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## SPINNING OF ARTIFICIAL FILAMENTS

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This invention relates to the preparation of filaments of organic derivatives of cellulose and relates more particularly to the formation of yarns, bristles and the like that are pliable and therefore easily worked.

An object of our invention is to form filaments that are more pliable than those heretofore made. A further object of our invention is to make yarns containing finer filaments than has heretofore been possible which yarns are more pliable and therefore can be knitted into fabric containing more stitches per unit length. Other objects of our invention will appear from the following detailed description.

Yarns or artificial straw or bristles made of organic derivatives of cellulose in the ordinary manner are not as pliable as may be desired, as shown by the fact that such yarns cannot be knitted as closely as is required in some cases, and such bristles and straw tend to break when knotted tightly or subjected to sharp bends. We have found that if an oleaginous substance and also a compound of the polyhydric alcohol class are added to the spinning solution containing the organic derivative of cellulose, yarns, bristles, straw and the like of greater pliability may be formed therefrom. While the presence of the oleaginous substances alone would tend to prevent the formation of fine filaments, the compound of the polyhydric alcohol class present permits the making of filaments of finer size than has been heretofore possible.

In accordance with our invention, we prepare filaments by extruding a solution of an organic derivative of cellulose in a suitable solvent, which solution contains a compound of the polyhydric alcohol class and an oleaginous substance through orifices of suitable size and shape into a medium causing solidification of the filaments thus formed.

Any suitable organic derivatives of cellulose such as organic esters of cellulose or cellulose ethers may be employed for making the filaments. Examples of organic esters of cellulose are cellulose acetate, cellulose formate, cellulose propionate and cellulose butyrate while examples of cellulose ethers are ethyl cellulose, methyl cellulose and benzyl cellulose. However, we prefer to employ an acetone soluble cellulose acetate and generally the solutions employed for spinning contain from 15 to 30% by weight of such cellulose acetate.

In making the spinning solution any suitable solvent for the derivative of cellulose may be employed. We prefer to employ acetone or mixtures of acetone and water, acetone and ethyl alcohol or acetone and methyl alcohol in varying proportions. However, other solvents or solvent mixtures may be employed, examples of which are mixtures of methylene chloride and ethyl or methyl alcohol and mixtures of ethylene dichloride and ethyl or methyl alcohol.

As stated the spinning solution contains a compound of the polyhydric alcohol class. The term "compound of the polyhydric alcohol class" includes not only the polyhydric alcohols but also their derivatives such as ethers or esters thereof. Examples of polyhydric alcohols are the glycols such as diethylene glycol or ethylene glycol and also glycerol and diglycerol. Examples of ethers of polyhydric alcohols are the mono methyl ethers of ethylene glycol or of diethylene glycol, the mono ethyl ethers of ethylene glycol or of diethylene glycol, and the mono butyl ethers of ethylene glycol or of diethylene glycol, as well as the corresponding di-methyl, ethyl or butyl ethers of these glycols. Examples of esters of the polyhydric alcohols are monoacetin and diacetin and the acetyl esters of diglycerol, diethylene glycol or ethylene glycol. These various compounds may be incorporated in the solutions of the derivative of cellulose in amounts varying from 2 to 20% of the weight of the cellulose acetate or other organic derivative of celulose.

In addition to the compound of the polyhydric alcohol class, the spinning dope or solution contains an oleaginous substance. The oleaginous substance may be a glyceride of a fatty acid or the free fatty acid, such as olein, stearin, oleic acid, stearic acid. Specific examples are olive oil, castor oil, cocoanut oil or the free fatty acids derived from such oils. Examples of other oleaginous substances are mineral oils such as kerosene, gasoline, mineral lubricating oils, petroleum jelly and the like. Any one of a mixture of two or more of these materials may be added to the spinning solution. As to the amount of oleaginous substance employed, this will generally vary from 2 to 20% of the weight of the organic derivative of cellulose present.

The spinning jets through which the solution of the derivative of cellulose is extruded may have any suitable number of orifices, say from 1 to 100, depending upon the number and size of the filaments to be formed. These orifices may have any shape. Generally for the formation of filaments to be associated to form yarn and for bristles, the orifices will be of circular shape, while for the making of artificial straw, the orifices will be in the form of slits.

In order to form the filaments, the solution of the derivative of cellulose is extruded through the orifices into a drying evaporative atmosphere, as in dry spinning, or into a precipitating or coagulating liquid bath, as in wet spinning.

For the making of fine filaments to be used in the form of yarn, the filaments, while they are being formed, may be drawn out or stretched in order to reduce their size or denier. This stretching is preferably performed within the spinning machine while the filaments are passing from the orifices where they are formed to a feed roller or outside thereof, and may be done by any suitable mechanical means. Thus, the filaments may be passed around rollers rotating at progressively increasing peripheral speed and thus stretched.

By our process, filaments of very fine size having deniers as low as 1.8 to 1.5 or less may be formed. These filaments may be associated together by twisting to form yarns, and this twisting may be done as a separate operation or in conjunction with the winding of the filaments as they are formed by any suitable device such as a cap spinning device.

The yarns thus formed have all the desirable properties of yarn containing fine filaments. Yarns and filaments made by our process have great pliability as shown by the fact that such yarn may be knitted into a fabric containing many more courses and wales than has been heretofore possible, and artificial bristles, horse hair or straw made in this manner may be knotted quite tightly or bent quite severely without breaking. Moreover, the filaments so formed have greater strength, particularly while wet, than filaments made by prior processes.

If desired, the compound of the polyhydric alcohol class employed may be removed from the filaments, yarns or the fabrics made from the yarns, by washing with water or other aqueous liquids such as ordinary scouring and dyeing baths. In order further to illustrate our invention but without being limited thereto, the following specific examples are given.

*Example I*

A solution of an acetone soluble cellulose acetate having an acetyl value of 54 to 55% is made by dissolving one part of the cellulose acetate in 3 parts of a solvent mixture consisting of 95 parts of acetone and 5 parts of methyl alcohol. To this solution there are added diethylene glycol and olive oil each in amounts equal to 5% of the weight of the cellulose acetate present. After thorough mixing, the solution is filtered and is extruded through orifices into a drying evaporative atmosphere. The filaments thus formed are then stretched by being passed to rollers rotating at relatively high peripheral speed and the filaments thus formed are associated together by twisting to form yarn. The filaments having a denier of 1.5 are formed in this manner, and this yarn is pliable and can be knit in a circular knitting machine to form closely knitted fabric.

*Example II*

The process of Example I is repeated with the exception that a mixture of 95 parts of acetone and 5 parts of water is employed as the solvent mixture and the amount of olive oil employed is increased to 10% of the weight of the cellulose acetate. Filaments having a denier of 1.7 are formed in this manner and the yarn formed from such filaments have all the desirable characteristics of the yarn made in accordance with Example I.

It is to be understood that the foregoing detailed description is given merely by way of illustration and that many variations may be made therein without departing from the spirit of this invention.

Having described our invention what we claim and desire to secure by Letters Patent is:

1. Method of forming filaments comprising extruding a solution containing an organic derivative of cellulose, which solution contains an oleaginous substance and a substance selected from the group consisting of polyhydric, including dihydric, alcohols and ethers thereof, through orifices into a medium that causes solidification of the filaments without removing said substances.

2. Method of forming filaments comprising extruding a solution containing an organic derivative of cellulose together with an oleaginous substance and an aliphatic alcohol containing at least two hydroxy groups, through orifices into a medium that causes solidfication of the filaments without removing said substance and said alcohol.

3. Method of forming filaments comprising extruding a solution containing an organic derivative of cellulose together with an oleaginous substance and an ether of an aliphatic alcohol containing at least two hydroxy groups, through orifices into a medium that causes solidification of the filaments without removing said substance and said ether.

4. The method of forming filaments comprising extruding a solution containing cellulose acetate in a solvent therefor, which solution contains diethylene glycol and an oleaginous substance, through orifices into a drying evaporative atmosphere.

5. The method of forming filaments comprising extruding a solution containing cellulose acetate in a solvent therefor, which solution contains diethylene glycol and olive oil, through orifices into a drying evaporative atmosphere.

6. Method of forming yarn comprising extruding a solution containing cellulose acetate in a solvent thereof, which solution contains diethylene glycol and an oleaginous substance, through orifices into a drying evaporative atmosphere, stretching the filaments thus formed, and associating the filaments to form yarn.

7. Method of forming yarn comprising extruding a solution containing cellulose acetate in a solvent thereof, which solution contains diethylene glycol and olive oil, through orifices into a drying evaporative atmosphere, stretching the filaments thus formed, and associating the filaments to form yarn.

8. Method of forming yarn comprising extruding a solution containing cellulose acetate in a solvent therefor, which solution contains diethylene glycol and olive oil, through orifices into a drying evaporative atmosphere, stretching the filaments thus formed until the same have a size of less than 1.8 denier, and associating the filaments together to form yarn, whereby yarn of increased pliability is formed.

9. Filaments containing organic derivatives of cellulose together with a compound selected from the group consisting of polyhydric, including dihydric, alcohols and ethers thereof, and an oleaginous substance.

10. Filaments containing cellulose acetate to-

gether with a compound selected from the group consisting of polyhydric, including dihydric, alcohols and ethers thereof, and an oleaginous substance.

11. Filaments containing cellulose acetate together with diethylene glycol and an oleaginous substance, and which are of greater pliability than similar filaments in which said diethylene glycol and oleaginous substance are absent.

12. Filaments containing cellulose acetate together with diethylene glycol and olive oil and which are of greater pliability than similar filaments in which said diethylene glycol and olive oil are absent.

13. Method of forming filaments comprising extruding a solution containing an organic derivative of cellulose in a solvent therefor, which solution contains a compound selected from the group consisting of polyhydric, including dihydric, alcohols and ethers thereof, that is a non-solvent for the organic derivative of cellulose and an oleaginous substance, through orifices into a medium that causes solidification of the filaments without removing said substance.

14. Method of forming filaments which comprises extruding a solution containing cellulose acetate in a solvent therefor, which solution contains a compound selected from the group consisting of polyhydric, including dihydric, alcohols and ethers thereof, in amount of 2 to 20% of the weight of the cellulose acetate present and an oleaginous substance in amount of 2 to 20% of the weight of the cellulose acetate present, through orifices into a drying evaporative atmosphere.

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