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R. D. EVANS

CORD FABRIC

Filed March 13, 1925

Fig. 4.

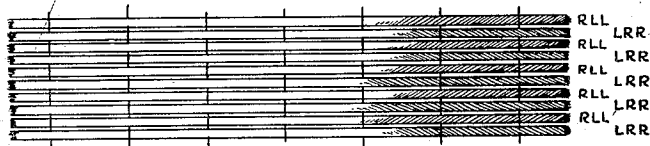


Fig. 5.

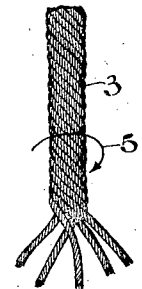


Fig. 2.

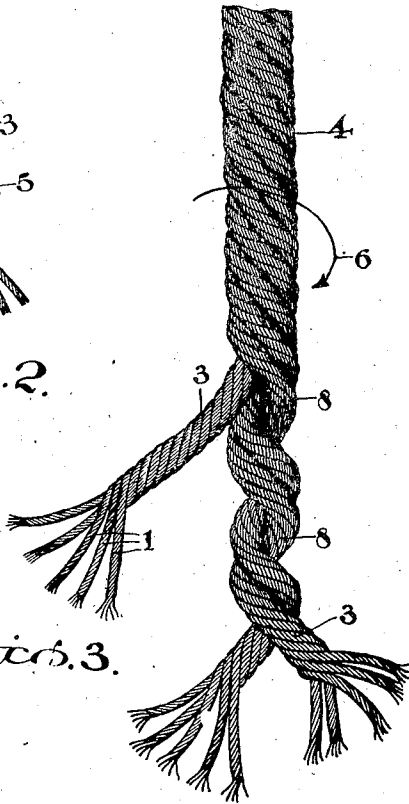


Fig. 3.

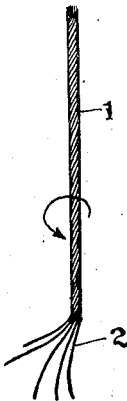


Fig. 1.

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CORD FABRIC.

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My invention relates to cord and textile manufacture, and it has, for its principal object, the provision of a method of constructing cords which will efficiently withstand wear resulting from repeated flexure under tension.

Another object of my invention is to provide a new cord fabric whose cords do not readily fail from internal chafing due to flexure under tension.

Another object of my invention is to provide a fabric for use in the manufacture of cord tires for vehicles, which shall give better and longer service.

Briefly, the invention consists in disposing the subordinate elements comprising a cord in such manner that the destructive action, which results from any intra-cord motion under tension, will be reduced to a minimum.

With these and other objects in view, my invention will be more fully described, illustrated in the drawings and particularly pointed out in the appended claims.

In the drawings:
Fig. 1 is an elevational view of a portion of a yarn, utilized to form a cord in accordance with my invention;

Fig. 2 is an elevational view of a portion of a strand, formed of a plurality of yarns, such as shown in Fig. 1;

Fig. 3 is also an elevational view of a portion of a cord assembled by properly arranging a number of the structural elements shown in the previous figures;

Fig. 4 is a diagrammatic view of a fabric construction embodying my cord in which the cords are singly alternated between those having their last two twists to the right and those having their last two twists to the left; and

Fig. 5 is a diagrammatic view of a fabric construction embodying my cord in which groups of cords are alternated between those having the last two twists to the right and those having their last two twists to the left.

In setting forth the details of my invention, I shall describe a cord having three progressively subordinate elements. It should be understood, however, that the principles are not limited to this particular construction, but may be applied to others without departing from the scope of the invention. It is customary to designate the three elements which comprise the cord as fiber, yarn and strand. This will be better understood by re-

ferring to the drawings. A yarn 1 is formed of spun textile fibers 2, a plurality of yarns being twisted together to make a strand 3 and, finally, a plurality of strands are twisted together to form a cable or cord 4.

A common characteristic of all previous cord constructions for tires lies in the fact that the last two twists (in the example shown this would correspond to twists of the strand and the cable) are in opposite directions. The number of turns per inch in any twist may vary according to the use which is made of the product, but the directions thereof have long been fixed.

It is obvious that with such a cord, i. e., one having three subordinate elements, four possible constructions lie within the scope of present day practice.

Direction of twist		
Yarn	Strand	Cable
1 Right.....	Right.....	Left.....
2 Left.....	Right.....	Left.....
3 Right.....	Left.....	Right.....
4 Left.....	Left.....	Right.....

If such a cord is twisted and then released, it will tend to regain its former state of equilibrium. The reason for this phenomenon lies in the fact that the various elements comprising the cord are twisted in opposite directions and the forces tending to relieve their stresses oppose each other. In a well constructed cord the opposing stresses are so matched that there is no net effect, this resulting in what is known as a balanced cord. The property dealing with the inherent tendency to establish an equilibrium between the opposing stresses is known as the cord-balance. If an equilibrium has not been reached, the cord will tend to curl and kink and is said to have a poor cord-balance.

I have discovered that cords having their last two twists in opposite directions possess the following characteristic. The yarns near the center of the cord and at the periphery of a strand lie at a large angle with respect to the axis of the cord. In cords, such as have been used in the construction of pneumatic tires, this angle approaches 90°, so that these yarns near the center of the cord lie substantially transverse to the direction of the cord's axis.

When such cords are subjected to tension

and flexure the stresses developed react destructively inasmuch as any relative motion between yarns of adjoining strands will effect a chafing action at their point of contact. This action is severe because such contacting yarns of adjoining strands near the center of the cord rub against one another in a direction substantially transverse with respect to the axes of the yarns themselves.

I have discovered that it is possible to secure a satisfactory degree of cord balance by making the last two twists in the same direction, and by so doing to secure a very much greater resistance to internal chafing under tension than is realized with cords whose last two twists are in opposed directions.

Thus, by making the strand and cable twists in the same direction, as illustrated by the arrows 5 and 6, I have produced a marked change in the inherent characteristics of the cord structure. The yarns 8, at the periphery of a strand and near the center of the cord are substantially parallel to the axis of the cord. This change obviates the former failing because the yarns in adjoining strands are now substantially parallel to each other wherever they are in engagement, and any relative motion within the cord is parallel to the direction of the yarns. It is obvious, therefore, that chafing and cutting under tension is reduced to a minimum.

In a number of test runs I have compared the behavior of cords constructed by prior methods with mine. Such tests establish that the cord of my invention will withstand ten times as many deflections under tension as will the most resistant cords made according to the present standard methods. It is to be noted that the size of the cords tested was identical and their tensile strengths nearly so.

In a cord having three progressively subordinate elements of construction, I may employ either of the following twist combinations to accomplish the purpose of my invention:

Direction of twist		
Yarn	Strand	Cable
1 Right.....	Left.....	Left.
2 Left.....	Right.....	Right.

Those skilled in the art will appreciate that, in so radical a departure from the established fundamentals of cord construction, special precautions are necessary to effect a good cord-balance. In the new construction it is much more difficult to establish a static equilibrium between the opposing forces but, bearing in mind that a good cord balance is merely a convenience and not a property upon which the strength, durability or elasticity depend, I have found several proce-

dures conveniently applicable to offset its undesirable characteristics.

One method which I have employed is to impregnate the cord with a material which will stiffen the structure and thus oppose the unbalanced force. As an example of this, a cord fabric which is to be used in tire manufacture may be impregnated with rubber to resist the snarling action. The impregnation may be directly accomplished in a calendar mill or the fabric may be dipped in a solution or dispersion of the stiffening material and subsequently dried.

Another method which may be employed to effect the same result is to dispose the individual cords in such manner that their unbalanced forces will oppose each other. This may better be understood by referring to Figs. 4 and 5 of the drawings. If we assume that a cord in which the last two twists are to the right will tend to curl to the left and one in which the last two twists are to the left will tend to curl to the right, it is obvious that, by alternating the construction of the individual cords, their relative tendencies to curl will offset each other. Fig. 4 illustrates this arrangement where the cords are singly alternated. Likewise, groups of cords may be alternated to effect the same result, as illustrated in Fig. 5.

The third method of obviating the effects of an unbalanced cord is to proportion the degree of twist in each element so that the internal forces substantially neutralize each other. This necessitates an entire readjustment of specifications used in the present standard practice, not only in the relative direction of the twist, but also the degree thereof. For example, the following table compares the changes in the degree of twist which are necessary in order to obtain a balanced cord without seriously interfering with the properties which enhance its durability.

Twist	New twist		Ordinary twist	
	Direction	Degree turns/inch	Direction	Degree turns/inch
Yarn.....	Right.....	20 to 28.....	Right.....	16.5 to 17.5
Strand.....	Left.....	6 to 10.....	Right.....	16 to 17
Cable.....	Left.....	6 to 10.....	Left.....	7 to 8

This table applies to a specific cord known in the art as 23's/5/3, that is, three strands have been twisted to form the cable; five yarns have been twisted to form each strand; and the yarn employed is of the size known as 23's in the cotton-spinning industry, that is, twenty-three 840 yard-lengths will weigh one pound.

From the description given, it appears that the value of my invention lies in the fact that where there is relative motion within the cord, the direction of the peripheral yarns

is substantially parallel to the line of motion. Moreover, the invention is not limited by the size of the yarn, the number of twisted elements utilized or the degree of twist thereof. It is obvious that a fabric embodying this cord construction is especially adapted to vehicle tire manufacture. However, its applicability is not limited to this field alone, but may be advantageously extended to other products in which durability and undiminishing strength are of paramount importance, as for example belting, packing, etc.

Although I have described the application of the principles of my invention by utilizing a specific cord composed of three progressively subordinate elements (23's/5/3), it is evident that it is not so limited and that many modifications may be made in the application of the principles which I have herein set forth without departing from the spirit of the invention. I desire, therefore, that it shall be limited only in accordance with prior art and the appended claims.

What I claim is:

1. A cord comprising a plurality of strands, each strand being composed of a plurality of yarns, the yarns at the periphery of the strands near the center of the cord being substantially parallel to the axis of the cord.

2. A cord structure comprising a cable composed of a plurality of elements twisted together in a predetermined direction each element being composed of a plurality of subordinate elements twisted together in the same direction as the first mentioned elements.

3. A cord structure comprising a plurality of strands each composed of elements twisted together, said elements at the periphery of any strand near the center of the cord being substantially parallel to the cord's axis and

to the elements of other strands with which they are in mutual engagement.

4. A cord fabric comprising a plurality of cords each cord having a cable twist, a strand twist and a yarn twist, the cable and strand twists being in the same direction.

5. A cord fabric comprising a plurality of cords each composed of twisted strands forming a cable, a plurality of the cords having their strands and cables twisted in one direction and a plurality of the cords having their strands and cables twisted in the opposite direction.

6. A method of manufacturing a cord that comprises spinning a plurality of fibers in one direction to form a yarn, twisting a plurality of yarns in a reverse direction to form a strand and twisting a plurality of such strands in the last named direction to form the cord.

7. A method of manufacturing a cord that comprises twisting a plurality of twisted elements in one direction to form a strand and twisting a plurality of such strands in the same direction to form the cord.

8. A fabric for pneumatic tires embodying a plurality of cords, each having three twists, alternate cords of the fabric having their last two twists in one direction opposite the direction of the first twist.

9. A cord fabric comprising a plurality of groups of cords, each cord of one group including three or more elements and having a cable twist and a strand twist both in one direction, each cord of the adjacent group including three or more elements and having a cable twist and a strand twist both in one direction opposite the first mentioned direction.

In witness whereof, I have hereunto signed my name.

RHYS D. EVANS.