July 16, 1957 C. W. ROSE 2,799,133

DRAWABLE ROPE HAVING PRE-DRAWN SEGMENT AND METHOD FOR PRODUCING THE SAME

Filed May 24, 1951 2 Sheets-Sheet 1

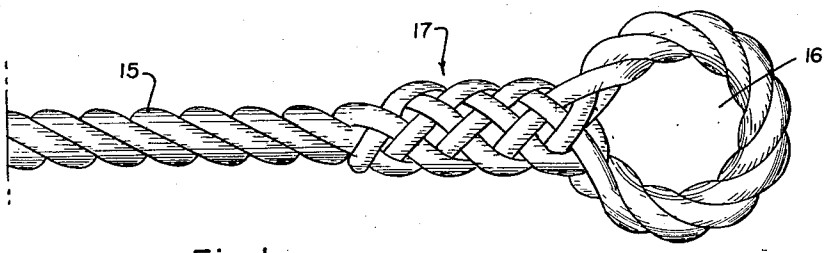


Fig. 1

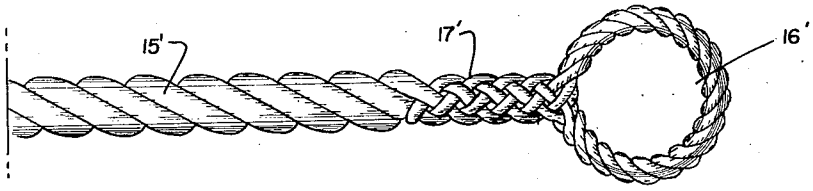


Fig. 2

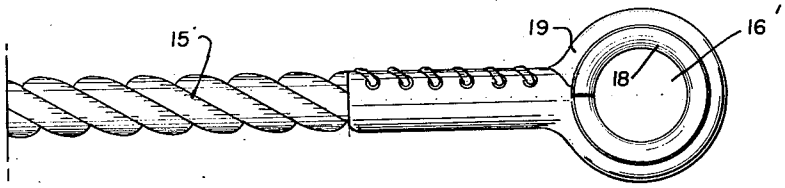


Fig. 3

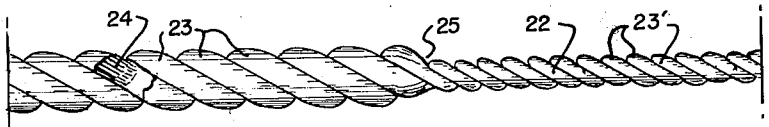


Fig. 4

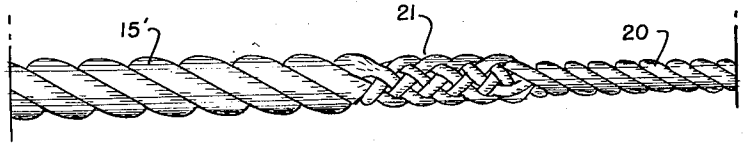


Fig. 5

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DRAWABLE ROPE HAVING PRE-DRAWN SEGMENT AND METHOD FOR PRODUCING THE SAME

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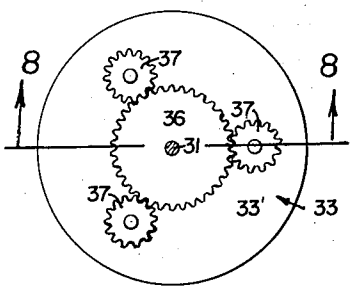


Fig. 7

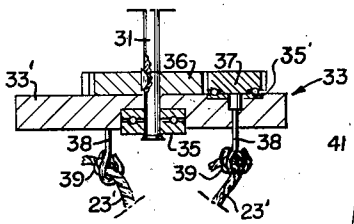


Fig. 8

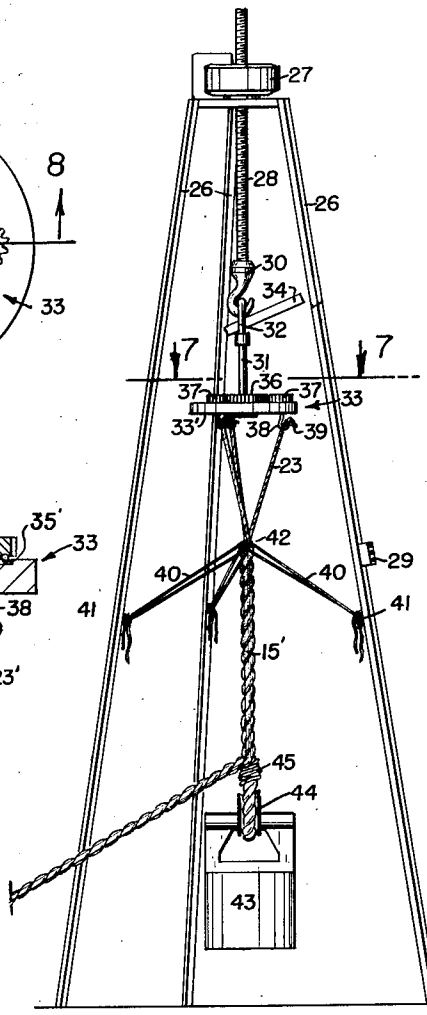


Fig. 6

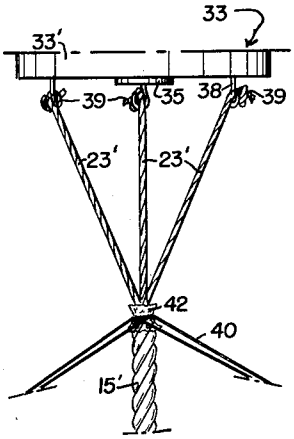


Fig. 9

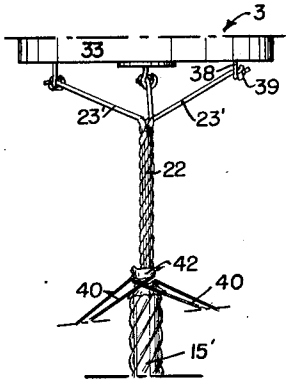


Fig. 10

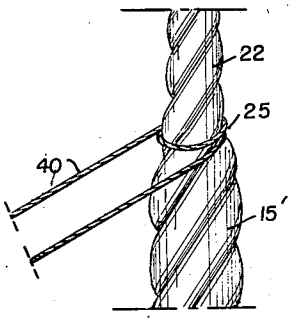


Fig. 12

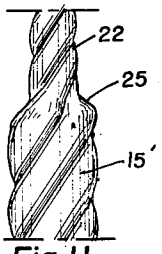


Fig. 11

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2,799,133

DRAWABLE ROPE HAVING PRE-DRAWN SEGMENT AND METHOD FOR PRODUCING THE SAME

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Application May 24, 1951, Serial No. 228,042

16 Claims. (Cl. 57—140)

This invention relates to a method and apparatus for splicing or otherwise connecting a stretchable or drawable rope such as nylon and for forming a new and improved splice or other connection in such rope, an object of the invention being to provide a splice or other connection in a pre-stretched or drawn connective segment of otherwise undrawn rope.

Other objects of this invention include the provision of a pre-stretched portion or drawn connective segment in a reach of otherwise stretchable or undrawn rope as for splicing or other preparation for attachment purposes which segment will not be loosened by subsequent drawing of the rope, which will retain the lay of the rope and not become unraveled or loosened by drawing or other manipulation of the originally undrawn portion of the rope; which permits the secure joining of drawable but undrawn rope with other types of rope; which is smaller than but as tight, compact and strong as the undrawn portion of the rope; which is especially adaptable for receiving a neat tight cover; which will retain a thimble as in an eye splice even after the rope is subjected to stress and fully drawn which is adapted to permit the otherwise undrawn rope to be effectively fastened to other elements by any conventional rope fastening means, and which is peculiarly adapted for such uses as joining to safety belts the safety ropes of such belts.

Still other objects of this invention include the provision of a new and novel method for drawing a selected portion of an undrawn, but drawable, rope; for so drawing such selected rope portion as to provide a clear point of demarcation between the undrawn and the drawn portions of the rope; for so drawing the selected rope portion without placing excessive strain upon the undrawn rope portion, thereby avoiding deformation or injury to the undrawn portion of the rope; for so drawing the selected rope portion and, coincidentally or subsequently, retwisting and re-laying the fibres of the drawn strands and thereupon forming a new, tight lay of the drawn portion of the rope; and for so drawing a selected portion of the rope in a manner which is simple, easy and inexpensive.

Still other objects of this invention include the provision of a new and novel apparatus for drawing a selected portion of an undrawn, but drawable, rope which will draw the said selected portion and subsequently retwist and re-lay the drawn strands; which may be operated either manually or mechanically; which is simple and easy to operate; and which is economical to build and to maintain in use.

With these, and other objects, in view, all of which more fully hereinafter appear, my invention comprises a certain new and novel article and new and novel steps and processes and combinations and arrangements of parts, as hereinafter described, and as defined in the appended claims, and illustrated in preferred embodiment in the accompanying drawing in which:

Figure 1 shows a portion of undrawn rope with a conventional eye splice formed at one end.

Figure 2 illustrates a portion of drawable rope with the end segment pre-drawn in accordance with the present invention, and with an eye splice formed therein.

Figure 3 illustrates the Fig. 2 structure with a protective jacket covering the eye and splice and with a thimble in the eye.

Figure 4 illustrates a piece of drawable rope with its end pre-drawn, twisted and laid as in preparation for forming a splice.

Figure 5 shows a running splice joining a predrawn end portion of drawable rope with a non-drawable rope.

Figure 6 is an elevation view of apparatus for drawing, twisting and re-laying the strands of the end segment of a drawable rope.

Figure 7 is a section as taken on the indicated line 7—7 at Fig. 6.

Figure 8 is a section as taken on the indicated line 8—8 at Fig. 7.

Figure 9 is a fragmentary view of the apparatus illustrated at Fig. 6, showing the portion holding the strands, and showing the strands being twisted in preparation for their re-laying.

Figure 10 is similar to Fig. 9 but showing the strands laid, as upon completion of the drawing and re-laying operation, preliminary to forming a splice.

Figure 11 is a fragmentary detail, on an enlarged scale, of the juncture between the drawn and the undrawn portions of the drawable rope.

Figure 12 is a fragmentary detail similar to Fig. 11, but showing further the manner of looping a thong around the rope as for drawing.

The production of fibrous materials from nylon and some similar plastics, hereinafter referred to as nylon, requires a drawing step to properly condition the fibres. The molecular structure of such materials has a characteristic property which permits a large permanent elongation at the yield point of a fibre under tension, and before a permanent set occurs. However, once the fibre is drawn, it attains its ultimate strength. This characteristic property is taken advantage of in the construction of various types of safety belts and ropes to provide a stretchable rope or stretchable reach in the safety rope, for such a rope will draw out or permanently elongate in an inelastic manner under sufficient force, such as that exerted by a falling body attached to the rope. This drawing will absorb the energy generated by such a fall and eliminate sudden and severe shocks, which are dangerous and constitute an undesirable feature of safety belts and ropes of substantially nonyielding character. The dangerous rebound incident to the use of ropes having great elasticity is also avoided.

However, it follows that a safety rope of undrawn material, once drawn, loses its normal shape, becoming smaller in diameter as it increases in length, and acquiring a slack, limp lay of the strands, and the splices and hitches, made in or with such rope, likewise become limp, disconnect from the thimbles and tend to fall apart once the rope is again slacked. Once drawn, such rope is generally incapable of another use, but it is desirable, and often essential, that the splices or joining means at the segments of the rope where the rope connects with other elements remain secure, so that the safety rope cannot become disconnected from its attachment elements such as its anchorage by subsequent handling of the drawn rope. To solve this problem, the present invention was conceived and developed, and comprises in essence, a splice or like connection formed in a predrawn connective segment of an otherwise stretchable reach of undrawn nylon rope and consists, further, in a method and apparatus for pre-drawing such selected segment of an undrawn nylon rope preparatory to form-

ing the splice or hitch. It was discovered that such a splice is neat in appearance and is adaptable for covering with a jacket, of leather or other material, and insures the maintenance, in unaltered condition, of the elements of the connecting assembly.

In considering, for example, the conventional eye splice in an undrawn connective segment of the rope, as illustrated at Fig. 1, it is to be noted that the end of rope **15** is reversed upon itself to form an eye **16**, and that the ends of the strands are then tucked into the lay of the rope adjacent the eye to form the splice **17**. The diameter of the rope in the eye **16** is the same as the diameter of the rope **15** and the diameter of the splice **17** is appreciably greater. The illustration is of either ordinary or undrawn nylon rope. If the rope be undrawn nylon, it may be drawn to as much as five times its original length, whereupon the lay of the rope will naturally become limp, and the portion forming the splice **17** will likewise become limp, the splice loosened and the eye internally enlarged. This undesirable condition is known to those skilled in the art, and considerable effort has been expended to develop a satisfactory means of joining the end or other connective segment of a generally undrawn nylon rope, either to another rope or to itself as in a splice.

An eye splice may be tied at the end of a stretchable reach **15'** of a rope of undrawn nylon in accordance with the present invention where a sufficient portion, of the connective segment is pre-drawn, as in a manner hereinafter described, to permit the forming of an eye **16'** and a splice **17'** in such pre-drawn connective segment, all as clearly illustrated at Fig. 2. It is to be noted that in such an eye splice the strands in the loop forming the eye **16'** are considerably smaller in diameter than those of the undrawn rope portion **15'**, and that the splice **17'** may be no larger in diameter than the undrawn rope portion **15'**. The smaller diameter of the splice **17'** not only improves the appearance of the eye splice over that of a conventional splice, but also permits the splices to be neatly covered and shielded as by a leather jacket **19**, as clearly illustrated at Fig. 3 where a conventional thimble **18** is also illustrated. Further, this splice cannot be stretched, deformed or normally broken because it is formed with pre-drawn fibres which retain all of their original strength. Moreover, the rope is double in the spliced area.

A pre-drawn connective segment of an undrawn nylon rope may be used to connect the undrawn rope with other ropes as by splicing, as shown by the short running splice illustrated at Fig. 5. In such case, the end of the stretchable reach **15'** of an undrawn nylon rope is connected with a conventional undrawable rope **20**, a running splice **21** being made with the strands of the undrawable rope **20** and strands of a pre-drawn connective segment of the otherwise undrawn nylon rope **15'**. Where the strands of the rope **20** are about the same size as the strands of the pre-drawn portion of the rope **15'**, it is to be noted that the splice is small in diameter, and neat and compact compared with the undrawn portion of the rope **15'**.

The pre-drawn connective segment **22** (Fig. 4) of the nylon rope may be used for attaching the rope to a post or connective ring by an ordinary knotting which will not be loosened or pulled out of shape if the undrawn portion of the rope is drawn. Likewise, this connective segment **22** may be secured in any other manner used for securing rope, as by being embedded in a mastic.

In the formation of a rope, having a plurality of strands **23** laid or wrapped about each other with each strand comprising a number of individual fibres **24** (as illustrated at Fig. 4), it is essential that there be an adequate number of twists of the fibres in each strand and an adequate number of wraps in the lay of the strands about each other in a given length of rope to provide a rope of desirable rigidity and hardness. Generally, the smaller the rope, the more twists and wraps per given length are

required. It follows that if a given length of rope is drawn, to say five times its former length, without any change of strand twists or lay wraps, the result will be an exceedingly limp and slack aggregate of fibres and strands. A splice in such a rope is entirely unsatisfactory. The basic steps in forming a pre-drawn portion, as **22**, of an otherwise undrawn rope, is to grip and hold the ends of the strands of that portion of the rope **15'** which is to be pre-drawn; to draw said strands until the fibres in such strands are fully drawn; then to twist the fibres **24** of each strand **23** to a desired degree of tightness, and to then again wrap or lay the strands **23'** about each other with their new and increased twist holding them in the tighter and closer re-lay.

It is essential that the rope should be gripped at the point which is to be the limit of the pre-drawn connective segment, indicated by shoulder **25**, Fig. 4, and the individual strands **23** should be gripped and separated at their ends preliminary to the drawing operation.

A pre-stressing of the rope, as with a tensile load which is not quite sufficient to cause drawing, assists the operation by reducing the necessary gripping force at shoulder **25**, thereby lessening the possibility of bruising the rope fibres at that point by such gripping.

Adequate soaking of the rope in water or other softening agent, which will not materially change the permanent properties of the nylon, reduces to a considerable extent, the force required to draw nylon rope, and this step will facilitate the pre-drawing operation.

A preferred apparatus for drawing a segment of a nylon rope is illustrated at Figs. 6 through 10 and Fig. 12, and as here illustrated comprises a frame for suspension of the rope which is, conveniently, a tripod **26** having, at its apex hoisting or raising means here illustrated as a motorized lift **27** operable by switch **29** to raise, lower or hold a vertical shaft **28**. A conventional chain or cable hoist may be used. Shaft **28** is disposed in the upper portion of the tripod **26** and carries a swiveled hook **30** at its lower end. Center bar **31** is suspended from hook **30** by an eye **32** and carries a spinner head **33** at its lower end. Eye **32** is of sufficient proportions to receive a bar **34** adapted to rotate the bar **31** and the gears in the spinner head **33** carried thereby.

The spinner head **33**, including a plate **33'**, is pivotally hung from the center bar **31**, suitable bearings **35** being provided to lessen frictional resistance between the plate **33'** and the bar **31**. A center or sun gear **36** is affixed to the center bar **31** above and adjacent the plate **33'** and meshes with three planetary gears **37** which are rotatably mounted upon said plate about said center gear. While three planetary gears **37** are shown, for use with conventional 3-strand rope, this gearing may be modified in any manner necessary to conform with different types of rope.

The planetary gears **37** are mounted upon bearings **35'** with carrier hooks **38**, or other attachment means, depending therefrom through the plate **35'**, said hooks being adapted to engage the ends of strands **23** or a rope **15'**. These strands **23'** may be connected to hooks **38** in any suitable manner as by simply knotting their ends as at **39**. It follows that any rotation of the center gear **36** causes simultaneous rotation of the hooks **38** carried by the planetary gears **37**; and this action may be used to twist each of the strands **23'**, connected to said hooks, to a uniform tightness.

Prior to this twisting operation, the plate **33'** will have been rotated, responsive to the force of the drawing operation, in such reverse manner as to partially separate and remove the lay of the strands of the drawn portion of the rope, the head is then rotated to remove the balance of the lay as illustrated in Fig. 9, and the plate must be held against rotation during the fibre twisting operation. The subsequent release of said plate **33'** causes it to revolve, due to tension resulting from the fibre twisting of the strands. This tension-induced rotation causes a re-

lay in the drawn segment of the rope, which neutralizes the twist in the strands.

The rope **15'** must be held, by any suitable means, at the point of the shoulder **25**. In the herein described embodiment the rope **15'** is engaged at the point of the shoulder **25**, by suitable thongs **40**, there being a thong connected to each leg of the tripod as by hooks **41**, the triangular disposition of the thongs causing an even distribution of the forces exerted on the rope. Each thong is wrapped one full turn about the rope **15'** and preferably over a shield **42**, which may be of a soft, tough material, interposed between the thongs and the rope **15'**. The shield is not shown at Fig. 12 as it is unnecessary for the purpose of that figure. It follows that any pull upon the rope **15'** from the spinner head **33** will cause the thongs **40** to tightly grip the rope and avoid slipping.

When the rope is soaked, as a step prior to the drawing, it is desirable to soak exactly that portion of the rope which is to be drawn and the grip of the thongs on the rope should be applied at the exact point where the wet and dry portions of the rope meet.

It is desirable to apply to the rope, below the point of attachment of the thongs, the maximum pre-tension which will stretch the rope to the limit of its elasticity but which is just insufficient to draw the rope. Such pre-tension will appreciably lessen the required force of the thongs **40** on the rope at the shoulder **25** and thus lessen the danger of injury to the rope at that point. This pre-tension may comprise simply a weight **43** carrying a thimble **44** about which the rope may be wrapped and fastened as with a cord **45**, as clearly illustrated at Fig. 6.

If equivalent, horizontally disposed, apparatus is used, the pre-tension applied by means of a weight may be obtained by running the rope over a pulley.

In operation, the rope **15'** is mounted in the apparatus as illustrated at Fig. 6 with the strands **23** of the rope upper end interrelatively untwisted sufficiently to be respectively secured to the hooks **38**. Switch **29** is operated resulting in raising rod **28** and spinner head **33** and causing tension on the rope by lifting weight **43**. The thongs **40** then come into play and the further lifting of head **33** causes the thongs to grip and arrest the movement of the rope at shoulder **25**, resulting in the elongation of the portion above the shoulder as the spinner head continues to be raised. This results in drawing said upper portion which drawing is continued until said upper portion has been drawn to its limit whereupon the strands are twisted by the planetary gears and then re-layed into a drawn rope, all in the manner hereinbefore described.

While I have herein described and illustrated several forms of my product, various steps of a method and a preferred apparatus, other and equivalent products, modifications and alterations of apparatus and steps will occur to those skilled in the art, all within the scope and spirit of my invention, hence it is my desire that I be limited in my protection, not by the embodiments and details herein illustrated and described, but only by the proper scope of the appended claims.

I claim:

1. The process of drawing a pre-determined segment of a rope, formed of drawable fibres in an undrawn state and of a character which may be permanently greatly elongated before attaining a fully drawn state, including the steps of holding the rope at a pre-determined terminus of said segment, untwisting and drawing the strands in said segment to substantially their fully drawn length and retwisting and then relaying said strands all to a tightness substantially that of the undrawn rope portion.

2. The process of drawing a pre-determined segment of a rope, formed of drawable fibres in an undrawn state and of a character which may be permanently greatly elongated before attaining a fully drawn state, including the steps of holding the rope at a pre-determined terminus of said segment, drawing the strands in said segment to substantially their fully drawn length and thereby loosening the strand twists and unlaying said strands and retwisting and then re-laying said strands to a tightness substantially that of the undrawn rope portion.

3. The process defined in claim 2, including the step of imposing a pull on the rope including said predetermined segment, such pull being substantial but somewhat less than that required to draw the rope, and being maintained while the strands in said segment are being drawn whereby to reduce the necessary force to hold and to draw the strands in said segment.

4. The process defined in claim 2, including the step of subjecting the predetermined segment of the rope to a treatment adapted to temporarily lessen the required drawing force.

5. The process as defined in claim 2, including the step of soaking the pre-determined segment of the rope in a softening solution and thereby temporarily lessening the required drawing force.

6. The process defined in claim 5 wherein the soaking step is confined to said pre-determined segment.

7. The process defined in claim 2 wherein the step of holding the rope at the segment terminus includes gripping the rope by means which encircle the rope thereby equalizing pressure upon the strands throughout the rope periphery.

8. The process defined in claim 7 wherein said gripping means has an inner surface softer than the fibres of the rope to thereby avoid bruising the fibres.

9. In combination with connective means for holding a rope at a connective segment, stretchable rope formed of drawable fibres which may be drawn and permanently greatly elongated to a fully drawn state, including a stretchable reach wherein the fibres are in an undrawn, drawable state and a connective segment where the fibres are in a drawn, substantially undrawable state and connected to said means.

10. A stretchable rope having fibres twisted into strands and strands twisted into the rope lay, wherein the fibres are formed of drawable material capable of being drawn and permanently greatly elongated to a fully drawn state, including a stretchable reach wherein the fibres are in an undrawn, drawable state, and a connective segment where the fibres are in a drawn, substantially undrawable state, being looped to form an eye with the pre-drawn lay of said segment being interwoven with themselves behind the eye and thereby forming a substantially unstretchable eye splice.

11. The stretchable rope defined in claim 9, wherein a sharp demarcation lies between said stretchable reach and said connective segment.

12. A rope having a stretchable portion and an unstretchable portion interconnected by splicing said portions together, said stretchable portion having fibres twisted into strands and strands twisted into rope lay wherein the fibres are formed of a drawable material capable of being drawn and permanently greatly elongated to a fully drawn state, said stretchable portion including a stretchable reach wherein the fibres are in an undrawn, drawable state, and a connective segment where the fibres are in a drawn, substantially undrawable state, the lay of said segment being interwoven into said unstretchable portion as a connective splice.

13. A splicing section at the end of a stretchable rope having fibres twisted into strands and strands twisted into the rope lay, wherein the fibres are formed of drawable material capable of being drawn and permanently greatly elongated to a fully drawn state, wherein the fibres at said section are in a drawn, substantially fully-elongated undrawable state with the strands in said section being twisted into a rope lay having a tightness substantially that of the twist of the rope lay of the unstretched portion of the rope.

14. A stretchable rope having fibres twisted into strands and strands twisted into the rope lay, wherein the fibres

are formed of drawable material capable of being permanently greatly elongated to a fully drawn state, including a stretchable reach wherein the fibres are in an undrawn, drawable state and a connective segment wherein the fibres are in a drawn substantially undrawable state with the strands in said segment being twisted into a rope lay having a tightness substantially that of the twist of the rope lay of the unstretched portion of the rope, said connective segment being looped to form an eye with the pre-drawn lay of said segment being interwoven with themselves behind the eye and thereby forming a substantially unstretchable eye splice.

15. A rope having a stretchable portion and an unstretchable portion interconnected by splicing said portions together, said stretchable portion having fibres twisted into strands and strands twisted into the rope lay, wherein the fibres are formed of a drawable material capable of being drawn and permanently elongated to a fully drawn state, said stretchable portion including a stretchable reach wherein the fibres are in an undrawn, drawable state and a connective segment wherein the fibres are in a drawn, substantially undrawable state with the strands in said segment being twisted into a rope lay having a tightness substantially that of a twist of the rope lay of the unstretched portion of the rope, said rope lay of the connective segment being interwoven into the lay of the unstretchable portion as a connective splice.

16. A splicing section in a stretchable rope having fibres twisted into strands and strands twisted into the rope lay, wherein the fibres are formed of drawable material capable of being drawn and permanently greatly elongated to a fully drawn state, wherein the fibres at said section are in a drawn, substantially fully-elongated undrawable state with the strands in said section being twisted into a rope lay having a tightness substantially that of the twist of the rope lay of the unstretched portion of the rope.

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