

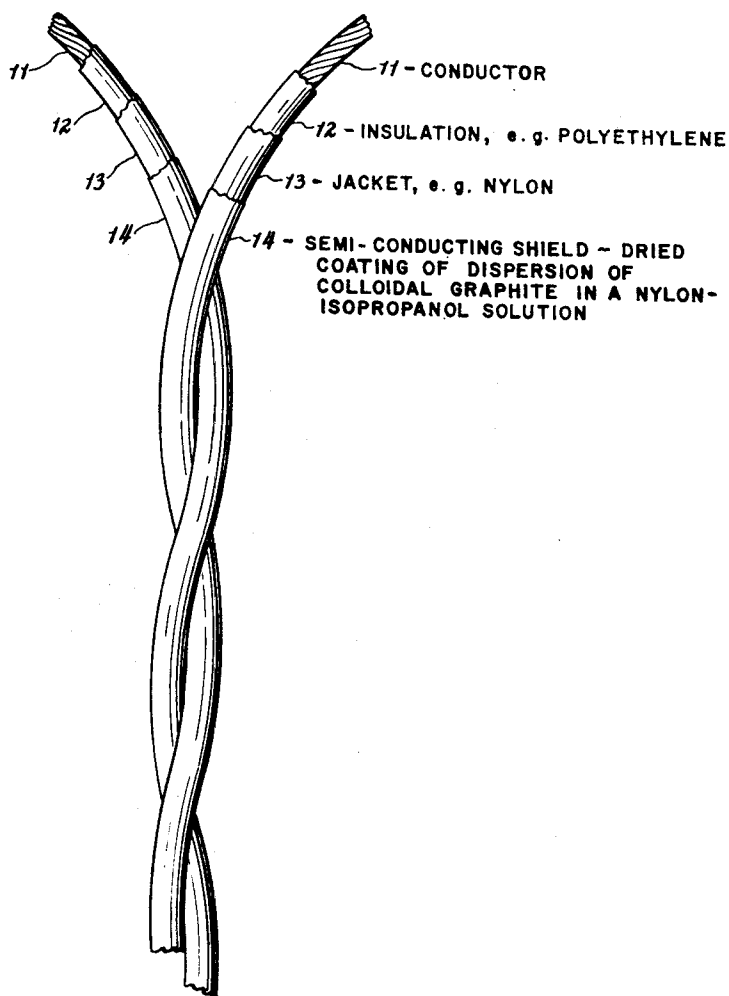
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METHOD OF FORMING SEMI-CONDUCTOR NYLON LACQUER

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METHOD OF FORMING SEMI-CONDUCTIVE NYLON LACQUER

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This invention relates to shielded electric conductors and to shielded, twisted conductor pairs, the shielding being of the type sometimes designated "semi-conducting." This invention also relates to a graphite-bearing nylon lacquer utilized to provide the semi-conducting shielding layer, and to the method for preparing such lacquer. The invention will be described with particular reference to a twisted pair field wire suitable for voice frequency transmission, but it will be evident that the shielding of this invention may be employed on other types of electric wire and cable constructions, and that the nylon lacquer may have utility in other applications where a thin, tough semi-conducting layer is called for.

Desirably the mutual capacitance of twisted pair field wire should not be substantially affected by environmental conditions from dry to wet. Preferably the degree of stability should be in the range of 90%-95%, or higher, i.e. the mutual capacitance change from dry to wet conditions should not exceed 5% to 10%, at most.

In one type of twisted pair field wire each conductor is insulated with a wall of polyethylene and the polyethylene is protected by an overlying jacket of nylon. The polyethylene has excellent electrical characteristics and the nylon provides a tough, flexible and abrasion-resistant covering. It appeared that in such field wire the mutual capacitance might be stabilized by providing an additional covering of semi-conducting nylon shielding around each insulated conductor, provided the nylon could be made sufficiently conducting without serious loss of its physical advantages, including toughness and low temperature flexibility. However, nylon meeting these specifications was not available and the prospects for producing such a nylon were considered by experts in the art to be poor.

It is an object of this invention to provide an improved semi-conducting nylon lacquer and an improved method for making such lacquer. It also is an object of the invention to provide an improved shielded electric conductor. Another object of the invention is to provide an improved twisted pair field wire having stable electrical characteristics under wet and dry conditions, and particularly having a mutual capacitance stability greater than 95% for conditions ranging from dry to wet. Still another object is to provide conductor shielding which has a high degree of permanence, which has good resistance to abrasion, and to flaking during repeated flexing at room temperature and at temperatures well below zero, and which has good resistance to natural weathering. It is an object of the invention to accomplish the foregoing improvements and advantages at low cost and with slight increase in the size and weight of the insulated conductor or twisted pair. Other objects and advantages of the invention will become obvious or will be pointed out as the description proceeds.

An embodiment of the invention in a twisted pair field wire has been selected for purposes of illustration and description and is shown in the single figure of the accompanying drawing. The electric conductors 11 are

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shown as stranded and ordinarily will be so made in twisted pair field wire. However, this is not an essential of the invention. Each conductor is covered with a wall 12 of insulating material, for example an extruded covering of polyethylene which has good electrical characteristics. Over the insulation of each conductor is a protective jacket 13, for example an extruded covering of nylon. Nylon offers numerous advantages as a sheathing material for the conductors of field wire because of its good resistance to abrasion and its ability to withstand repeated flexing at low temperatures. Over each jacket 13 is a semi-conducting shielding layer 14 comprising one or more dried coatings of the semi-conducting nylon lacquer of the present invention.

In providing a shielding layer for such field wire it is desirable that the shielding layer be a continuous covering which will adhere to the protective jacket 13 and which will have physical characteristics not substantially less desirable than the characteristics of the nylon jacket. The shielding layer must, of course, be sufficiently conducting to insure the desired stability in mutual capacitance. Thus, looking at it in one way, the problem might be said to be that of making nylon sufficiently conducting without serious loss of its physical advantages as a jacketing material.

It is believed that prior to the present invention no material which would meet these requirements was available. The present invention provides a semi-conducting nylon lacquer which may be applied in the form of one or more thin coatings over and adhering firmly to the nylon protective jacket. The shielding layer thus formed is sufficiently conductive to insure a stable mutual capacitance in the twisted pair construction. The shielding layer substantially retains the desirable physical characteristics of the nylon, and it does not substantially alter the appearance of the product.

This lacquer comprises a dispersion of colloidal graphite in a nylon-isopropanol solution, the graphite and nylon together comprising the solid content and constituting substantially 10%, by weight, of the whole. I have found that the ratio of graphite to nylon, by weight, must be substantially 2 to 1 in order to obtain the requisite conductivity for stabilizing mutual capacitance as above described. Suitable dispersion of the graphite to provide conductivity is obtained by using a colloidal form of graphite and by using isopropyl alcohol, also known as isopropanol, in preparing the lacquer. In the following example all proportions are by weight unless otherwise specified.

As an example, 100 parts of nylon FM-6501 was dissolved in a boiling isopropanol-water mixture. Nylon FM-6501 is made by E. I. du Pont de Nemours & Company and is understood to be a 6, 6-6, 6-10 interpolymers. (H. C. Haas et al., Journal of Polymer Science, vol. XV, pages 427-446, 1955.) The isopropanol used was technical grade, 98%, and in the example there were 720 parts of isopropanol and 180 parts of water, a ratio of 4 to 1, and making the total 1000 parts of solution.

To this solution, while still hot, was added an equal amount, i.e. 1000 parts, of a 20% dispersion of colloidal graphite in isopropanol, the resulting mixture being stirred until there were no lumps. In the particular example being described a material known as "Dag 154" was used. This is a product of Acheson Colloids Company, Port Huron, Michigan, and is described by that company as a 20% dispersion of colloidal graphite in isopropanol.

The resulting mixture was diluted by adding a third equal amount, i.e. 1000 parts, of an isopropanol-water mixture consisting of 640 parts of isopropanol and 360 parts of water.

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The lacquer thus produced contained 10% of solids, the solids comprising 6.67% graphite and 3.33% nylon. The lacquer also comprised 72% isopropanol and 18% water. This formulation may exhibit a tendency to gel upon standing and prior to use should be heated to approximately 125° F. and stirred until a smooth dispersion without lumps is obtained. The lacquer may be further diluted with isopropanol to the desired coating consistency for application to wire.

Coating of the wires with this lacquer may be done in a lacquer tower. Preferably the wire will receive a preheat pass through the tower before the first coat of lacquer is applied, and one or more additional coats of lacquer may be applied thereover, each being dried in the tower before the next one is put on. Twisted pair field wire as described hereinabove and having two coats of this semi-conducting nylon lacquer was found to have a mutual capacitance stability in excess of 95%.

Reference has been made hereinabove to the fact that the ratio of graphite to nylon should be at least about 2 to 1 in order to obtain the desired stability. If the ratio is greatly in excess of 2 to 1, the desirable physical characteristics of the nylon will suffer. As long as an excessive amount of graphite is not incorporated in the lacquer, the graphite actually improves the physical characteristics of the nylon by improving its resistance to natural weathering.

The term "nylon" as used in the claims hereof means a linear polyamide which is soluble in a mixture of alcohol and water, as disclosed in the aforesaid H. C. Haas et al. paper in the Journal of Polymer Science. The Du Pont nylon FM-6501, described hereinabove as a 6, 6-6, 6-10 interpolymer is, as far as is known to applicant, the only commercially available linear polyamide which is soluble in such a mixture. However, there are other linear polyamides disclosed in the Haas et al. paper and in the patent literature which have similar properties and which would be suitable for preparation of the semi-conducting lacquer of this invention.

I claim as my invention:

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1. In the production of a semi-conducting nylon lacquer, the steps of forming a 10% solution of nylon in isopropanol and water by dissolving the nylon in a boiling isopropanol-water mixture, adding to the hot solution a 20% dispersion of colloidal graphite in isopropanol, and diluting the mixture to the desired consistency by adding isopropanol-water mixture all measurements being by weight.

2. In the production of a semi-conducting nylon lacquer, the steps of forming a 10% solution of nylon in isopropanol and water by dissolving the nylon in a boiling mixture of four parts of isopropanol and one part of water, adding to the hot solution a 20% dispersion of colloidal graphite in isopropanol, and diluting the mixture to the desired consistency by adding isopropanol-water mixture all measurements being by weight.

3. In the production of a semi-conducting nylon lacquer, the steps of forming a 10% solution of nylon in isopropanol and water by dissolving the nylon in a boiling mixture of four parts of isopropanol and one part of water, adding to the hot solution an equal amount of a 20% dispersion of colloidal graphite in isopropanol, and diluting the above mixture by adding a third equal amount of an isopropanol-water mixture, all measurements being by weight.

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