

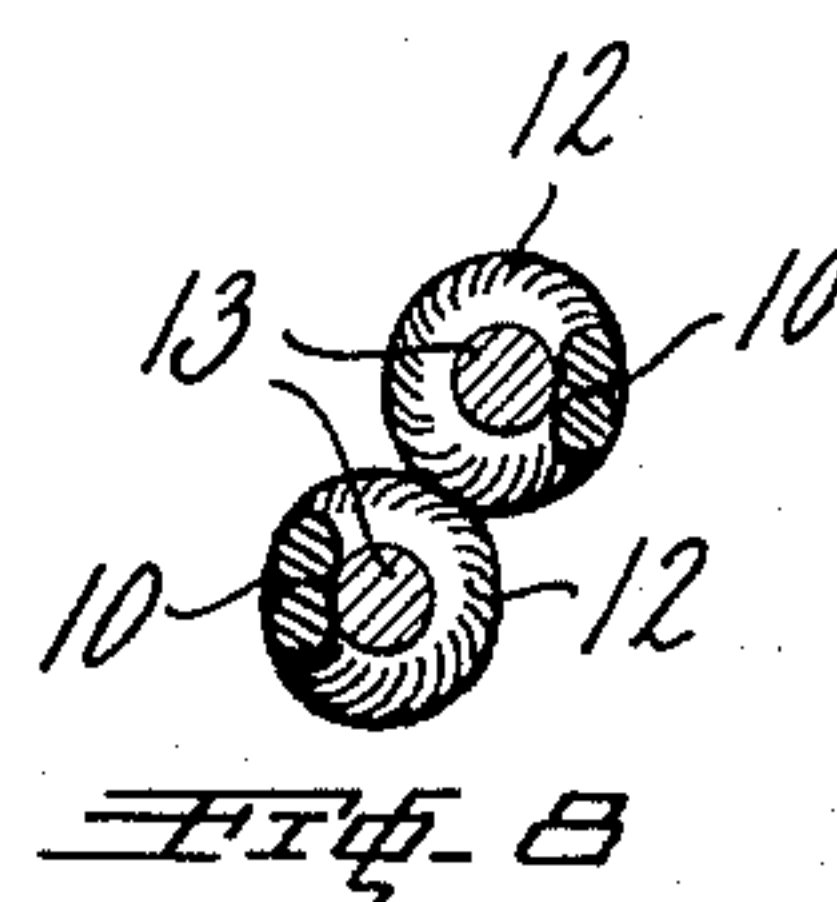
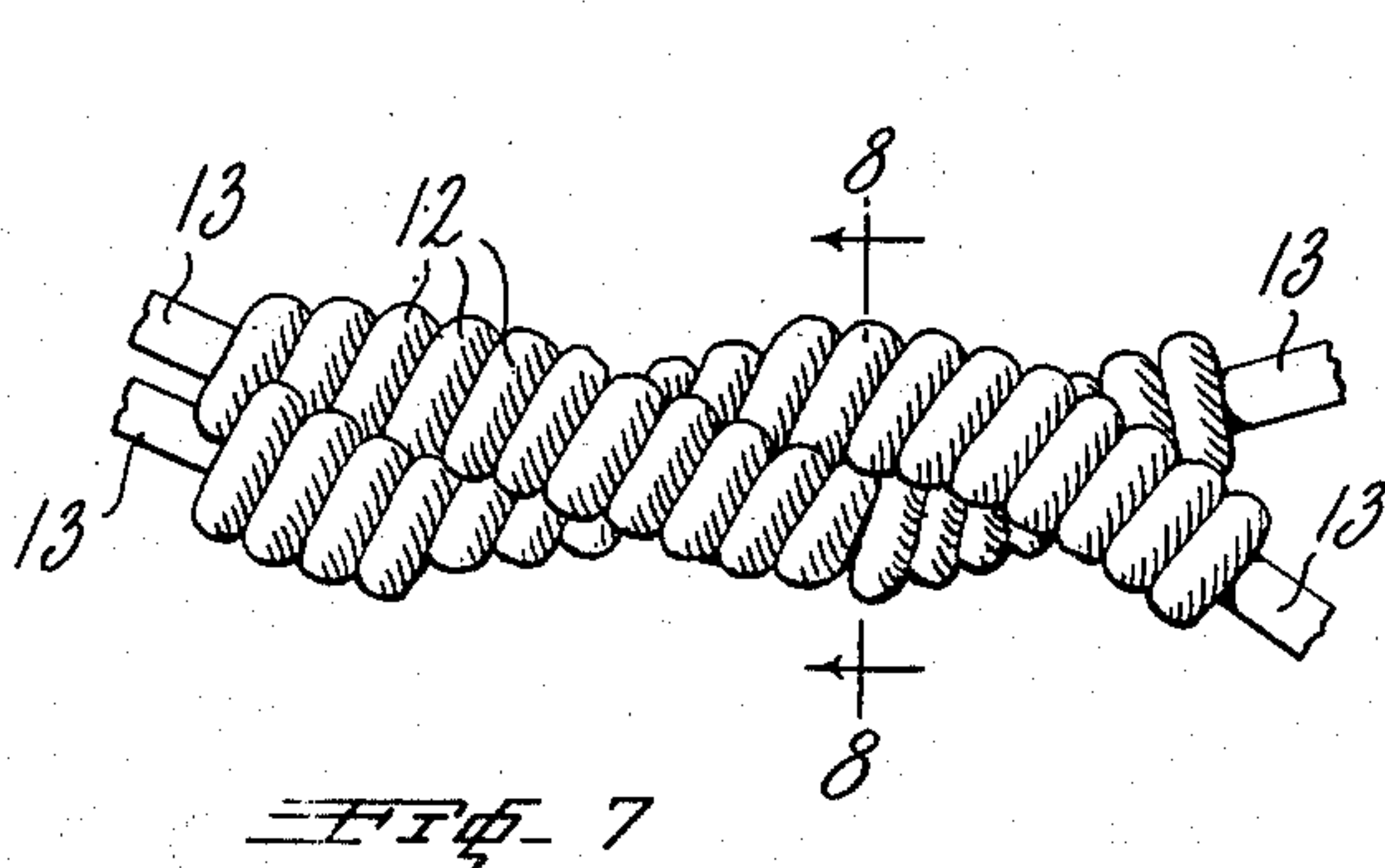
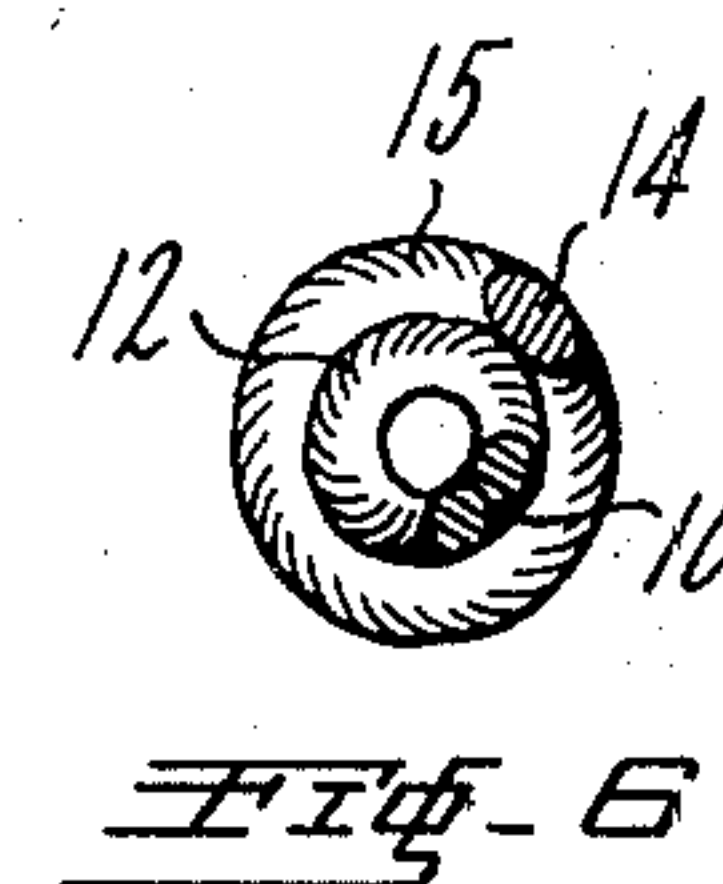
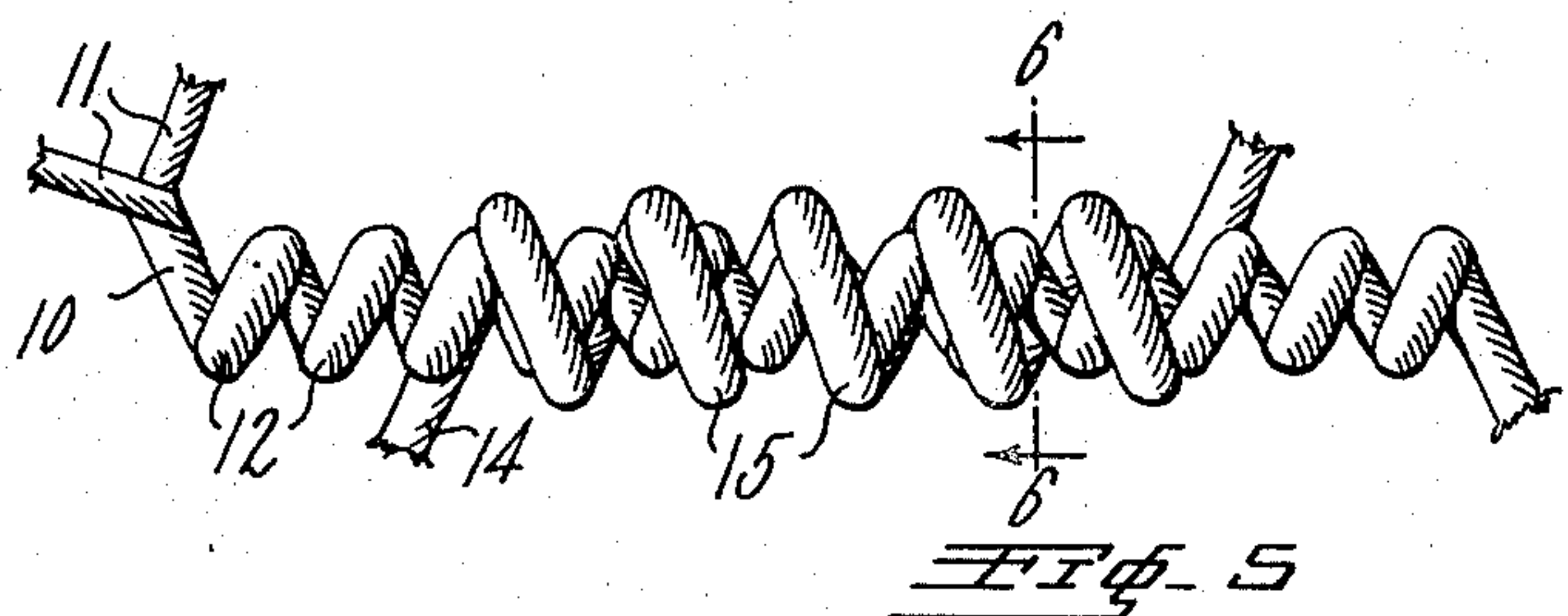
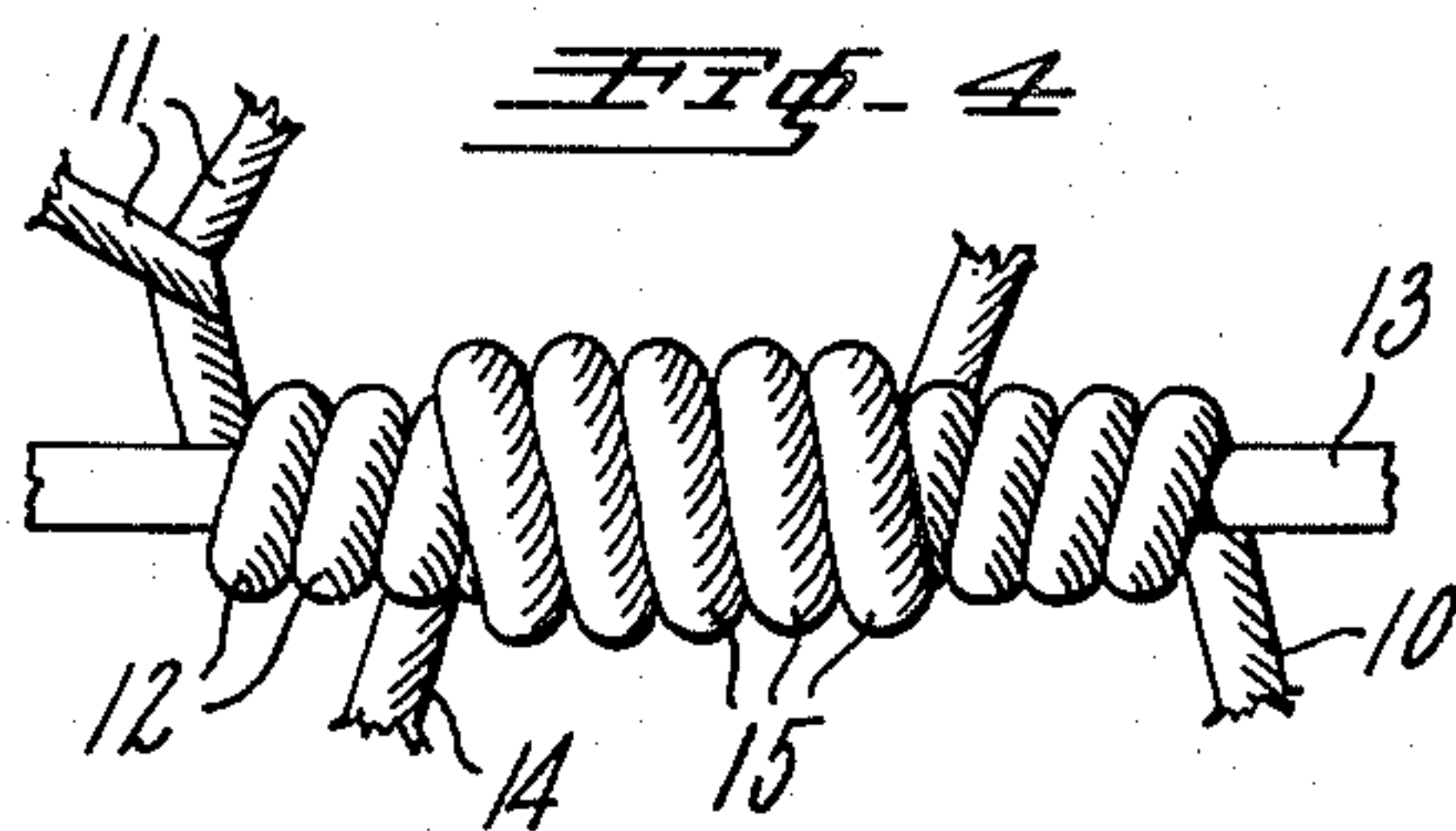
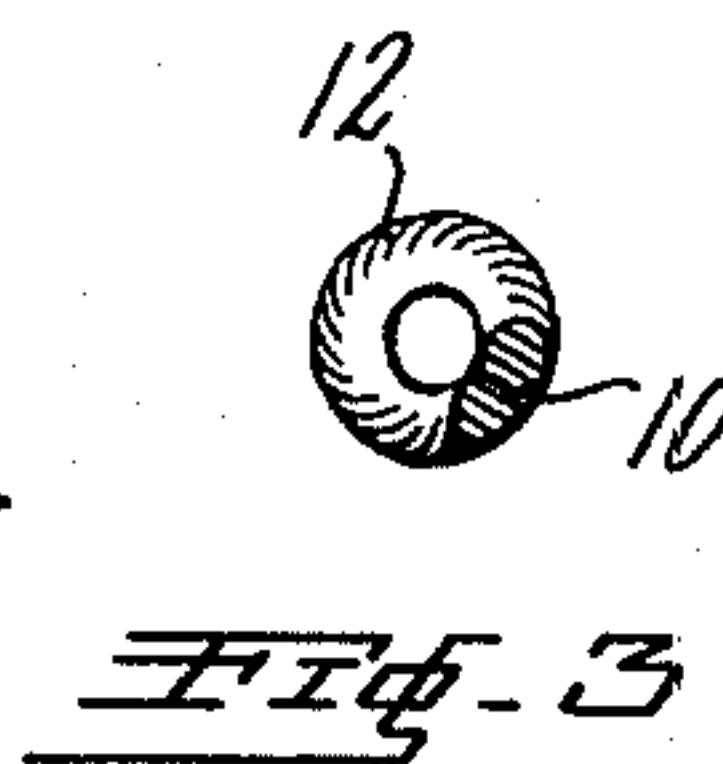
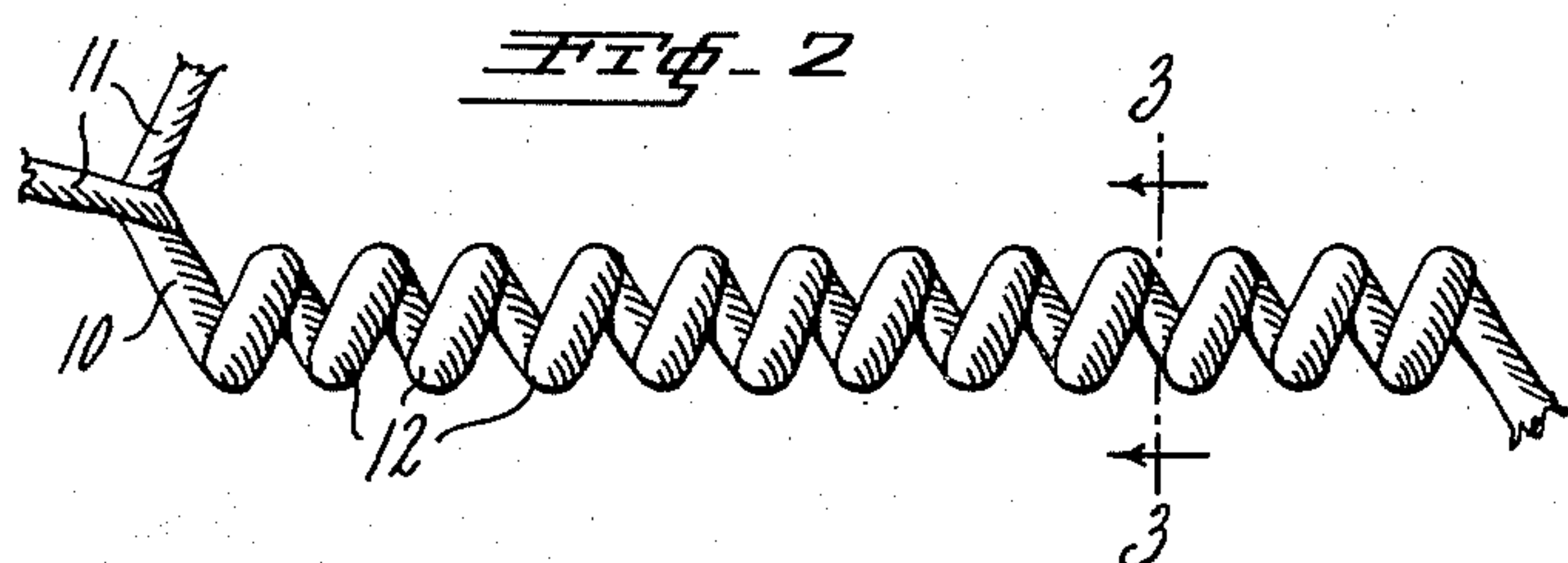
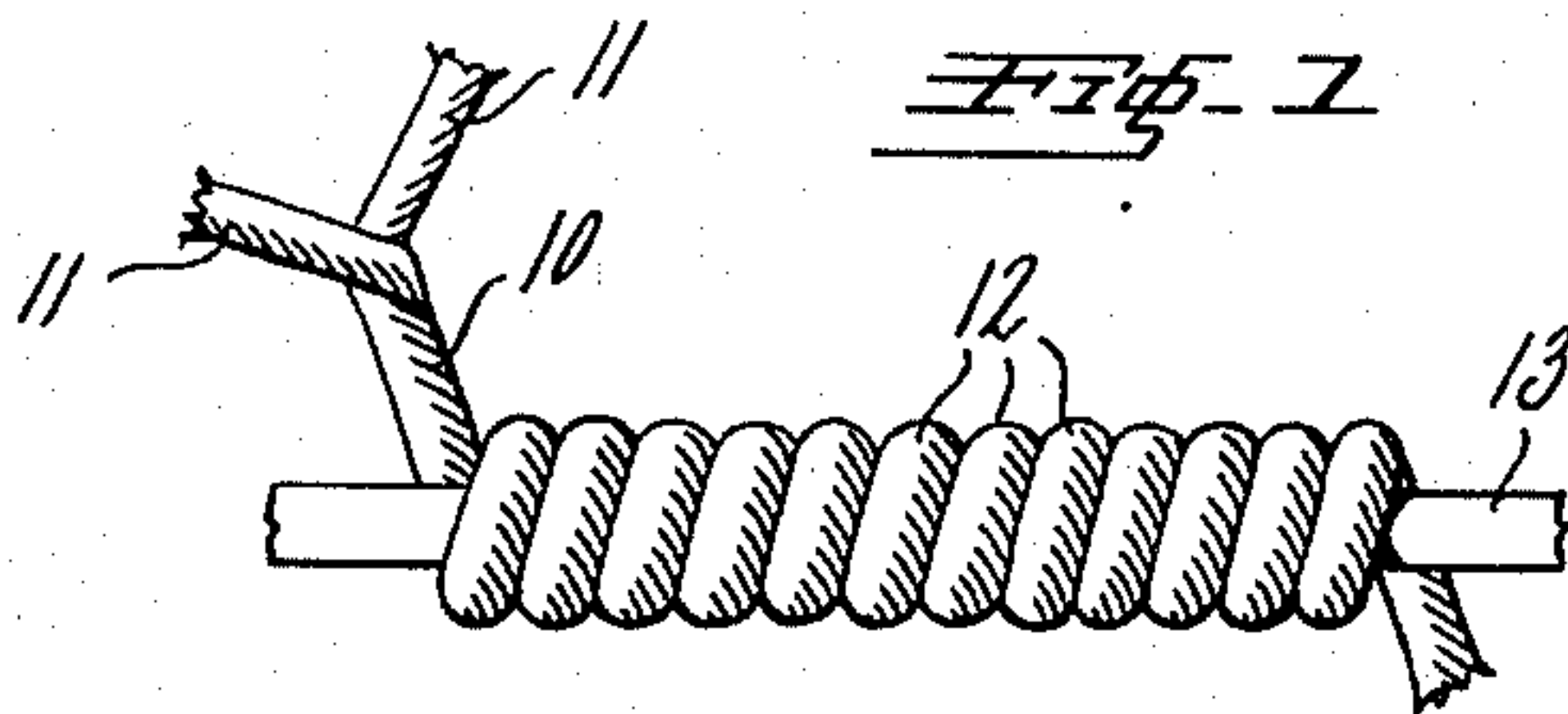
Oct. 23, 1945.

B. H. FOSTER

2,387,320

HIGHLY STRETCHABLE YARN

Filed Aug. 5, 1944



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## UNITED STATES PATENT OFFICE

2,387,320

## HIGHLY STRETCHABLE YARN

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9 Claims. (Cl. 57—139)

This invention relates to an all-textile yarn having high stretch characteristics so that it will stretch and contract very much like an elastic yarn having a rubber core.

High stretch or crepe yarns are well known and have been extensively used heretofore, the amount of twist imparted to such yarns is usually two or three times that of ordinary yarn of the same material. These crepe yarns as constructed heretofore have a stretch range up to about 50% and a comparatively weak and slow return. Such yarns have been used to produce crepe fabrics, surgical bandages and other fabrics where the contractive action of a high twist yarn is desired.

Crepe yarns as constructed heretofore have been difficult to handle, weave or knit because of their inherent tendency to kink and twist up the moment the tension is relieved. This tendency of crepe yarns to buckle, kink and snarl makes them difficult to work and is the cause of much annoyance and loss of time.

The present invention contemplates an all-textile yarn having stretch characteristics or an elastic extensibility range which may be much greater than that of the crepe yarns employed heretofore, and this increased stretch range is secured without imparting to the yarn a corresponding increase in the tendency of the same to kink or snarl.

In carrying out the present invention a crepe yarn is employed which may be a single yarn having a crepe twist, or it may be two or more single yarns plied together with a crepe twist. Such a crepe yarn, in accordance with the present invention, is coiled helically about a central axis in the same direction in which this yarn is highly twisted. The effect of this is to impart to the yarn a high number of coils or wraps in addition to its high twist, so that these wraps will materially increase the range of stretch of the yarn over that imparted by the high twist alone. The helical coils impart a long controlled stretch to the yarn and give it a good "kick" or contractive action. Such a yarn having a high twist and a high number of coils has a better contractive force than the usual crepe yarn, and while it may still tend to kink the numerous small coils disperse the kinks and thereby keep them so small that they will easily pull out when the yarn is tensioned.

The highly twisted and coiled yarn contemplated by the present invention may be balanced or unbalanced and it may be formed of cotton,

wool, rayon, silk, nylon or other well known or preferred yarn, and the elastic extensibility range imparted to the yarn by the present invention may be controlled to provide any desired stretch range from 50% to 300% or more as desired.

An important feature of the invention resides in the construction whereby the range of stretch imparted to the present yarn may be controlled accurately. This may be done by winding a crepe yarn in contacting coils about a small core yarn to provide a yarn having one range of stretch, and by winding a similar yarn about a larger core yarn to provide a yarn with a greater range of stretch. The purpose of the core yarn is to determine the size of the coils and such core yarn is later destroyed so that the twisted and wrapped yarn will be free to stretch. It will be understood that the larger the coils the greater the yarn can stretch as these coils straighten out, and that a corresponding reduction in the added twist will occur as the coils are increased in size.

The present yarn when in the relaxed, shrunk or contracted condition will have a large number of fine helical coils in addition to its high twist, but to secure the results herein contemplated it is important that the helical coils shall extend in the direction in which the yarn is twisted so that the twist of the yarn will increase as the coils are straightened out and the twist of the yarn will decrease as the yarn contracts and again assumes its helical condition.

The yarn having the novel construction so far described will be unbalanced and when free from tension will kink up to some extent, but this is found not to be serious because, as above stated the coils tend to disperse the kinks so that they will pull out readily when tensioned.

The highly stretchable unbalanced yarn of the present invention can be balanced by wrapping a second highly twisted yarn in the opposite direction over the first helically wound yarn, or a balanced construction can be produced by taking the unbalanced highly twisted and highly coiled yarn just described and plying two such yarns together so that their ply twist will be in the opposite direction to that in which the yarns are coiled.

The above and other features of the present invention will be more fully understood from the following description when read in connection with the accompanying drawing, wherein:

Fig. 1 is a side elevation of an unbalanced yarn constructed in accordance with the present in-



vention and comprises a highly twisted ply yarn wound helically about a core yarn.

Fig. 2 shows the construction of Fig. 1 after the core yarn has been removed and the highly twisted helically wound yarn has been partly stretched.

Fig. 3 is a sectional view taken on a line 3—3 of Fig. 2.

Fig. 4 is a side elevation of a balanced yarn constructed in accordance with the present invention and comprises one twisted and coiled yarn forming an inner cover about which a second twisted yarn is wrapped as an outer cover.

Fig. 5 shows the construction of Fig. 4 after the core yarn has been removed and the remaining balanced yarn is partly stretched.

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 5.

Fig. 7 is a side-elevation of a modification showing a balanced stretchable yarn formed by ply twisting together two yarns such as shown in Fig. 1; and

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 7.

A very simple form of the present invention resides in the unbalanced twisted and coiled yarn shown in Figs. 1, 2 and 3 of the drawing. The balanced construction shown in Figs. 4, 5 and 6 is easily produced by winding a second highly twisted yarn spirally about the construction shown in Fig. 1 but in the opposite direction to the first windings; and the balanced construction shown in Figs 7 and 8 is produced by twisting together two of the yarns shown in Fig. 1 with a ply twist that is in the reverse direction to the helical windings.

In making up the construction shown in Figs. 1, 2 and 3 a single yarn or ply yarn as desired may be used and it may be formed of any preferred or well-known textile fibres or filaments. Such yarn which is designated by 10 in the drawing is shown as a ply yarn formed by twisting together two ordinary yarns 11. The twist imparted to the yarn 10 is a high twist or crepe twist which is preferably two or three times as high as that of the ordinary yarn of the same material. The number of twist per unit length imparted to the yarn 10 may however vary considerably depending upon the nature and size of the yarn used and the amount of stretch desired in the finished product. The twist imparted to the yarn 10 should be in the opposite direction to that of the twist of the individual strands 11.

As soon as the desired high twist or crepe twist has been imparted to the yarn 10 it may be coiled helically about a central axis in the direction of its twist to form the helical coils 12, and it is extremely important that the coils 12 be wound in the same direction in which the yarn 10 is twisted. For example, if the strands 11 have what is known as a Z twist then the yarn 10 should have an S twist and the coils 12 likewise should be in the S direction.

In the construction shown the highly twisted yarn 10 is coiled helically upon a core yarn 13, and when such core yarn is used it should be weak enough to permit it to be easily broken and thereby permit the twisted and coiled yarn 10 to be stretched, or the core yarn 13 should be formed of a different type of fibre or filament from that of the yarn 10 so that the core yarn 13 may be chemically destroyed without injuring the highly stretchable yarn 10.

As above stated an important feature of the present invention resides in the construction

whereby a yarn having any desired stretch and good contractive action throughout a range of from 50% to 300% or more can be produced. This stretch control is secured by varying the size of the core used. For example in experimenting in this field a cotton yarn such as 1 end of 80 S/2 was used as the crepe yarn and this was wound tightly about 1 end of 150 denier acetate yarn, as shown in Fig. 1 of the drawing, this produced a twisted and coiled yarn having about a 100% stretch. Next the same type of crepe cotton yarn was similarly wound around a core formed of two of the acetate yarns just described, and this produced a twisted and coiled yarn having about a 200% stretch. Likewise when three of these acetate yarns were used in the core about a 300% stretch was secured.

It is desired to point out however, that the stretchable yarn of the present invention may be formed without coiling the same upon a core yarn such as 13, for example, the highly twisted yarn 10 shown in Fig. 1 of the drawing could readily have the desired coils 12 imparted thereto by employing the apparatus shown in the Gammeter Pat. No. 1,982,208 so that the yarn 10 may be wound helically upon the needle shown in the Gammeter patent. After the yarn 10 is wound upon such needle it may be progressively removed therefrom by slipping it endwise of the needle off of its free end, so as to produce a coiled yarn having an opening at the center as shown in Fig. 3. This clearly discernible opening at the center of the coils is an essential feature of the present invention. Therefore when the present twisted and coiled yarn is relieved from tension the diameter of a coil 12 will always be more than twice the diameter of the yarn 10.

After the coiled yarn of Fig. 1 has had the core 13 removed therefrom and the yarn 10 is slightly stretched it should have the approximate appearance of the open helical coils shown in Fig. 2. It is desired to mention however, that while a stretchable yarn constructed in accordance with the present invention should, when relaxed, assume clearly discernible convolutions, such convolutions may be less uniform in appearance than shown in Fig. 2 of the drawing.

In carrying out the present invention it is deemed advisable, at least in most cases, to so construct the stretchable yarn shown in Fig. 2 of the drawing that when it is in the fully relaxed condition it will have a greater number of coils per inch than the twists of the crepe yarn 10 per inch. When such a construction is employed the high twist imparted to the yarn 10 will give it considerable stretch, and the coils 12 will impart to such yarn a much greater stretch.

The action of the present yarn shown in Fig. 2 of the drawing is such that when it is placed under sufficient tension to straighten it out the twists imparted to the yarn 10 will increase as the coils 12 are straightened out, and as the tension upon the yarn is reduced the coils 12 will reappear with a corresponding reduction in the twist of the yarn 10. It will therefore be seen that the high twist of the yarn 10 and the large number of fine helical coils 12 work together to impart a long range stretch to the textile yarn. Furthermore, as above stated the provision of the coils 12 throughout the length of the highly twisted yarn 10 prevents the yarn 10 when relaxed from kinking to a serious degree, since the coils 12 disperse such kinks and confine them to short lengths of yarn. This is extremely important because if in handling, weaving or knit-



ting the present yarn it becomes slack and kinks up, these kinks will all disappear as soon as the yarn is subjected to a moderately strong pull.

If the yarn 10 is formed of cotton fibers or viscose rayon then the core 13 may be formed of cellulose acetate, for example, since such a construction may be treated with acetone which will destroy the cellulose acetate core without injuring the cotton or viscose rayon yarn 10. The core 13 may be removed either before or after the construction of Fig. 1 is embodied in a fabric. It will be understood that as long as the core yarn 13 is present it acts as a stop thread and will hold the twisted coiled yarn 10 from stretching, so that it may be woven, knitted or otherwise formed into a fabric as a non-stretchable yarn, and then the core 13 may be broken or destroyed to produce a fabric having stretch characteristics approaching that of elastic fabric employing rubber threads in its construction.

Should it be desirable to provide a balanced high stretch yarn in place of the unbalanced high stretch yarn of Figs. 1, 2 and 3 of the drawing, this is easily accomplished as will be apparent from Figs. 4, 5 and 6 of the drawing, by wrapping around the coils 12 of Fig. 1 an outer cover formed of a highly twisted or crepe yarn 14 so as to form the helical coils 15 that surround the coils 12. It is highly important however, that the twist of the yarn 14 shall be in the opposite direction to the twist of the yarn 10, and that the helical winding 15 shall be in the same direction as the twist of the yarn 14 but in the opposite direction to that of the windings 12. The yarn 14 may be made of the same textile material as the yarn 10 or a different textile material as desired. For example the yarn 10 may be formed of cotton and the yarn 14 may be formed of viscose rayon to improve the appearance and feel of the finished stretchable yarn. After the core 13 is removed from the construction shown in Fig. 4 and the balanced yarn is partly stretched it should appear more or less as shown in Fig. 5 of the drawing.

The construction shown in Fig. 1 may be produced on a covering machine of a type which has been extensively used heretofore to wind a cover about a rubber core to produce an elastic yarn of the single cover type. The construction shown in Fig. 4 of the drawing may be produced on a similar covering machine adapted to wind a right and left hand cover about a central core.

Instead of winding an outer cover over the inner cover as shown in Figs. 4, 5 and 6, to produce a balanced construction, a balanced highly stretchable yarn may be produced as shown in Figs. 7 and 8. This is accomplished by employing two yarn constructions such as shown in Fig. 1 of the drawing and twisting them together as shown in Fig. 7 with a ply twist, but it is important that this ply twist be in the opposite direction to that of the winding of the coils 12. After the construction of Fig. 7 is made the core yarns 13 should be removed.

In order that the constructions of the present invention may be further understood, the following examples are given:

Example of construction shown in Fig. 1 of the drawing:

#### I. Construction

Core: 1 end of 150 den., acetate yarn  
Wrapping: 1 end of 80 S/2, cotton yarn  
Twist multiplier of wrapping yarn 7.1

#### II. Analysis—Before core is removed

Yards per lb.	7,350
Wrapping:	
Twist per inch	45S
Wraps per inch	105S
Length of yarn in 1 yd. of covered core	119 inches
Gauge	.0062 do

#### III. Analysis—After removal of core

Yards per lb.	10,700
Per cent elongation	85
Per cent elongation at break	170
Tensile strength in grams	254
Length of 1 yd. after removing core	40 inches
Gauge	.0056 do

Example of construction shown in Fig. 4 of the drawing:

#### I. Construction

Core: 1 end of 150 den., acetate yarn  
First wrapping: 1 end of 80 S/2, cotton yarn  
Twist multiplier of first wrapping, 9.5  
Second wrapping: 1 end of 150 den., viscose yarn  
Twist multiplier of second wrapping: 8.1

#### II. Analysis—Before core is removed

Yards per lb.	2,540
First wrapping:	
Twist per inch	60S
Wraps per inch	115S
Length of yarn in 1 yd. of covered core	138 inches
Second wrapping:	
Twist per inch	48Z
Wraps per inch	113Z
Length of yarn in 1 yd. of covered core	230 inches
Gauge	.022 do

#### III. Analysis—After removal of core

Yards per lb.	4,560
Per cent elongation	110
Per cent elongation at break	150
Tensile strength in grams	256
Length of 1 yd. after removing core	37 inches
Gauge	.019 do

Example of construction shown in Fig. 7 of the drawing:

#### I. Construction

Core: 1 end of 150 den., acetate yarn  
Wrapping: 1 end of 80 S/2, cotton yarn  
Ply twist: 2 ends of the Fig. 1 construction twisted together

#### II. Analysis—Before core is removed

Yards per lb.	2,720
Wrapping:	
Twist per inch	45S
Wraps per inch	113S
Length of yarn in 1 yd. of covered core	132 inches
Ply twist	12.3Z
Gauge	.024 inches

#### III. Analysis—After removal of core

Yards per lb.	4,450
Per cent elongation	130
Per cent elongation at break	208
Tensile strength in grams	455
Length of 1 yd. after removing core	39 inches
Gauge	.022 do



A highly stretchable yarn construction in accordance with the present invention will have a lower elastic modulus and slower recovery than a rubber covered elastic yarn, but this may be desirable for use in some wearing apparel such for example as in light weight under-garments, bathing suits, tops of stockings, waist bands, etc. The present stretchable yarn has the further advantages over elastic yarn containing rubber in that it may be repeatedly washed or dry cleaned without injury, and is free from the odor of rubber. It also should give good wear and retain its stretchable characteristics until it is worn out.

The term crepe twist has been herein used as meaning a twist considerably higher than ordinary yarn twist, and as including a wider twist range than that indicated by the three twist multipliers given in the above tables.

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

1. An all-textile yarn having high stretch characteristics, comprising a yarn having a crepe twist and which in this highly twisted condition is coiled helically about a central axis in the direction it is twisted, so that it has in its relaxed condition a diameter that is more than twice the diameter of the uncoiled yarn and a greater number of helical coils per inch than the twists of the crepe yarn per inch forming such helix.

2. An all-textile yarn having an elastic extensibility range in excess of 50 per cent, comprising a yarn having a crepe twist and which in this highly twisted condition is coiled helically about a central axis in spaced relation thereto and in the direction in which it is twisted, so that it has in its relaxed condition a greater number of helical coils per inch than the twists of the crepe yarn per inch forming such helix.

3. An all-textile yarn having high stretch characteristics, comprising a yarn having a crepe twist and which in this highly twisted condition is coiled helically about a central axis in the direction in which it is twisted, so that it has in its relaxed condition a diameter that is more than twice the diameter of the uncoiled yarn and a large number of fine helical coils in addition to its high twist.

4. An all-textile yarn having an elastic extensibility range in excess of 100 per cent, comprising a yarn having a crepe twist and which in this highly twisted condition is coiled helically about a central axis in spaced relation thereto and in the direction in which it is twisted so that it has in its relaxed condition a large number of fine helical coils in addition to its high twist.

5. An all-textile yarn having high stretch characteristics, comprising a crepe yarn having superposed thereupon in the same direction a higher number of contacting helical coils per inch than the crepe twists per inch, whereby the yarn when relaxed is characterized by the presence of identifiable convolutions encircling an open center and the diameter of the convolutions is more than twice the diameter of the uncoiled yarn.

6. A balanced all-textile yarn having high stretch characteristics, comprising a yarn having a crepe twist and which in this highly twisted condition is coiled helically about a central axis in spaced relation thereto and in the direction in which it is twisted, a second yarn having a crepe twist in the opposite direction and wound helically over the coils of the first yarn, but in the opposite direction to said first coils, and each of said crepe twisted yarns having in the relaxed condition a large number of helical coils.

7. A balanced all-textile yarn having an elastic extensibility range in excess of 100 per cent, comprising a yarn having a crepe twist and which in this highly twisted condition is coiled helically about a central axis in spaced relation thereto and in the direction in which it is twisted, a second yarn having a crepe twist in the opposite direction and wound as a cover helically over the coils of the first yarn but in the opposite direction to said first coils, and each of said crepe twisted yarns having in the relaxed condition a large number of helical coils.

8. A balanced all-textile yarn having high stretch characteristics, comprising two crepe yarns each of which is twisted in the same direction and which in its highly twisted condition is coiled helically in the direction in which it is twisted to form two separate stretchable yarns each of which in the relaxed condition has a large number of fine coils in addition to its high twist, and said twisted and coiled yarns being twisted together in the opposite direction to form a balanced highly stretchable ply yarn.

9. An all-textile yarn having high stretch characteristics, comprising a plurality of crepe yarns each of which is twisted and helically coiled in the same direction to form separate stretchable yarns, each of which in the relaxed condition has a large number of fine coils in addition to its high twist, and said twisted and coiled yarns being twisted together in the opposite direction to form a substantially balanced and highly stretchable ply yarn.

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