg of the U about the other. By comparison with the yarn shown in Fig. 4 the yarn shown in Fig. 3 is badly out of balance and has the two legs of the U twisted and kinked about each other. This latter view illustrates a yarn made in accordance with the present invention before it has been subjected to a heating treatment to set the cover and to balance the yarn. A yarn made in accordance with the teachings of the prior art but having an insufficient number of core twists per inch would also twist and kink in the same manner as the yarn shown in Fig. 3.

Referring next to Fig. 5, there is shown a length of yarn which has a covering of the preferred heat-and-shrinkable thermoplastic textile strands in accordance with this invention. This view shows the yarn after the core has been covered but before the cover has been heat set and heat shrunk. The cover is very loose on the core 10, and the yarn has a bad appearance. After this yarn is heated, the cover will shrink into snug engagement with the core to give a yarn having the good appearance and balance shown in Figs. 1 and 4. The amount of shrinkage necessary in any given heat shrinkable thermoplastic covering yarn to produce a well covered and balanced yarn such as that shown in Figs. 1 and 4 will vary among yarns, but it has been found that if the covering strands 11 are shrunk $50\% \pm 11\%$ a well covered yarn will be produced. That is, if a one yard length of the covering strands 11 shrinks to 18 inches ± 4 inches, a well covered yarn will be produced.

Referring next to Fig. 6, there is shown a ring twister which may be used to cover cores in accordance with this invention. In this device, two ends 11 of shrinkable and settable covering yarns are led from cones 12, suitably supported, through tension devices 13 and over bars 14 to guide eyes 15. A twisted core 10 is led from a spool 16 to a similar eye. A suitable tensioning means and let-off device, here shown as a drum 17 running in frictional contact with the threads on the spool 16, retards the rotation of the spool 16 and controls the amount and

the tension of the rubber thread 10 supplied to its guide eye.

From the guides 15 the strands 11 are led several times about a pair of metering rolls 18, 19 which control the amount of these strands which are fed to the twisting point. The core 10 is led from its guide to the bar 20 where it joins the strands 11, and the core and covering strands are led together downwardly therefrom through the usual pigtail guide 21 to the traveler 22 on the ring 23 to be wound in the wrapped condition shown in Fig. 5 on the usual bobbin 24 supported on the rotating spindle 25.

Referring next to Fig. 7, there is shown a spinning frame for making yarns in accordance with this invention in which the covering strands 11 are in the form of relatively twist-free roving. In this device, the rubber core is supplied from a spool 16 and let-off device 17 to the front pair of drafting rolls 26. The roving 11 is led from packages 12' to the drafting rolls 26, and the drafted roving 11 is led with the core 10 to the usual pigtail guide eye 27 and thence to the traveler 28 and ring 29 to be wound in a wrapped condition on the bobbin 30 carried by the spindle 31, all in a well-known manner.

As illustrating further the present invention, the following table gives the structural characteristics of several specimens of elastic yarn made in accordance with this invention as well as comparable data on specimens of yarn made in accordance with the teachings of the prior art. In considering the data in this table, it is to be noted that the data were compiled from measurements of a yard length or on a fraction of a pound of the elastic yarns, and consequently any slight error in measurement thereof may have been multiplied in the figures given in the table. Nevertheless, the data are accurate within the tolerances recognized in the trade.

Designation.....	A	B	C	D	E	F
1. Gauge of bare circular rubber thread.	.0133.....	.0133.....	.0111.....	.0111.....	.010.....	.010.
2. Turns per inch relaxed core before covering.	150.....	77.....	90.....	160.....	190.....	210.
3. Material of covering.....	200 Den. Filament Viscose.	200 Den. Vinyon NOZZ.	120 Den. Vinyon NOZZ.	36/1 Cotton.	1-20/1 Dynel, 1-30/1 Dynel.	40/1 Cotton.
4. Turns of rubber core per inch of finished yarn, relaxed.	56.25.....	20.68.....	46.85.....	75.....	75.85.....	84.
5. Inches of relaxed bare rubber core per one yard of finished yarn, relaxed.	18.....	18.....	25.8.....	22.4.....	17.7.....	19.2.
6. Wraps of cover per inch of finished yarn, relaxed.	18.75.....	17.82.....	17.65.....	25.....	17.65.....	27.
7. Gauge of finished yarn...	.0155.....	.0197.....	.0165.....	.0140.....	.0185.....	.0125.
8. Yards of finished yarn per pound (relaxed).	4,700.....	3,450.....	6,450.....	6,500.....	4,750.....	8,030.
9. Extensibility of finished yarn (maximum stretch).	140%.....	300%.....	155%.....	125%.....	120%.....	135%.

Yarns A, D and F are representative yarns made of the materials and by the means used heretofore. A comparison of yarns A and B shows that although the core and covering size are the same (items 1 and 3) and the number of wraps of cover per inch (item 6) are similar, the yarn embodying this invention (B) requires much fewer turns of pre-twist (item 2) and when finished has a much greater extensibility (item 9) than does the yarn (A) constructed according to the teachings of the prior art. A comparison of yarns C and D show that for two similar yarns, the present invention requires much less pre-twisting (item 2) than does a yarn constructed according to the methods of the prior art. When yarns E and F are compared, it will be noted that although pre-twist of core (item 2), core size (item 1) and extensibility (item 9) are similar, the cover of yarn E (item 3) is approximately twice as heavy as the cover of yarn F. In yarn E the percentage by weight of core and cover respectively are 19% and 81%, while in yarn F they are 49% and 51%. Thus by utilizing this invention, approxi-

mately the same number of turns of pre-twist may be used to balance a much heavier cover than by the teachings of the prior art.

The heating treatment employed to balance the yarns and to shrink the covers on the core for specimens B, C and E consisted of immersing the covered yarns in water maintained at a temperature of 200° F. for 5 minutes. Of course, any suitable heating treatment could be substituted for the one used to shrink the yarns given in this table. Thus, for example, the yarns could be placed in a heated oven, or in a chamber supplied with live steam, etc.

It will be appreciated by those skilled in this art, that the present invention can be utilized to produce yarns having varying characteristics. Although perhaps it will have its greatest advantage when used to produce single covered yarns having greater stretch than yarns of this type produced heretofore it will be useful to produce yarns generally of this type at reduced cost. Thus yarns can be produced having a limited stretch of only 75 to 150% which utilize cores that have been pre-twisted to a much lesser extent than necessary when the principles of this invention are not utilized. Still other advantages of yarns produced in accordance with this invention may be produced in a suitable yarn if desired.

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

1. A balanced single covered elastic yarn of the type described comprising a rubber core having a low twist, strands of thermoplastic textile materials wrapped thereabout in a direction opposite to the direction of core twist, said cover and said core having approximately the same number of turns per inch, said cover being heat-set and shrunk on said core, said yarn having an extensibility of at least 250%.

2. A balanced elastic yarn of the type described, comprising a twisted elastic core, said core having a number of turns per inch less than that necessary to balance the torque exerted on it by its untreated cover, covering strands of thermoplastic material wrapped thereabout in a direction opposite to the twist of the core, said cover being heat-set on the core, whereby the elastic yarn is balanced.

3. A balanced elastic yarn of the type described comprising a twisted elastic core, said core being twisted an amount insufficient to balance the twisting torque exerted on it by its cover when untreated, covering strands of thermoplastic textile material wrapped about said core in a direction opposite to the twist in said core, said covering strands being heat-set and shrunk on said core.

4. A balanced single covered elastic yarn of the type described, comprising a twisted rubber core, said core being twisted an amount insufficient to balance the twisting torque exerted thereon by its cover when untreated,

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heat shrinkable thermoplastic covering strands wrapped about said core in a direction opposite to the twist in said core, said covering strands being heat-set and shrunk on said core, and said elastic yarn having a maximum extensibility of at least 250%.

5. A method of making a single covered balanced elastic yarn which comprises, twisting a rubber thread, wrapping strands of heat shrinkable thermoplastic material about the twisted rubber thread in a direction opposite to the twist in the thread to produce an unbalanced yarn having a loose cover, and heating the unbalanced yarn to shrink the cover on the core and to relieve the unbalancing torque in the cover.

6. A method of making a single covered balanced elastic yarn having a stretch of at least 250%, which comprises wrapping heat shrinkable thermoplastic strands about a twisted rubber thread which is twisted an insufficient amount to balance the covering strands, and heating the unbalanced yarn to shrink the thermoplastic strands on the rubber thread and to balance the yarn.

7. In a method of making a balanced elastic yarn, the steps comprising wrapping heat-shrinkable thermoplastic strands about a twisted rubber core to produce an un-

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balanced yarn, and heating the unbalanced yarn to shrink the cover from 39 to 61% on the core to produce a balanced yarn of good appearance.

8. In a method of making a balanced elastic yarn, the steps comprising wrapping heat shrinkable thermoplastic strands about a twisted elastic core which is twisted an insufficient amount to balance the covering strands, and heating the unbalanced yarn to shrink the cover on the core and to balance the yarn.

References Cited in the file of this patent

UNITED STATES PATENTS

2,146,966	Lilley	Feb. 14, 1939
2,263,612	Chittenden	Nov. 25, 1941
2,263,614	Cote	Nov. 25, 1941
2,343,892	Dodge et al.	Mar. 14, 1944

FOREIGN PATENTS

112,928	Australia	May 1, 1941
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OTHER REFERENCES

"Southern Power and Industry," May 1945, pages 96-98.