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J. M. HARRIS

2,393,530

FLEXIBLE SLEEVING

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Fig. 1.

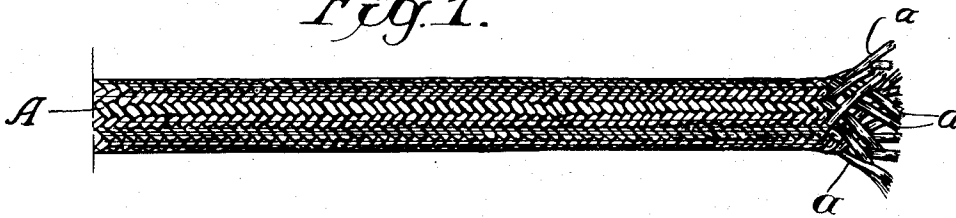


Fig. 2.

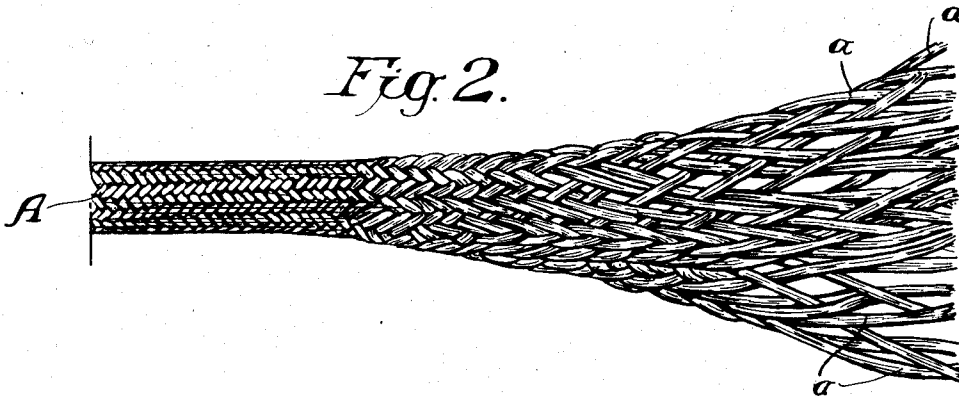


Fig. 3.

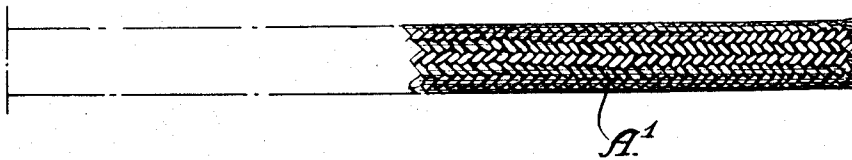


Fig. 4.

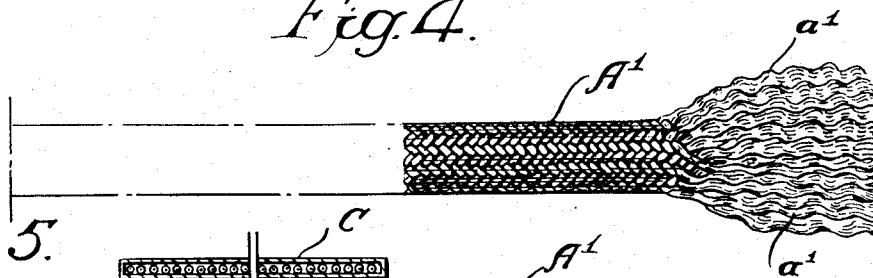
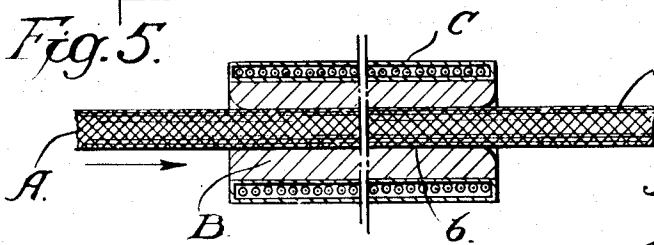


Fig. 5.



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UNITED STATES PATENT OFFICE

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FLEXIBLE SLEEVING

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2 Claims. (Cl. 87-9)

This invention relates to flexible dielectric tubing adapted for use as insulating sleeving on wires of electrical apparatus, or wherever the use of such insulation may be desired.

The invention relates particularly to dielectric sleeving of the braided type, wherein the structure is made of yarn composed of what is commercially known as "Fiberglas," i. e. a yarn composed of a multiplicity of extremely fine continuous flexible glass filaments. This type of tubing is well known in the art and has been in general use for the purposes noted for a number of years.

Fiberglas filaments are inherently resilient, and when bent to a small radius arc, such as takes place when yarns composed of these filaments are interwoven or interbraided in a fabric, tend to straighten out when released. This condition causes excessive fraying or raveling of the fabric when the braided sleeving is cut to length for use.

The excessive fraying of the sleeving has been a constant source of annoyance in assembling and repairing electrical devices where this sleeving is extensively used, as on the pig-tail wires connected to the brushes of certain popular types of electric motors.

In order to reduce the excessive fraying of the sleeving, to a minimum, it has been the customary practice to coat the sleeving with a varnish, lacquer or dye, which, when it dries has a tendency to harden. This hardening of the lacquer reduces the flexibility of the tubing, proportionately to the thickness of the coating, and the reduction in fraying is more or less proportionate to the thickness of the coating, i. e. the thicker the coating the less tendency there is to fraying, and vice versa.

Consequently, in order to obtain a workable condition, the coating is reduced in thickness, which is only partially effective in reducing the tendency of the cut sleeving to fray.

The primary object of the invention is to eliminate the inherent tendency of the braided sleeving to fray, without reducing the flexibility of the sleeving.

In fact, tubing or sleeving produced in accordance with the present invention has a higher degree of flexibility than the sleeving normally had before coating, i. e., as the sleeving comes off the braiding machine, as will be clearly understood from the following description taken in connection with the accompanying drawing, of which:

Fig. 1 is a side view of one end of a piece of Fiberglas tubing, drawn to a somewhat enlarged scale, and showing the tubing as it comes from

the braiding machine on which it has been fabricated, with the end of the tubing frayed as it occurs simultaneously with the cutting of the tubing;

Fig. 2 is a view similar to Fig. 1 illustrating how the fraying of the primary tubing increases with handling thereof;

Fig. 3 is a side view of one end of a piece of tubing made in accordance with the principles of the present invention;

Fig. 4 is a view similar to Fig. 3 illustrating the tubing as having been forcibly raveled by picking the yarns apart, at the cut end of the tubing, with a sharp instrument; and

Fig. 5 diagrammatically illustrates a piece of apparatus employed in treating the tubing in accordance with the present invention.

As shown in the drawing, the tubing A is composed of a multiplicity of yarns *a*, *a* which are interbraided in the usual manner, with each of the yarns *a* composed of a multiplicity of individual continuous flexible glass filaments extending substantially parallel to each other and loosely twisted together to produce the individual yarns.

As previously noted, the individual filaments have an inherent tendency to straighten out when bent sharply and then released. This tendency carries through and is somewhat increased in each of the yarns *a*, as a result of the multiplicity of filaments of which the yarn is composed being loosely twisted together. When the tubing is cut transversely as indicated at the right hand end of Fig. 1, this inherent tendency of the filaments and yarns to straighten out causes the yarns to spring apart at and adjacent the cut, which causes the tubing to ravel or fray excessively, simultaneously with the cutting of the tube.

As the tubing or sleeving is subsequently handled, during application of the sleeving to electrical wires, for example, or during assembling of the sleeved wires in an electrical apparatus in which the sleeved wires are employed, aggravates the fraying condition to an extent substantially as illustrated in Fig. 2.

As is well known in the art of braiding and weaving, at the places where any two yarns are interlaced as a result of the weaving or braiding operation the yarns are bent on a radius consistent with the radii of the respective yarns around which they are bent, and the individual yarns are maintained in this sharply bent condition in the finished fabric.

In accordance with the present invention, it

has been found that if and when the sharp bends in the yarns of braided tubing composed of Fiber-glas filaments are "set," the bends of the cross- ing yarns remain hooked around and substan- tially lock with each other and that as a result thereof all tendency of the sleeving or tubing to ravel, when cut transversely disappears. The set crimps or bends are diagrammatically illus- trated at *a1* in Fig. 4 of the drawing.

It has also been noted in practicing the present invention that the "setting" of the sharp bends or crimps increases the flexibility of the tubing or sleeving as a whole, as a result of the elimina- tion of the tendency of the individual yarns and filaments to straighten out.

In accordance with the principles of the pres- ent invention, the "setting" of the interlacing crimp in the individual yarns and filaments is effected by subjecting the finished tubing, i. e., the tubing as it comes from the braiding ma- chine, for example, to heat of a predetermined temperature sufficient to produce a slight soften- or annealing of the glass filaments. For the pur- pose of the present invention, it has been found that heating of the filaments to a temperature of about 1200° F. to 1500° F. produces the result desired.

In order to soften or anneal the glass filaments in accordance with the present invention, the tube A is preferably passed through a snug-fit- ting bore *b* or a cylindrical die B of desired length and which is heated to the annealing tem- perature, as by electrical heating coils C. The tube A passing through the bore of the heated die B, in the direction of the arrow Fig. 5, emerges as the finished tube *A1* of Figs. 3, 4 and 5 at a rate of substantially 500 feet per hour.

During the passage of the tube through the heated die the exterior surface of the tube A is preferably in contact with the bore *b* of the die B which causes the individual yarns and fila- ments of which the tubing is composed to become softened at points of interlacing thereof, and, as the tube *A1* emerges from the die B and is per- mitted to cool, the individual yarns and fila- ments become permanently "set" in the interlac- ing curvatures assumed during the braiding oper- ation.

This "setting" of the curves of the individual yarns and filaments reduces the inherent tend- encies of the yarns and filaments to straighten out, and, in so doing, eliminates the tendencies of the tube to ravel when cut.

The "setting" of the interlacing kinks in the individual yarns and filaments subsequent to the interlacing of the yarns in the tubing, also re- duces the collective effort of the yarns and fila- ments to straighten out and produce a resilient stiffness in the tubing, thus the tube assumes a more flaccid state than when it came from the braiding machine.

In some instances it may be desirable to effect a slight or partial fusing of the interlaced yarns and filaments together, in addition to the afore- said "setting" of the interlacing kinks in the yarns, to eliminate the raveling or fraying of the tubing. This may be accomplished by elevat- ing the temperature of the "setting" die to a point where flowing of the glass begins. How- ever, fusion is not particularly desirable as it tends to destroy rather than promote flaccidity in the tubing.

If desired, the tubing of the present invention may be given a coating of varnish, lacquer or dye for the purpose of providing differently colored wires in an electrical circuit or apparatus and the density of the coating may be employed to control the state of flaccidity of the sleeving if desired.

I claim:

1. The process of treating a braided textile tub- ing composed of yarns formed of flexible glass filaments which consists in moving the tubing axially through a heating device heated to a tem- perature of approximately 1200° F. to 1500° F. at a linear speed of approximately 500 feet per hour for permanently crimping said filaments at points of interlacing of said yarns as effected by fabri- cation of said tubing subsequent to said fabrica- tion, to eliminate fraying of the tubing when cut transversely and to increase the flaccidity of the tubing.

2. A flaccid di-electric sleeving comprising a braided textile tubing made in accordance with the process of claim 1.

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