

[54] **METHOD AND APPARATUS FOR
MANUFACTURE OF STRANDS AND
CABLES**

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[57] **ABSTRACT**

Strands or cables made of filamentary material, metallic or non-metallic, particularly intended for use as reinforcing elements in flexible sheet material. Method and apparatus for assembling and twisting together the elements of the strand or cable to produce strands and cables having a high capacity for elastic elongation when tensioned, and thus high resistance to fatigue.

[30] **Foreign Application Priority Data**

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[58] Field of Search.....
57/58.3-58.38, 58.52-58.57, 58.87, 59

[56] **References Cited**

17 Claims, 5 Drawing Figures

UNITED STATES PATENTS

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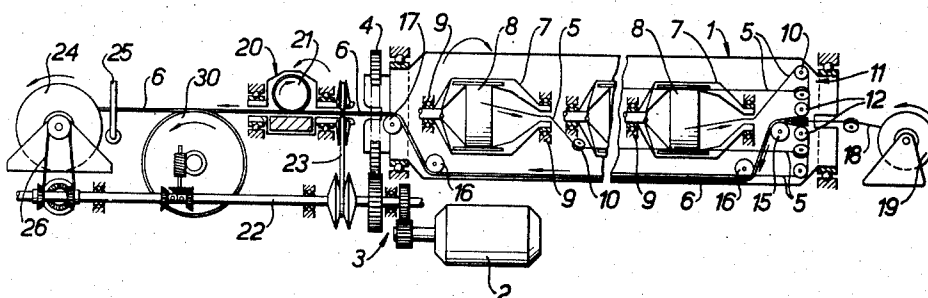
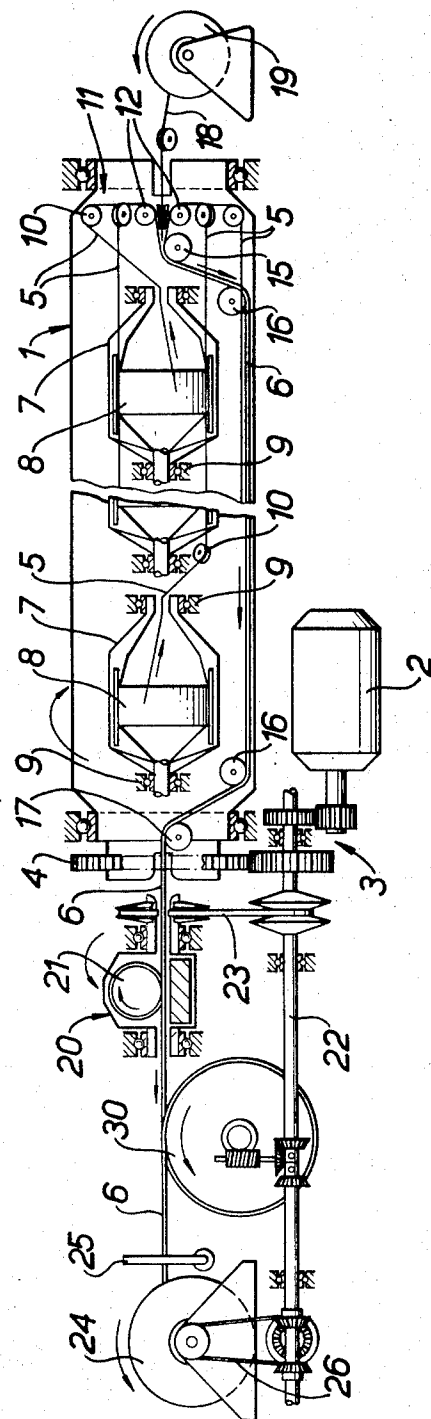


FIG. 1.



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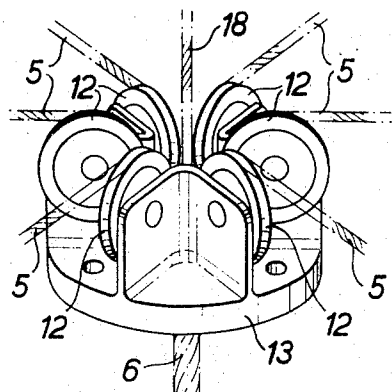


FIG. 2.

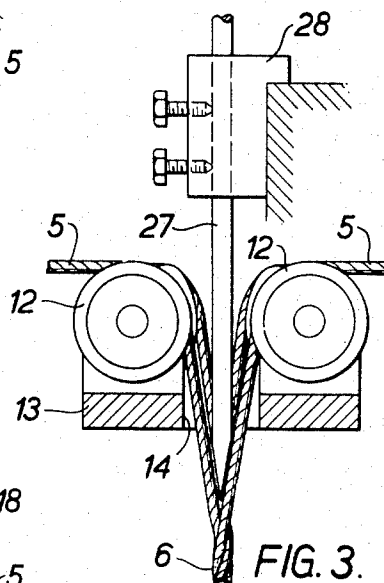


FIG. 3.

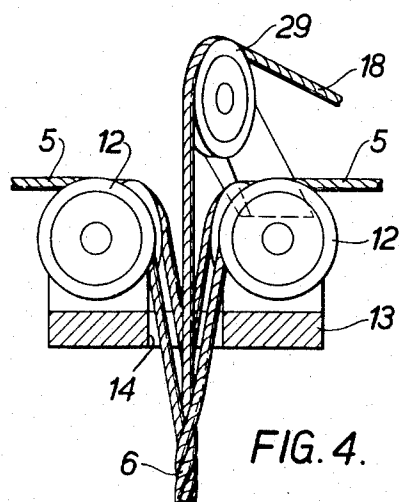


FIG. 4.

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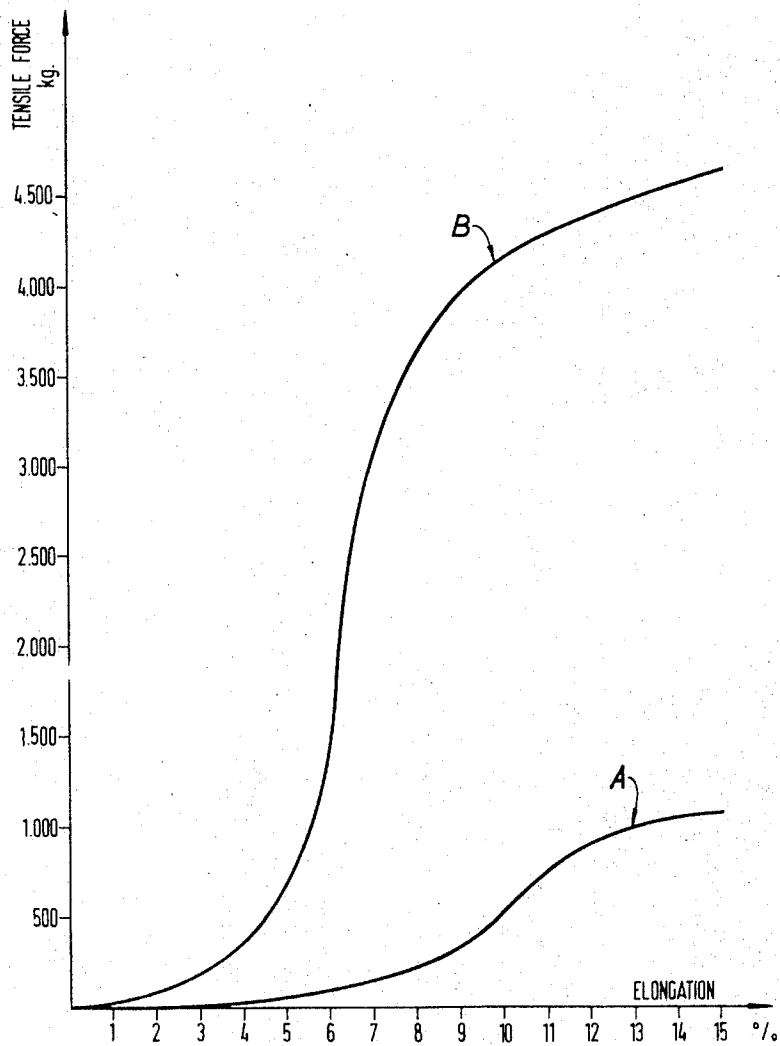


FIG. 5.

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METHOD AND APPARATUS FOR MANUFACTURE OF STRANDS AND CABLES

SUMMARY OF THE INVENTION

This invention relates to the manufacture of strands or cables made of filamentary material, which filamentary material will usually be metal wire but could be non-metallic. A strand is defined as being at least two filaments twisted together, while a cable is defined as being at least two strands twisted together. It is a primary object of the invention to provide an improved method and apparatus for assembling and twisting together the elements of a strand or cable, to produce strands and cables having a high capacity for elastic elongation when tensioned, and thus high resistance to fatigue. Such strands and cables are particularly intended for use as reinforcing elements in flexible sheet material, e.g. of natural or synthetic rubber, for making vehicle tires, conveyor belts and the like.

Viewed from one aspect the invention provides a method of making a strand or cable comprising two or more elements twisted together, such method including the steps of feeding each of said elements in the same direction on a common axis from supply means therefore, leading the respective elements to guide means offset from said axis and carried by a rotary device rotating about said axis and relatively to said supply means whereby each of the elements is itself twisted before the elements are brought together, bringing the elements together on the said axis, and delivering the elements along said axis, in the direction opposite from their direction of feed, to receiving means relative to which said rotary device rotates, whereby the elements are twisted together to form a strand or cable by the relative rotation of said rotary device and said receiving means.

Viewed from another aspect the invention provides apparatus for making a strand or cable comprising two or more elements twisted together, by the method set forth above, comprising means for mounting a supply of each said element for feeding of the elements in the same direction on a common axis, element guide means carried in positions offset from said axis by a rotary device arranged to be driven in rotation about said axis and relatively to said element supply means whereby, in operation, each of said elements itself is twisted in its passage from its supply to said guide means and before the elements are brought together, further guide means carried by the said rotary device and arranged to bring the said elements together on the said axis and to deliver the elements along the axis, in the opposite direction from their said direction of feed, to receiving means relative to which the said rotary device is arranged to rotate in operation, whereby the elements are twisted together to form a strand or cable by the relative rotation of said rotary device and said receiving means.

Twisting of the elements of the strand or cable about themselves prior to bringing the elements together and twisting them about one another to form the strand or cable produces a strand or cable having a much higher capacity for elastic elongation than would be the case if the primary twisting of the individual elements were to be omitted. The method and apparatus set forth above enables this operation to be carried out in a simple and reliable manner.

Preferably the reversal of the direction of movement of the said elements relative to the said axis takes place before the elements are brought together.

The said receiving means is preferably arranged to rotate about the said axis in the opposite direction from the said rotary device, and may then be constituted by a device for removing the residual torsion from the strand or cable and straightening it.

In a preferred embodiment of the apparatus of the invention the said element supply mounting means comprises a plurality of devices for mounting respective reels of said elements, which devices are fixed against rotation in operation.

The said rotary device may be of any convenient construction but in a preferred embodiment it comprises a housing enclosing said element supply mounting means.

The said guide means for the elements of the strand or cable preferably includes an array of rotary guide members arranged around the axis of said rotary device to bring the said elements together on said axis in operation. Such array of guide members preferably includes a unitary assembly of such guide members mounted on a base member having a central aperture around which said guide members are arranged so as to guide the said elements into and through said aperture in operation, said aperture having its axis coincident with the axis of said rotary device.

The provision of such an array of guide members for the said elements permits the formation of strands or cables having a comparatively high number of elements, e.g. six to eight elements; each element now being fed via its own guide member the bringing together of such a comparatively high number of elements may be achieved in a controlled fashion, which is difficult or indeed impossible when using known apparatus in which the respective elements are fed directly from their respective supplies to a single guide pulley on which they are brought together.

Preferably the said further guide means includes a further rotary guide member arranged immediately downstream of the said aperture, with its guiding surface tangential to the axis of said rotary device, to receive and guide the elements as they pass through the said aperture. Additional rotary guide members may then be arranged in sequence downstream of said further guide member to guide the assembly of elements along a path offset from the axis of the rotary device, so as to by-pass said element supply mounting means, and then back on to said axis for delivery to said receiving means.

When the rotary device comprises a housing as aforesaid the said array of guide members may be mounted within the said housing adjacent one end thereof, and the said additional guide members may then include ones mounted from a side wall of the housing to define the said offset path of the assembly of elements.

Preferably the apparatus includes means for feeding a further element of the strand or cable into the center of the first-mentioned elements as the latter are brought together, to form a core element of the strand or cable. Such further element may be brought from the element supply means already mentioned or from another supply separate from the apparatus.

Various further and more specific purposes, objects, features and advantages will clearly appear from the detailed description given below taken in connection with the accompanying drawings which form part of this specification and illustrate merely by way of example an embodiment of apparatus according to invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following description and in the claims, parts will be identified by specific names for convenience, but such names are intended to be as generic in their application to similar parts as the art will permit. Like reference characters denote like parts in the several figures of the drawings in which:

FIG. 1 is a somewhat diagrammatic view, partly in side elevation and partly in section, of an apparatus for making strands or cables according to the invention;

FIG. 2 is a perspective view of a unitary assembly of rotary guide members incorporated in the apparatus of FIG. 1;

FIG. 3 illustrates the cooperation, with the device of FIG. 2, of means providing a false core whilst the elements of a cable are being brought together;

FIG. 4 is similar to FIG. 3 but shows the manner of incorporating a core element in such cable; and

FIG. 5 is a diagram illustrating the capacity for elastic elongation of two cables made in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, the apparatus according to the invention comprises a rotary device in the form of an elongate cylindrical drum-like housing 1 mounted for driven rotation about its axis in the clockwise direction as seen from the right-hand end of the figure. Drive to the rotary drum is from a motor 2 via a gear train 3 to a toothed wheel 4 on the left-hand end of the drum.

The drum 1 houses mounting means for supplies of strand elements 5 which are to be twisted together to form a cable 6. Such mounting means comprise a plurality of housings 7 for spools 8 of such strands; it will be seen that the central part of the drum, and thus some of the housings 7 therein, is cut away in the drawing. The housings 7 are mounted in bearings 9 supported from the drum 1 so that the housings do not rotate when the drum rotates.

Each of the housings 7 is so arranged that the strand which it carries exits therefrom on the axis of rotation of the drum 1. Each strand 5 is then led away from such axis and passes over guide means in the form of a grooved pulley 10 which is offset from the axis of the drum and is mounted on the latter to rotate therewith. It will thus be understood that, in operation, rotation of each of the pulleys 10 about the point at which the strand 5 exits from its spool housing on the axis of the drum 1 causes the strand to be twisted about its own axis, once for each revolution of the drum. The strand supplies will, of course, be so arranged that this twisting is in the sense which will tighten the individual filaments of the strand.

All of the strands 5 pass to an array of guide pulleys, generally indicated at 11, mounted at the right-hand

end of the drum 1 for rotation therewith. All of the guide pulleys of such array have their general planes extending radially of the drum axis so as to guide the strands 5 directly towards such axis once the strands have passed over the pulleys. It will be observed that the guide pulley 10 which receives the strand 5 from the spool housing 7 at the right-hand end of the drum 1 also constitutes one of the array of guide pulleys just mentioned.

The array of guide pulleys 11 includes a central unitary assembly of such pulleys, two of which are visible at 12 in FIG. 1. Six of such pulleys 12 are provided in this embodiment of the invention and are mounted on a base plate 13 as shown in FIG. 2. The base plate 13 is secured to the body of the drum 1 to rotate therewith, and is formed with a central aperture 14 (FIGS. 3 and 4) which is circular and has its axis coincident with the rotational axis of the drum 1.

The assembly of guide pulley 12 serves to bring the individual strands 5 together on the rotational axis of the drum 1, and at the same time the direction of movement of the strands is reversed compared with the direction in which the strands approach the array of guide pulley 11, such reversal being carried out partly by the outer ones of the array of pulleys 11 and partly by the inner assembly of pulleys 12.

At this point a core strand 18 is led into the center of the assembly of strands as they are brought together, such core strand being supplied from a separate spool 19 mounted externally of the drum 1.

A further guide pulley 15 is arranged immediately downstream of the assembly of pulleys 12 with its guide surface tangential to the rotational axis of the drum. Having been brought together on the drum axis as just mentioned, the assembly of strands 5 passes over the guide pulley 15. By now the strands are being twisted together into the form of the cable 6 by means acting on them further downstream and which will be described later. Having passed around the guide pulley 15 the cable is led away from the axis of the drum 1 and over a series of additional guide pulleys 16 mounted on the side wall of the drum so that the cable now travels back along the drum in a path offset from the axis thereof, so as to by-pass the strand mounting housings 7.

Having reached the left-hand end of the drum, as seen in FIG. 1, the cable is led back on to the axis of the drum and around a final guide pulley 17 which is mounted on the drum to rotate therewith and has its guiding surface tangential to the drum axis.

The cable now passes to receiving means in the form of a device 20 which is driven in rotation in the opposite direction from the drum 1. This device is of a kind which is adapted to remove residual torsional stresses from the cable and to straighten it, the cable passing around a roller 21 in such device at the same time as it is rotated about its axis. As a result, the strands of the cable are twisted together by the rotation of the drum 1 relative to the receiving device 20, and such twisting effect is in fact transmitted as far back as the point in the apparatus at which the strands 5 are first brought together, as previously mentioned. This latter feature is illustrated in FIGS. 2 to 4, where it will be seen that twisting of the strands 5 about one another begins immediately downstream of the unitary assembly of guide pulleys 11.

The rotary device 20 is driven from the motor 2 via a shaft 22 and a belt drive 23.

From the device 20 the cable passes around a grooved wheel 30 driven from the shaft 22. The cable then passes to a take-up spool 24 via a laying device 25 which reciprocates lengthwise of the spool 24 to lay successive layers of the cable on the spool. The take-up spool 24 is driven from the shaft 22 via a belt drive 26.

The pull for drawing the respective strand elements 5 from their supply spools and subsequently for drawing the assembled cable through the apparatus comes from the driven wheel 30 which frictionally engages the cable as the latter passes around the wheel.

FIG. 3 shows an alternative arrangement in which the core strand 18 is omitted, a pointed rod 27 forming a false core element being mounted on the axis of the drum 1 to rotate therewith. The rod 27 is mounted in a mounting block 28 so as to be adjustable lengthwise for optimum effect.

FIG. 4 shows another arrangement, in which the core strand 18 is led from a supply spool mounted in the drum 1 like the supply spools for the strands 5, the strand 18 passing over a guide pulley 29 rotatable with the assembly of guide pulleys 11. In this embodiment the core strand will, like the strands 5, be twisted about itself before incorporation in the cable.

In both FIG. 3 and FIG. 4 two of the six strands 5 making up the cable are omitted for the sake of clarity of illustration.

It will thus be understood that, in cable made in the apparatus and by the method of the invention, each individual strand 5 will be twisted about its own axis by one full rotation for every rotation of the drum 1, and furthermore each of the strands will be again twisted by one further rotation about the axis of the assembled cable for every rotation of the drum. As a result, a very substantial shortening of the pitch of each of the individual strands is achieved, which gives the strands, and thus the cable, a high capacity for elastic elongation when tensioned, and thus a high resistance to fatigue. By appropriate choice of the make-up of the strands forming the elements of the cable the tensile resistance, capacity for elongation, and flexibility of the resulting cable can be chosen as desired.

FIG. 5 illustrates the tension-elongation characteristics of two cables, illustrated by curves A and B, made in accordance with the invention. The cable of curve A has a 3×7×0.2mm. core surrounded by six strands each of 7×0.40 mm., and has a large capacity for elastic elongation under a small tensile force. The cable of curve B has a 3×7×0.50mm. core surrounded by 6 strands each of 7×0.31 mm., and undergoes a smaller degree of elastic elongation for a substantially greater tensile force than the cable of curve A.

It will be appreciated that although the apparatus illustrated in the drawings has been described relative to the manufacture of a cable made up of strands, it can also be used to make a strand made up of individual filamentary elements, e.g. wires.

Strands and cables made in accordance with the invention can if desired be wrapped with one or more metallic or non-metallic protective helical strips, and/or be provided with a metallic or non-metallic protective coating. The core strand or filament, if provided, need not always be of metal even if the outer elements of the strand or cable are metallic; thus it could be of rubber, for example, if desired.

It will thus be seen that the invention provides a method and apparatus whereby strands and cables incorporating a comparative large number, e.g. six to eight elements, can be put together in a simple and reliable fashion whilst being twisted in such a manner as to have a high capacity for elastic elongation under tension. Such strands and cables are particularly suitable for incorporation as reinforcement elements in flexible sheet material, for example for making vehicle tires and conveyor belts, but may of course also be employed in numerous other fields.

While the invention has been described and illustrated with respect to certain preferred examples which give satisfactory results, it will be understood by those skilled in the art after understanding the principle of the invention, that various changes and modifications may be made without departing from the spirit of the invention.

What is claimed is:

1. A method of making a strand or cable comprising at least two multifilament elements twisted together, comprising the steps of feeding each of said elements in the same direction on a common axis from supply means therefor, leading the respective elements to guide means offset from said axis and carried by a rotary device rotating about said axis and relatively to said supply means whereby each of the elements is itself twisted before the elements are brought together, passing the elements about guide means to reverse the direction of feed, subsequently bringing the elements together on the said axis, and delivering the elements along said axis, in the direction opposite from their direction of feed, to receiving means relative to which said rotary device rotates, whereby the elements are twisted together to form a strand or cable by the relative rotation of said rotary device and said receiving means.

2. Method according to claim 1, wherein the said receiving means rotates about the said axis in the opposite direction from the said rotary device.

3. Method according to claim 1, including the step of removing the residual torsion from the strand or cable and straightening the same.

4. Method according to claim 1, including the step of feeding a further element of the strand or cable into the center of the first-mentioned elements as the latter are brought together, to form a core element of the strand or cable.

5. Apparatus for making a strand or cable having at least two multifilament elements twisted together, comprising a plurality of element supply spools, means for coaxially mounting said spools for feeding of the elements in the same feed direction on a common axis, element guide means carried in positions offset from said axis, a rotary device carrying said element guide means into said positions and arranged to be driven in rotation about said axis and relatively to said spools whereby, in operation, each of said elements is itself twisted in its passage from its respective spool to said guide means and before the elements are brought together, further guide means carried by the said rotary device and arranged to bring said elements together on said axis, receiving means located in the path of said elements from said further guide means and receiving said elements from said further guide means along said axis, in the opposite direction from their said direction

of feed, said receiving means rotating in a direction relative to the direction in which said rotary device is arranged to rotate in operation, whereby the elements are twisted together to form a strand or cable by the relative rotation of said rotary device and said receiving means.

6. Apparatus according to claim 5, wherein said rotary device comprises a housing enclosing said element supply mounting means.

7. Apparatus according to claim 5, including means for feeding a further element of said strand or cable into the center of said first-mentioned elements as the latter are brought together, to form a core element of the strand or cable.

8. Apparatus according to claim 7, wherein said array of rotary guide members is mounted within said housing adjacent one end thereof.

9. Apparatus according to claim 5, wherein said guide means includes an array of rotary guide members arranged around the axis of said rotary device to bring said elements together on said axis in operation.

10. Apparatus according to claim 9, wherein said array of rotary guide members includes a unitary assembly of such guide members, a base member for mounting and supporting said unitary assembly of guide members and having a central aperture around which said guide members are arranged so as to guide the said elements into and through said aperture in operation, said aperture having its axis coincident with the axis of said rotary device.

11. Apparatus according to claim 10 wherein the said further guide means includes a further rotary guide member arranged immediately downstream of the said

aperture, said further rotary guide member having a guiding surface tangential to the axis of said rotary device for receiving and guiding the elements as they pass through said aperture.

12. Apparatus according to claim 11, wherein said further guide means includes additional rotary guide members arranged in sequence downstream of said further guide members to guide said elements when assembled along a path offset from the axis of the rotary device for by-passing said element supply mounting means, said assembled elements moving then back on to said axis for passage to said receiving means.

13. Apparatus according to claim 12, wherein said array of rotary guide members is mounted within said housing adjacent one end thereof.

14. Apparatus according to claim 13 wherein the said additional guide members include ones mounted from a side wall of the housing for defining said offset path of the assembly of elements.

15. Apparatus according to claim 14, wherein said receiving means comprises a device for removing the residual torsion from the strand or cable and straightening the same, said device rotating about the same axis as said rotary device but in opposite direction to the latter.

16. Apparatus according to claim 5, wherein said receiving means comprises a device for removing the residual torsion from the strand or cable and straightening the same, said device rotating about the same axis as said rotary device but in the opposite direction to the latter.

17. Apparatus according to claim 5 and further including means to fix said spools against rotation.

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