

Jan. 29, 1963

K. H. INDERFURTH ETAL

3,075,794

TENSION KNOT AND METHOD OF FORMING SAME

Filed April 25, 1961

3 Sheets-Sheet 1

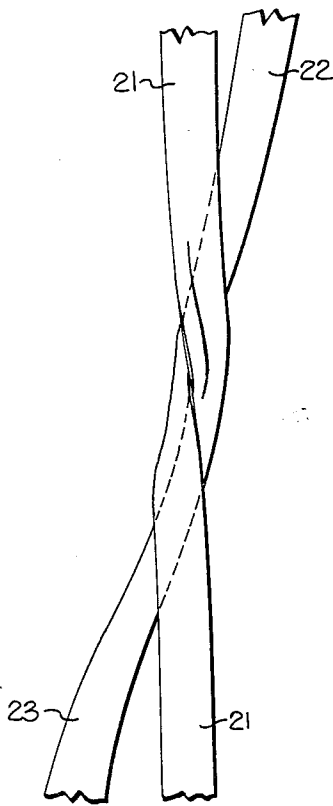
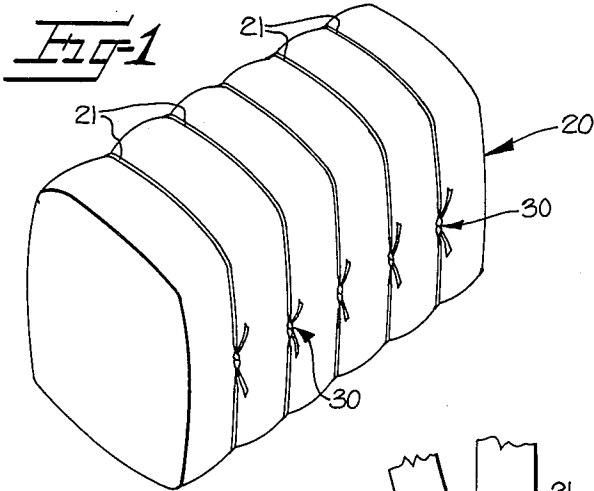


FIG-2

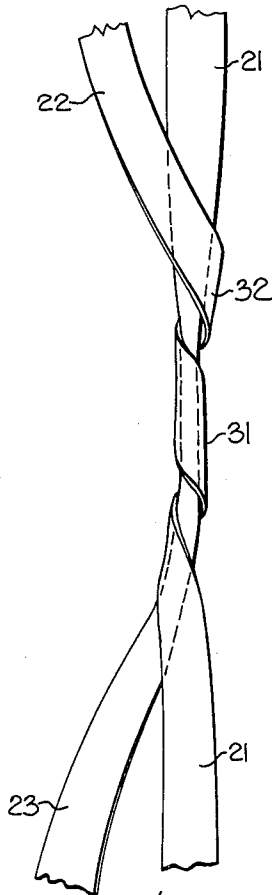


FIG-3

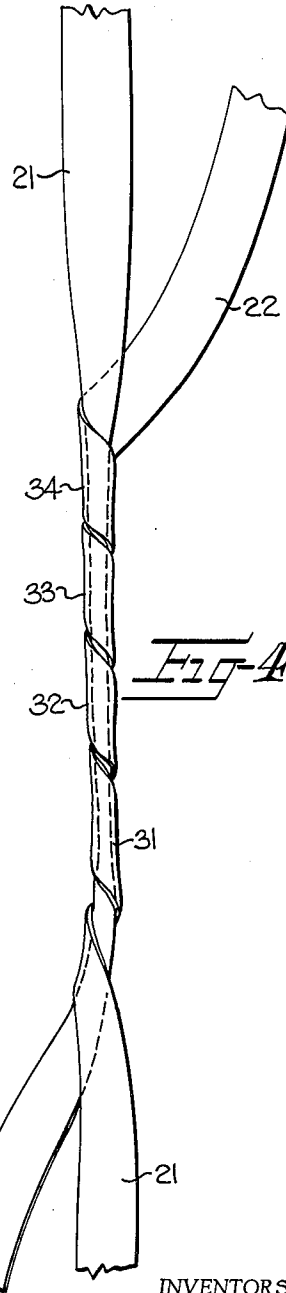


FIG-4

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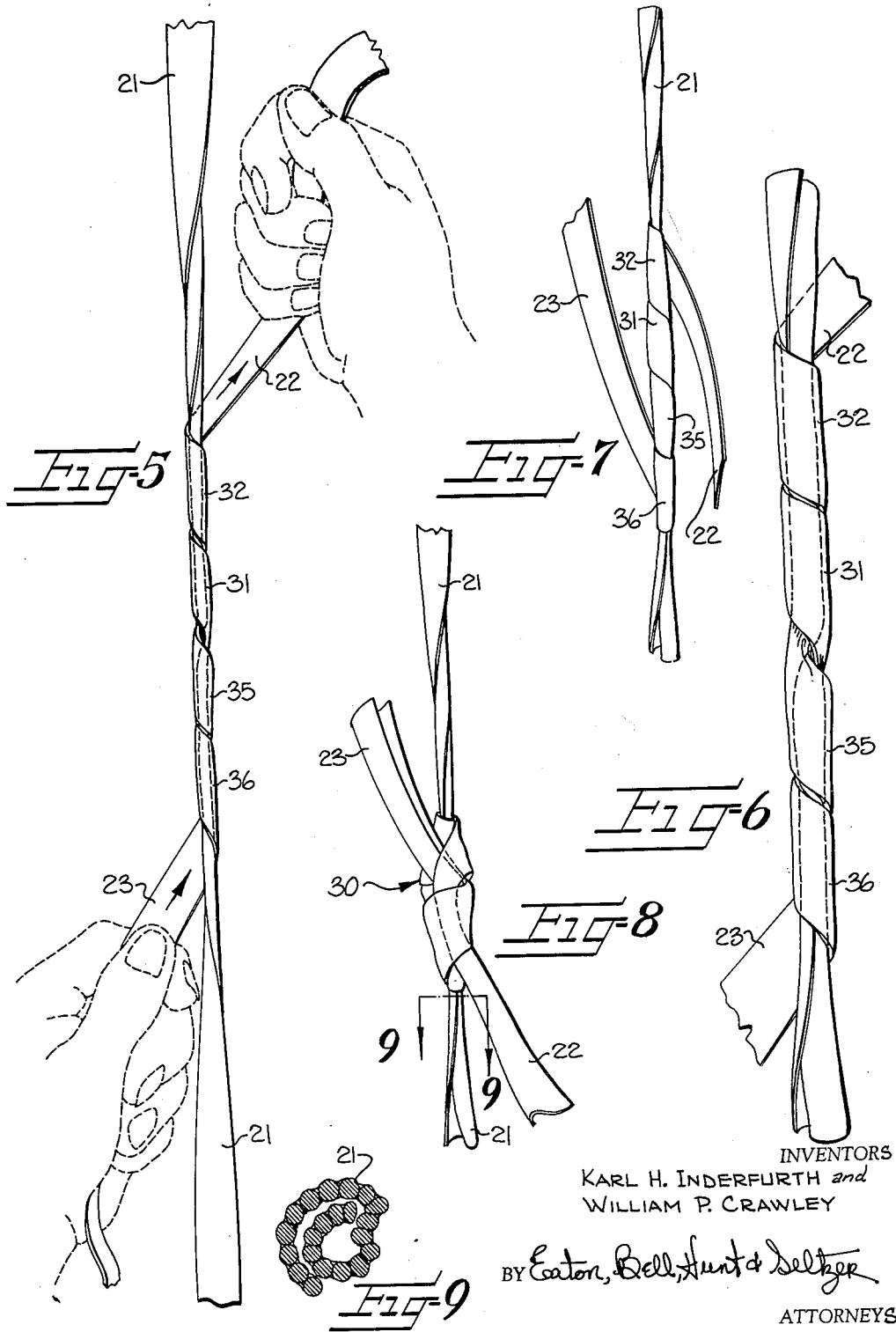
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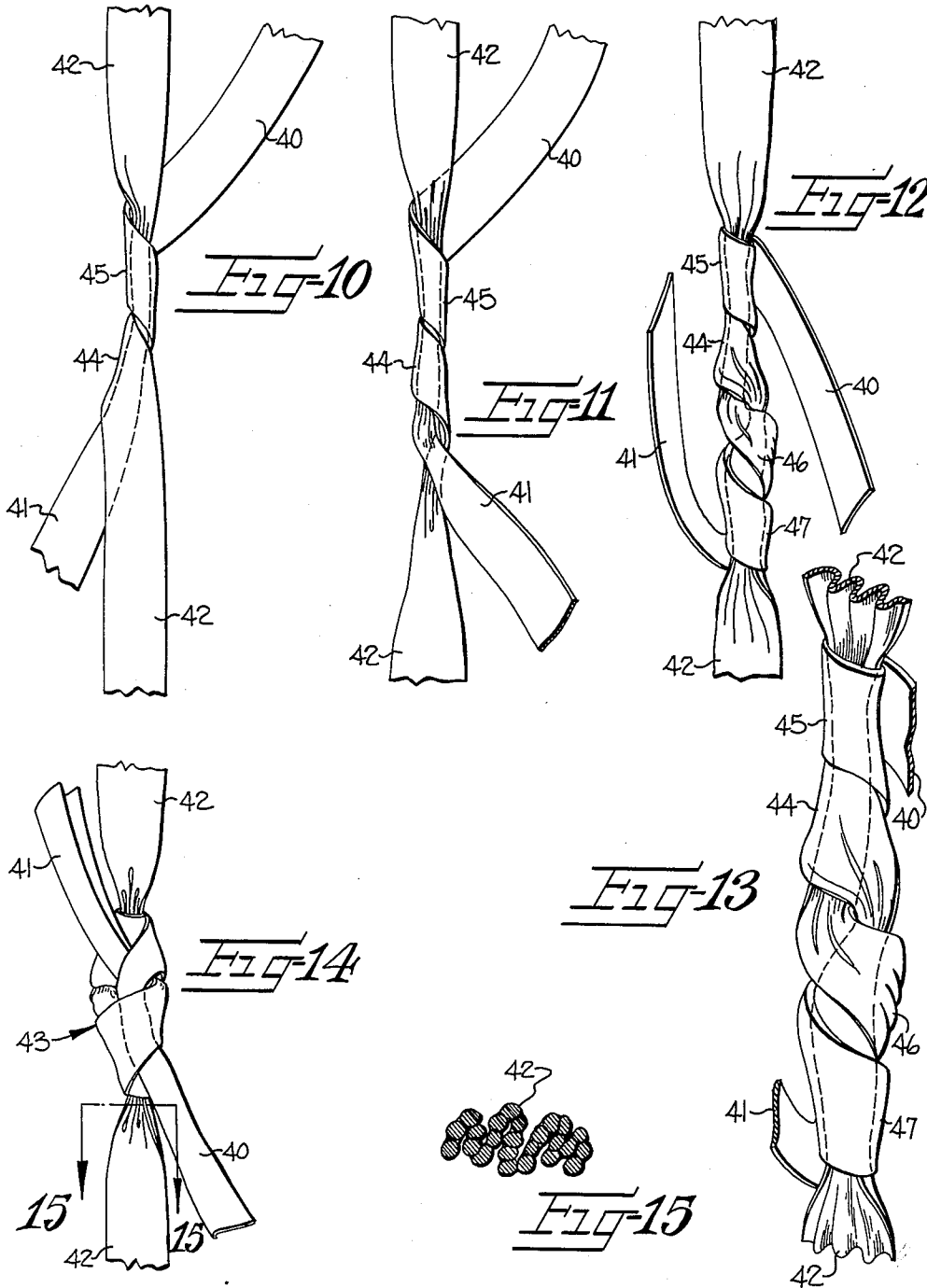
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Filed April 25, 1961

3 Sheets-Sheet 3



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3,075,794

**TENSION KNOT AND METHOD OF FORMING SAME**

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 Filed Apr. 25, 1961, Ser. No. 105,386  
 7 Claims. (Cl. 289-1)

The present invention relates to a novel knot for uniting opposite end portions of a web of ribbon-like material and the method of forming the same.

Webs of ribbon-like textile material have been used in a variety of areas for some time as a substitute for conventional cordage and metal bands for the banding of containers and in the packaging of certain materials. However, such ribbon-like materials heretofore available were not sufficiently strong to permit their being used as a substitute for metal bands in the baling of textile fibers, cloth and the like wherein the baling material was compressed to a high degree and thereby had considerable inherent tendency to expand.

Recently, an improved web of ribbon-like textile material has been developed which has considerably higher tensile strength with tests indicating that the degree of tensile strength was sufficiently great to permit the same to be used as a substitute for metal bands in the baling of various materials.

However, it was soon learned that conventional knots could not be employed for securing opposite ends of this material together since the knots used resulted in a shearing action of the web material in the knot area, thus not permitting the tensile strength of the web material to be fully utilized and thereby resulting in bands of this material rupturing and breaking under the expansive forces of the baled material shortly after being formed.

In an attempt to overcome the rupturing problems of this ribbon-like material, various modifications were made in conventional knots, mainly taking the form of increasing the number of wrappings. These attempts also resulted in failure and continued rupturing and breaking of the web in the knot area occurred.

Another problem encountered in the use of conventional knots to unite the opposite ends of the improved web was a bunching up of the web in the central portion of the knot. This bunching up in the central portion allowed only a relatively small amount of slippage when the compressive force was removed and therefore the slippage in the knot absorbed only a small amount of the initial expansion of the bale. This resulted in a high shearing force being maintained in the knot area of the web at all times which materially increased the chances of breakage. Also, the small amount of slippage in the conventional knots had been taken up by initial expansion of the bale, and thus there was no further or subsequent slippage which could absorb a portion of the added force applied to the web due to dropping or other rough handling of the bale.

The present invention was developed to obviate the aforementioned difficulties encountered in the use of the improved web for baling purposes. The knot of the present invention avoids the shearing problem by causing the portions of the web within and immediately adjacent to the loops to be rolled upon themselves and thus approach circular form in cross section. Also, the knot of the present invention allows initial slippage to absorb some of the initial expansion of the compressed bale and subsequent slippage to absorb some of the force applied to the web because of dropping of the bale or other rough handling.

It is therefore an object of the present invention to

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provide a novel knot for uniting opposite end portions of a web of ribbon-like material and a method of forming the same wherein the aforementioned difficulties are not encountered since the portions of the web within and immediately adjacent to the loops of the knot are caused to assume somewhat circular form in cross section thereby preventing the edges thereof from cutting into the loops of the knot and allowing both initial and subsequent slippage.

A more specific object of the present invention is to provide a novel knot and method of forming the same wherein a plurality of overhand loops are formed around a first end portion of the web by a second end portion and the free ends thereof are tied together with the portions of the web within and immediately adjacent to the overhand loops being rolled into somewhat circular form in cross section to prevent the edges thereof from cutting into the loops of the knot and wherein the thus formed knot allows at least some initial and subsequent expansion of the bale or container.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which—

FIGURE 1 is an isometric view showing a bale being encircled by the aforementioned improved web of ribbon-like material with the opposite end portions of the web being secured together by a knot embodying the features of the present invention;

FIGURES 2 through 5 are enlarged fragmentary views illustrating steps in the novel method of tying the knot of the present invention;

FIGURE 6 is a further enlarged fragmentary view of the medial portion of the structure shown in FIGURE 5;

FIGURE 7 is a fragmentary view illustrating still another step in the novel method of forming the knot of the present invention;

FIGURE 8 is a fragmentary view of the completed knot of the present invention;

FIGURE 9 is an enlarged section taken substantially along line 9-9 in FIGURE 8;

FIGURES 10 through 14 are similar to FIGURES 2 through 8 and show for purposes of comparison an experimental knot and the method of forming the same wherein the ends of the web material have been individually wrapped around each other with the resulting formed knot lacking the desired characteristics of the knot of the present invention; and

FIGURE 15 is an enlarged section taken substantially along line 15-15 of FIGURE 14.

Referring to the drawings and more particularly to FIGURE 1, there is shown a bale 20 which is bound with a web of ribbon-like material 21 having the aforementioned high tensile strength and which has the opposite ends thereof secured together by a knot 30 embodying the features of the present invention.

Knot 30 is formed in opposite end portions 22, 23 of web 21 to unite the same together. The first step in the formation of knot 30 is to pass end portion 22 of web 21 across above end portion 23 and then across beneath the same to form a first overhand loop 31. End portion 22 is again passed across above and then across beneath end portion 23 to form a second overhand loop 32 and the procedure is repeated to form third and fourth overhand loops 33 and 34, respectively, with the loops formed being shown as arranged in a corkscrew-like manner and which loops may be positioned with a partial overlap if desired. It should be noted that as end portion 22 is passed around end portion 23, end portion 23 is folded or collapsed within

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the overhand loops 31, 32, 33, 34 causing the lateral dimension thereof to be reduced.

The number of overhand loops formed by passing end portion 22 around end portion 23 may be varied from at least two up to ten. However, it has been determined that better results are obtained if the number of loops do not exceed eight since tests have indicated some reduction in tensile strength of the knots formed with a greater number of loops. The reason for this appears to be due to the increased distance between the opposite end portions of the web prior to finally typing them together following the formation of the loops. This increased distance apparently imparts some distortion in the loops when the end portions of the web are drawn toward each other to be united to complete the knot. Thus, the preferred range of loops is two to eight.

Once the desired number of overhand loops have been formed, a pulling force is exerted on end portion 22, while end portion 23 is simultaneously relaxed, such that at least some of the overhand loops formed by end portion 22 around end portion 23 are unwrapped thereby imparting a rolling action or rotary movement to web 21 in the area within the overhand loops and immediately adjacent thereto. The rotary movement or rolling action of the portion of web 21 within and immediately adjacent to overhand loop 32 (FIGURE 5) causes the same to roll upon itself and to approach circular form in cross section. At the same time this rolling action causes the relaxed end portion 23 to form overhand loops 35, 36 which in effect replace the unwrapped loops. The free ends of end portions 22 and 23 are then drawn toward each other, which causes the same to be doubled back on themselves, and are tied together preferably by passing end portion 23 across above and then across beneath end portion 22 and drawing the thus formed loop tight to anchor the completed knot 30.

It is noted that the rolling of the web to approach circular form in cross section within the loops and adjacent thereto greatly reduces the surface area of the web and in effect transforms a flat ribbon-like material into a shape closely corresponding to conventional cordage. This change in shape is very important in offsetting the squeezing or pinching action being imparted to the web, particularly by the terminal loops defining opposite ends of the knot. With the surface area of the web presented being reduced while at the same time being substantially increased in cross-sectional area, there is little likelihood of the terminal loops exerting a shearing action thereon.

Also, the circular configuration of the web of the ribbon-like material within the overhand loops which are substantially flat, allows the loops to slip along the web therewithin when tension is applied to the web. The slippage serves to absorb some of the initial force and subsequent forces to prevent breakage of the web of ribbon-like material.

When loops 35 and 36 are formed by the rolling action, there is no abrupt change in direction of the end portions of the web between loops 31 and 35. On the contrary, close examination of the formed loops is necessary to determine where the change-over in direction took place. This feature is very important as will be brought out in greater detail later.

Referring now to FIGURES 10 through 15, these views are believed to be of value in clearly pointing up the novelty of the instant invention. As a matter of fact, these views are illustrative of a type of knot originally developed and used but which proved to be a failure under test conditions. The reasons for such failure will be more apparent once the characteristics of this formed knot are pointed out and compared with those characteristics previously described. Opposite end portions 40, 41 of a web of ribbon-like material 42, substantially the same as web 21, are united by a knot 43

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which lacks the features of the knot 30 of the present invention.

Knot 43 is formed by passing end portion 40 of web 42 across above and then across beneath end portion 41 to form an overhand loop 44 therearound. The same procedure is repeated to form a second overhand loop 45 around end portion 41. End portion 41 is then passed across above and then across beneath end portion 40 to form an overhand loop 46 thereabout. This procedure is repeated to form another overhand loop 47 around end portion 40. The end portions 40, 41 are then drawn toward each other and tied together preferably by passing end portion 41 across above and then across beneath end portion 40 and drawing the ends up tightly.

The resultant knot 43 lacks the desired characteristics of the knot of the present invention since the portions of the web within the loops are merely collapsed or squeezed upon themselves and are not caused to assume circular form in cross section as in knot 30 as previously described. Also, inasmuch as the end portions 40, 41 were individually wrapped around each other to form the overhand loops, a bunching up of the web in the central area of the knot results as is clearly indicated in FIGURE 13. The portions of the web of ribbon-like material within and immediately adjacent to the distal loops 45, 47 of knot 43 are not caused to approach circular form in cross section inasmuch as no rolling action or rotary movement is imparted thereto as was the case in the previously described knot and therefore the same is merely collapsed or squeezed together upon itself forming accordion-type folds therein as is indicated in FIGURE 15. When tension is applied to web 42, the accordion folds tend to become flattened thereby presenting an increased surface web area which in turn reduces the thickness of the web which results in the web being readily sheared by the squeezing or pinching action imparted thereto by the distal loops 45, 47. Also, since the web of ribbon-like material bunches up in the central portion of the knot, the loops have only a small amount of initial slippage.

This bunching up of the web in the central portion of the knot, previously referred to, is primarily caused by the abrupt change in direction of the end portions of the web which form loops 44, 46. The cross over point of the web portions between loops 44, 46 has resulted in a very weak area being formed, with many tests indicating that this area readily ruptures and breaks under tension. The reason for this weakness is apparently due to the shearing action of the cross over web portions on each other, which shearing action is aggravated by the fact that the web portions have not been reduced to approach circular form in cross section.

Referring now to the loops 31 and 35 of knot 30, it will be apparent that the rolling action eliminates the acuteness of the angle of the web portions at the cross over point between the loops 31, 35 in addition to causing the web portions to approach circular form in cross section. This elimination of the acuteness of the angle of cross over has resulted in virtually eliminating the aforementioned shearing action of the web portions.

It is therefore believed apparent that a novel knot for uniting opposite end portions of a web of ribbon-like material is provided wherein there are no abrupt changes in web portions at the cross over and wherein the portions of the web within and immediately adjacent to the loops of the knot are caused to approach circular form in cross section to prevent the loops thereof from cutting into the encircled portions of the knot and rupturing the web.

In the drawings and specification there has been set forth a preferred embodiment of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

We claim:

1. A knot for uniting first and second opposite end portions of a web of ribbon-like material of indefinite length, said first end portion being wrapped around said second end portion to form at least one overhand loop with the portion of said second end portion within and adjacent to the overhand loop being twisted in one direction said second end portion being wrapped around said first end portion to form at least one other overhand loop with the portion of said first end portion within and adjacent to the overhand loop being twisted in the opposite direction, the portions of the web within and adjacent to the overhand loops having a substantially cylindrical formation to prevent the edges thereof from tending to cut through the loops and thereby weakening the same, the end portions being doubled back upon themselves and each of said end portions passing over and then under the other end portion to thus complete the knot.

2. A knot for uniting first and second opposite end portions of a web of relatively stiff ribbon-like material of indefinite length, said first end portion being wrapped around said second end portion to form a plurality of overhand loops with the portion of said second end portion within and adjacent to the overhand loops being twisted in one direction, said second end portion being wrapped around said first end portion to form a plurality of overhand loops with the portion of said first end portion within and adjacent to the overhand loops being twisted in the opposite direction, the portions of the web of ribbon-like material within and adjacent to the overhand loops having a substantially cylindrical formation to prevent the edges of the web from cutting into the loops and to allow both initial and subsequent slippage, the first and second end portions being doubled back upon themselves and each of said end portions passing over and then under the other end portion to thus complete the knot.

3. A method of forming a knot in two end portions of relatively stiff ribbon-like material comprising the steps of placing the said end portions in juxtaposition while wrapping one of the end portions around the other end portion at least twice, exerting a lateral pull on said one end portion to cause an unwinding of the same from about the other end portion while permitting said other end portion to become wrapped about said one end portion and then tying said end portions together.

4. A method of forming a knot in two end portions of relatively stiff ribbon-like material comprising the steps of placing the said end portions in juxtaposition while wrapping one of the end portions around the other end portion at least twice, exerting a lateral pull on said one end portion to cause an unwinding of the same from about said other end portion while at the same time permitting said other end portion to become wrapped about said one end portion and thereby twisting the wrapped portion of said other end portion in one direction and thereby twisting said one end portion in the opposite direction into substantially cylindrical formations, and then tying said end portions together.

5. A method of forming a knot in two end portions of relatively stiff ribbon-like material of indefinite length comprising the steps of holding one of the end portions of the web while wrapping the other end portion of the web therearound to form a predetermined number of loops

while causing the web within the loops to collapse and fold upon itself, exerting a lateral pulling force on the other end portion of the web while relaxing the one end portion of the web to cause at least some of the loops to become unwrapped while permitting said one end portion to become wrapped about the other end portion of the web and while causing the portions of the web within and immediately adjacent to the loops to roll upon themselves to reduce the cross-sectional configuration thereof to approach circular form and then drawing the first and second end portions toward each other and tying them together by passing each end portion under the other in an opposite direction to form a knot.

6. A method of forming a knot in a web of relatively stiff ribbon-like material of indefinite length having first and second end portions comprising the steps of passing the second end portion of the web around the first end portion to form a predetermined number of loops while causing the web within the loops to collapse and fold upon itself, exerting a lateral pulling force on the second end portion of the web while relaxing the first end portion of the web to cause at least some of the loops to become unwrapped and thereby imparting a rolling action to the portion of the web within and immediately adjacent the loops, the rolling action imparted to the second end portion adjacent the loops causing new loops to be formed therearound by the relaxed first end portion of the web, the rolling action also twisting the portion of the second end portion within and immediately adjacent to the new loops in one direction and twisting the portion of the first end portion within and adjacent to the loops in the opposite direction to reduce the cross-sectional configuration thereof to approach circular form and then drawing the first and second end portions toward each other and tying them together by passing each end portion under the other in an opposite direction to form a knot.

7. A method of forming a knot for uniting first and second opposite end portions of a web of relatively stiff ribbon-like material of indefinite length comprising the steps of placing the end portions in overlapping relation, passing the second end portion around the first end portion to form four overhand loops while causing the first end portion within the loops to collapse and fold upon itself, exerting a lateral pulling force on the free end of the second end portion while relaxing the free end of the first end portion to cause two of the overhand loops formed around the first end portion to become unwrapped and thereby imparting a rolling action to the portions of the first and second end portions within and immediately adjacent to the remaining loops and thereby causing such portions of the first and second end portions to be twisted in opposite directions and to approach circular form in cross-section, the rolling action of the second end portion causing the free end of the first end portion to become wrapped therearound to form two overhand loops therearound, then drawing the end portions toward each other and tying the same together by passing each end portion under the other in an opposite direction to form a knot.

#### References Cited in the file of this patent

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