Jan. 3, 1956 L. S. TOBIAS 2,729,055

COMPOSITE CORD

Filed May 7, 1952

Fig. 1.

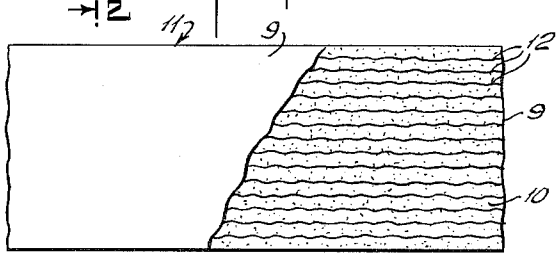


Fig. 2.

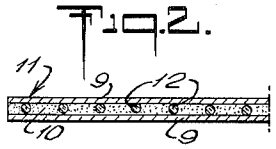


Fig. 7.

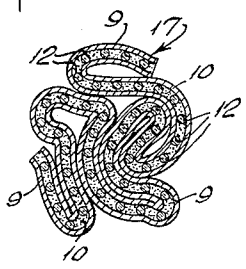


Fig. 3.

Fig. 4.

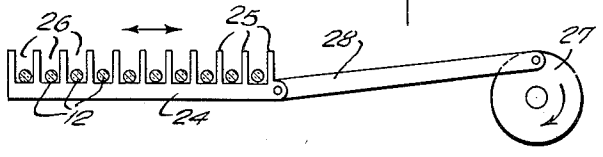


Fig. 6.

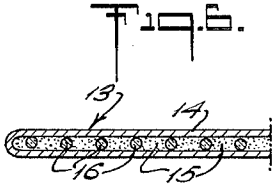
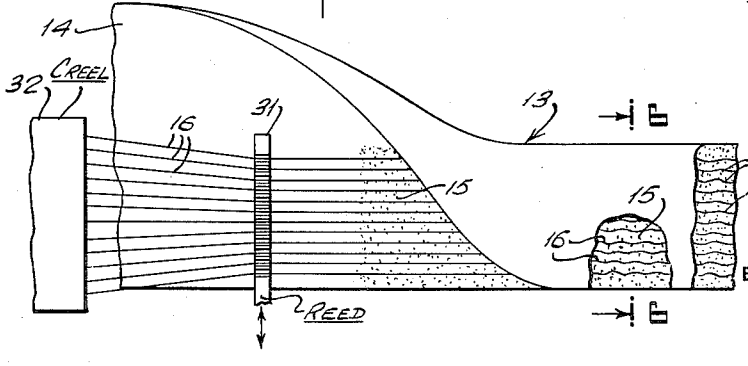


Fig. 5.



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COMPOSITE CORD

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Application May 7, 1952, Serial No. 286,476

10 Claims. (Cl. 57—154)

This invention relates to new and useful improvements in composite cords, and particularly seeks to provide a novel card cord fabricated from web material enclosing strands of another material, so combined therewith as to obtain the cumulative tensile strength of both components.

High strength cord such as binder and baler twine has been made for many years from vegetable fibers such as sisal or henequen. The cord strength is generally determined by the tensile strengths knotted and unknotted. The knot strength of the vegetable fiber twines is generaly about 60% or less of the unkotted tensile strength of the twine due to extra strains and stresses in and about the knots. Baler twine, for example, generally demands a minimum knot strength of 150 pounds and thus requires an unknotted tensile strength of about 250 pounds or more which necessitates a twine of 1/8" in diameter running about 225 feet per pound.

Many attempts have been made to produce a better cord for binder and baler twine, but they have failed for various reasons. Twisted paper stock alone could not overcome the inherent low tensile strength of paper even though the knot strength was 75% to 95% of the unknotted tensile strength. Multi-filament glass strands were found to have a relatively high tensile strength, but the knot strength is only about 5% to 10% of the unknotted tensile strength. Even by coating and twisting the glass strands the knot strength could only be raised to about 30% of the unknotted.

In my copending application Ser. No. 211,767, filed February 19, 1951, there is disclosed and claimed a composite cord in which the knot strength is about 70% of the unknotted tensile strength and which is formed by incorporating straight spaced parallel glass strands between two paper surfaces in such a manner as to prevent the glass strands from contacting each other when the cord is formed.

This invention is an improvement over that described in the above-mentioned application in that composite cords constructed in accordance with the present invention are so fabricated that full advantage of the tensile strength of the paper or other sheet backing material is utilized as well as that of the glass or other reinforcing strands.

In accordance with past practice a 1" wide composite cord was fabricated from 40 straight glass strands of about 4 lbs. tensile each or about 160 lbs. cumulative which were embedded within a 2" ribbon of paper of about 40 lbs. tensile strength doubled over the strands, but the tensile strength of the composite cord was close to 160 lbs., thus being evidently a function of the cumulative glass strands only. Even if the amount of paper is doubled the tensile strength of the composite cord remains the same. This particular relationship of tensile strength has been continually observed in numerous experiments in this type of composite cord.

This is evidently due to the fact that the inherent stretch of paper is far greater than glass. The stretch of a single glass filament (204 of which generally make a strand) is practically zero. When a plurality of filaments are twisted together to form a strand a certain amount of slack is imparted to the strand, depending on the number of twists per inch, the tension under which the filaments are twisted, the diameter of the strand, etc., but the stretch will generally be less than 1%. This twisting is maintained at a minimum because the tensile strength decreases with increased twisting due to breaking of the glass filaments from the extreme abrasion that they exert when rubbing against each other. On the other hand, the stretch in paper is relatively greater, especially in the machine direction which also has a greater tensile than the cross direction. The stretch of paper is relatively constant but influenced slightly by type of fibers, type of paper, chemical additives, papermaking methods, etc. This stretch is not an elastic one inasmuch as the paper does not regain its original shape when the stretching force is removed. A recommended paper for composite cord is unbleached wet strength kraft of 20# basis weight (weight of 500 sheets 24" x 36") having a stretch of about 2% to 3%. A typical tensile test on a 1" wide strip of this paper showed a break at 17.8 pounds. If two strips of the above tested paper were used in a composite cord, as is generally the practice, the available strength of the paper would, of course, be about 35.6 pounds.

In the composite cord already discussed the glass strands, having relatively little stretch, break before any appreciable tension is applied to the paper and thereafter the paper breaks. Of course, if the paper had the greater tensile strength the tensile of the composite cord would be the function of the tensile of the paper only.

I have discovered that the tensile strength of the composite cord will reflect the cumulative tensile strengths of the components if the stretch of the components is equalized by imparting stretch to one component to equal the natural stretch of the other component.

Therefore, it is an object of this invention to provide a composite cord having a tensile strength equal to the combined tensiles of the cord components.

It is an object of this invention to provide a composite cord of the character stated which has components with different degrees of stretch, but in which the less stretchable component has a stretch mechanically imparted thereto to equal that of the other component.

Another object of this invention is to provide a cord of the character stated which has a high tensile strength.

A further object of this invention is to provide a cord of the character stated which retains a high percentage of its unknotted tensile strength in the knotted condition.

It is also an object of this invention to provide a cord of the character stated which is about 50% lighter in weight than cord having a corresponding knot strength and made from conventional materials such as sisal or henequen.

An additional object of this invention is to provide a cord of the character stated which comprises a supporting web having a plurality of curvilinear strands in generally spaced parallel relationship bonded thereto and the whole twisted or otherwise compacted into a cord.

With these and other objects in view, the nature of which will be more apparent, the invention will be more fully understood by reference to the drawings, the accompanying detailed description and the appended claims.

In the drawings,

Fig. 1 is a broken top plan view of a composite tape constructed in accordance with this invention;

Fig. 2 is a transverse section taken along line 2—2 of Fig. 1;

Fig. 3 is a schematic view of one method for making the composite cord;

Fig. 4 is an enlarged fragmentary transverse section

taken along line 4—4 of Fig. 3 and shows somewhat schematically one means by which lateral reciprocation may be imparted to the reed;

Fig. 5 is a top plan view of a modified composite tape and shows somewhat schematically the formation of the tape;

Fig. 6 is a transverse section taken along line 6—6 of Fig. 5; and

Fig. 7 is an enlarged transverse section of a twisted composite cord.

Referring to the drawings in detail, this invention as illustrated is embodied in a laminated composite cord wherein the glass strands are embedded in spaced parallel curvilinear relationship in an adhesive between paper strips.

As shown in Figs. 1 and 2, a pair of paper ribbons **9, 9** enclose therebetween a layer of adhesive **10** to form a tape generally indicated at **11**. Embedded within the adhesive is a plurality of spaced parallel curvilinear glass strands **12** that are shaped like corrugated board or crimped paper. A slight modification is shown in Figs. 5 and 6 wherein a tape generally indicated at **13** is formed from a single ribbon of paper **14** folded over on itself to enclose a layer of adhesive **15** which has embedded therein a plurality of spaced parallel curvilinear strands **16**. The tape **11** (or **13**) is then twisted or otherwise compacted to form the composite cord generally indicated at **17** and shown in cross-section in Fig. 7.

One form of apparatus that may be used to form the composite cord of this invention is shown schematically in Fig. 3. The bottom web of paper **9** is drawn from a supply roll and passes over roller **18** to an adhesive applicator roll **19** which is rotatably mounted in a gluepot **20** so that the applicator roll is partly immersed in adhesive and thus transfers the adhesive layer **10** to the lower surface of the traveling paper web. A squeeze roll **21** is mounted over the applicator roll **19** and helps control the quantity of adhesive on the paper. The web **9** continues half-way around the roll **21**, thus reversing the direction and surfaces so that the adhesive is now on the upper surface. The lower web is then drawn through and by a pair of draw rolls **22, 22**. The upper corresponding web **9** is drawn from a supply roll through the draw rolls **22, 22** in face to face relation with the lower adhesive web. Simultaneously the plurality of glass strands **12** is drawn from a supply creel **23** through a reed **24** and then through the draw rolls **22, 22** between the two webs **9, 9** and thus embedded and set in the adhesive layer **10**. The reed **24** is provided with a plurality of alternate teeth **25** and slots **26**, the slots each receiving a single glass strand and maintaining a spaced parallel relation between the strands. The reed is adapted to be reciprocated laterally across the webs as by crank and link connections **27** and **28** through any suitable source of power (not shown). It will, of course, be appreciated that the length of stroke of reciprocation of the reed may be suitably varied as may be the number of strokes per minute. The reciprocation of the reed in this manner causes the glass strands to be laterally swung back and forth as they become engaged in the adhesive between the paper webs and thus assume a generally spaced parallel curvilinear relationship in the combined tape. The strokes per minute and length of stroke of the reed are very important because they control the amount of stretch in the glass strands mechanically imparted thereto by the foreshortening effected as the result of reciprocating the reed. It may sometimes be necessary to provide an additional pair of draw rolls immediately preceding the reed **24** for drawing the glass strands only, but at a speed slightly faster than that of the subsequent draw rolls **22, 22**. Such an arrangement would minimize any tension on the strands as they pass through the reed and while they are being embedded in the adhesive on the paper web. The composite tape **11** emerges from the draw rolls **22, 22** and enters a regular paper cord twisting machine **29**, emerging therefrom as the twisted composite cord **17** to be wound on a storage reel **30**.

Figs. 5 and 6 show a modification wherein a single paper ribbon **14** has an adhesive layer **15** applied only to one-half of the strip. The reed **31**, creel **32** and glass strands **16** operate as in the above description, but the paper strip is folded over on itself to form the laminated composite tape **13** shown in Fig. 6 which can also be twisted or otherwise compacted to the general cross-section shown in Fig. 7.

Since the invention herein lies in the composite article details of the illustrated means of making the same have been omitted because many mechanisms capable of making the article can readily be thought of. The curvilinear glass strands might be preformed which would eliminate the need for reciprocating the reed. Furthermore, the reed might be stationary and the webs laterally reciprocated. The same effect could be attained by embedding the curvilinear glass strands in a web of paper as the web is being formed on the wet end of a paper machine. Also, it may be desirable to build up several layers of the laminated structure.

The amount of stretch to be imparted to the strands, of course, depends on the difference in stretch between the paper and the glass strands which depends on many factors, some of which have been discussed hereinbefore. The total foreshortening of the glass strands should be as nearly as possible equal to the total stretch of the paper, but it may not be technically feasible to have exactly equal stretches in the components. Therefore, when the term or concept of equal stretch is used herein it means substantially equal stretch within limits of practicality, wherein the composite cord substantially gains cumulative tensile strength from the components thereof by comparison with the tensile strength of any one component. Since the knotted tensile strength depends on the relatively short length of the cord involved in the knot the waves imparted to the strands should be as close together as possible for any given per cent of stretch.

The basic disclosure of the present invention is the mechanical creation of a stretch in an inherently non-stretchable component of the composite cord to equal the inherent stretch of a stretchable component, and should not be limited solely to the stretch relationship between paper and glass as shown in the example. The web might be formed from fabric, rubber, leather, cellophane or other flexible materials. The strands might be metal wires, regenerated yarns, chemical yarns, vegetable cords or many other materials.

It will also be appreciated that in some instances where the greatest inherent stretch might be in the strands it would be necessary to mechanically impart stretch to the web material to attain a cumulative tensile such as, for example, by creping paper.

The stretch may be imparted by many means in addition to the curvilinear shape of the strands, e. g., twisting, creping, crimping, etc., may be used, but twisting of glass fibers at the present time causes too much breakage of the individual filaments to be feasible since there is a loss of strand tensile strength.

The type adhesive used should be one which will maintain the spaced parallel relation of the glass strands on the paper through twisting, rolling, etc., but should allow a small degree of movement so that the strands can stretch with the paper. No rigid setting adhesive should be used which would not permit movement of the strands because no stretch would then be possible and the cord would not be sufficiently flexible for practical use. A further advantage would be gained if the adhesive has a tensile strength of its own at the stretch break point of the paper and glass because this would also add to the strength of the composite cord.

In making a composite cord according to this invention it would be possible for a 2" paper web (40 pounds tensile strength) containing fifty curvilinear glass strands

(4 pounds tensile strength per strand, 200 pounds cumulative tensile strength) to have a tensile strength approaching 240 pounds, whereas a composite cord with the same number of straight parallel-spaced glass strands would have a tensile strength only approaching 200 pounds.

It is believed that the composite cord disclosed herein will also increase the per cent knotted tensile strength retained in addition to increasing the absolute knotted tensile strength which will naturally increase with the increased unknotted tensile strength. It is known that paper alone has a high retention in its knotted tensile but that glass is very low. However, the imparted stretch will tend to relieve many of the stresses and strains on the glass strands about the knot, and thus cause a higher retention of the unknotted tensile strength.

Thus it will be seen that the herein disclosed invention is directed to a composite cord with equal stretch in the components, one component having such stretch mechanically imparted thereto, to gain advantage of the cumulative tensile strength of the components.

I claim:

1. A composite tape comprising a stretchable web, a layer of non-rigid adhesive on said web, and a plurality of stretchable strands embedded in said adhesive, said web and said strands having different inherent stretchabilities and the one with the least inherent stretch having mechanically imparted thereto sufficient additional stretch to substantially equal that of the other.

2. A composite tape comprising a stretchable web, a layer of non-rigid adhesive on said web, and a plurality of strands embedded in said adhesive, said strands having an inherent stretch less than that of said web and having mechanically imparted thereto sufficient additional stretch to substantially equal that of said web.

3. A composite tape comprising a pair of stretchable webs in a spaced parallel face to face relationship, a layer of non-rigid adhesive between said webs for bonding the same together, and a plurality of strands embedded in said adhesive, said strands having an inherent stretch less than that of said webs and having mechanically imparted thereto sufficient additional stretch to substantially equal that of said webs.

4. A composite tape comprising a pair of stretchable webs in a spaced parallel face to face relationship, a layer of non-rigid adhesive between said webs for bonding the same together, and a plurality of spaced parallel curvilinear strands embedded in said adhesive, said strands having an inherent stretch less than that of said webs and an imparted stretch effected by mechanically foreshortening the same into curvilinear formation by an amount substantially equal to the difference between the inherent stretch of said webs and said strands.

5. A composite cord formed from a tape comprising a pair of stretchable webs initially disposed in spaced parallel face to face relationship, a layer of non-rigid adhesive between said webs for bonding the same together, and a plurality of spaced parallel curvilinear strands embedded in said adhesive, said strands having an inherent stretch less than that of said webs and an imparted stretch effected by mechanically foreshortening the same in curvilinear formation by an amount substantially equal to the difference between the inherent stretch of said webs and said strands, said tape being compacted along the longitudinal axis to form the cord.

6. A composite cord formed from a tape comprising a pair of stretchable webs initially disposed in spaced parallel face to face relationship, a layer of non-rigid adhesive between said webs for bonding the same together, and a plurality of spaced parallel curvilinear strands embedded in said adhesive, said strands having an inherent stretch less than that of said webs and an imparted stretch effected by mechanically foreshortening the same into curvilinear formation by an amount substantially equal to the difference between the inherent stretch of said webs and said strands, said tape being twisted along the longitudinla axis to form the cord.

7. A composite tape comprising a pair of stretchable paper webs in a spaced parallel face to face relationshp, a layer of non-rigid adhesive between said webs for banding the same together, and a plurality of glass strands embedded in said adhesive, said glass strands having less inherent stretch than said paper webs and having mechanically imparted thereto sufficient additional stretch to substantially equal that of said webs.

8. A composite tape comprising a pair of stretchable paper webs in a spaced parallel face to face relationship, a layer of non-rigid adhesive between said webs for bonding the same together, and a plurality of spaced parallel curvilinear glass strands embedded in said adhesive, said glass strands having less inherent stretch than said paper webs and an imparted stretch effected by mechanically foreshortening the same into curvilinear formation by an amount substantially equal to the difference between the inherent stretch of said webs and said strands.

9. A composite cord formed from a tape comprising a pair of stretchable paper webs initially disposed in spaced parallel face to face relationship, a layer of non-rigid adhesive between said webs for bonding the same together, and a plurality of spaced parallel curvilinear glass strands embedded in said adhesive, said glass strands having less inherent stretch than said paper webs and an imparted stretch effected by mechanically foreshortening the same into curvilinear formation by an amount substantially equal to the difference between the inherent stretch of said webs and said strands, said tape being compacted along the longitudinal axis to form the cord.

10. A composite cord formed from a tape comprising a pair of stretchable paper webs initially disposed in spaced parallel face to face relationship, a layer of non-rigid adhesive between said webs for bonding the same together, and a plurality of spaced parallel curvilinear glass strands embedded in said adhesive, said glass strands having less inherent stretch than said paper webs and an imparted stretch effected by mechanically foreshortening the same into curvilinear formation by an amount substantially equal to the difference between the inherent stretch of said webs and said strands, said tape being twisted along the longitudinal axis to form the cord.

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