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[54] **SYNTHETIC FIBER END TAPERING METHOD**

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[51] **Int. Cl.** **A46d 1/04**
[58] **Field of Search** 300/1, 18, 21

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[57] **ABSTRACT**

A synthetic fiber end tapering method is provided which comprises the steps of binding the synthetic fiber filaments into a bundle; immersing the end portion of said bundle in a first liquid having ability to dissolve said synthetic fibers, so as to dissolve the surfaces of the filaments in said bundle in such a way that the degree of dissolving will be greater at the tip part of said end portion of the fiber bundle than at the upper part thereof; and then immersing the thus treated end portion of said fiber bundle in a second liquid whereby to elutriate the dissolved and/or swollen portions of the filaments remaining in the bundle.

9 Claims, 4 Drawing Figures

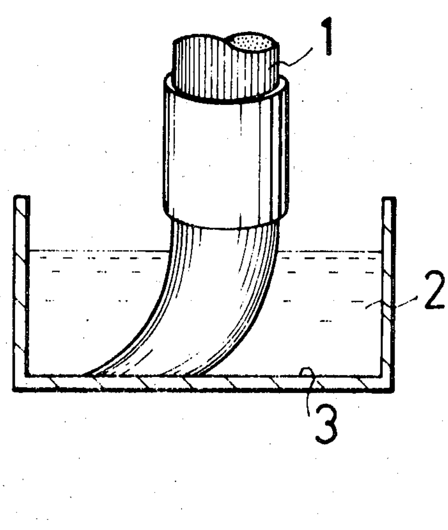


FIG.1

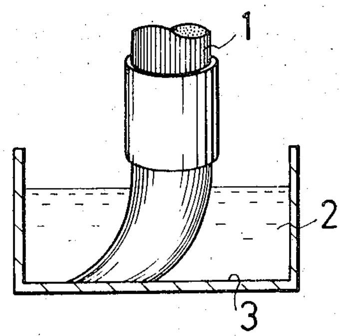


FIG.2

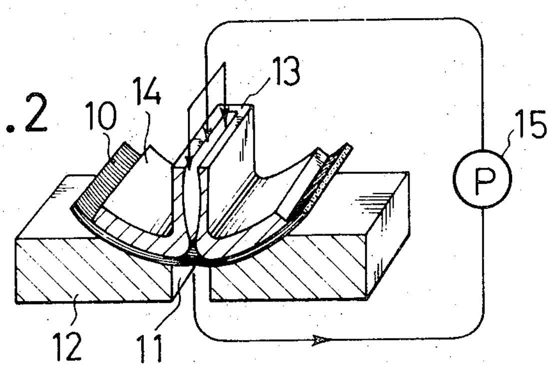


FIG.3

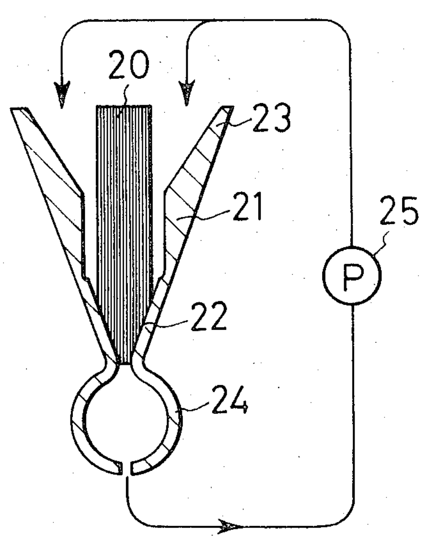
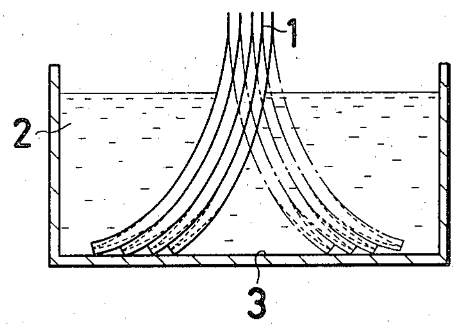


FIG. 4



SYNTHETIC FIBER END TAPERING METHOD

This invention relates to a method of providing sharp taper to the ends of synthetic fiber filaments by treating them with liquid solvents.

Animal hair which is generally gently and finely tapered toward the end is widely utilized for various types of commercial articles such as cosmetic brushes, hair pencils, brushes for painting or other purposes, textile fabrics, and so forth. The products made from such animal hair have moderate elasticity and excellent touch.

Use of synthetic fibers in place of such animal hair is being attempted, but as the filaments of synthetic fibers are generally of an elongated cylindrical configuration with uniform thickness throughout its length, they can hardly be utilized for such commercial articles as abovementioned unless fine and gentle taper like that of animal hair is provided at the ends of the filaments.

Among the known methods of tapering the ends of synthetic fibers is one in which the individual filaments are partially drawn by a thermal drawing operation and suitably cut at such parts, or one in which the filaments are abraded by a suitable abrasive means such as a grinder. However, the former method had a drawback that the thermal drawing operation is complicated and requires skill of the operator, while the latter method was disadvantageous in that it could not provide satisfactory gentle taper.

It is therefore the primary object of the present invention to provide a novel method for providing fine and gentle taper, just like that of animal hair, at the end portions of synthetic fibers with a simple and positive operation.

The synthetic fiber end tapering method according to the present invention comprises essentially the steps of binding filaments of synthetic fibers into a bundle, then dipping the end portion of said bundle in a first liquid which has ability to dissolve said synthetic fibers, thereby to dissolve or melt the surfaces of the filaments in the end portion of said bundle in such a manner that the degree of surface dissolving is advanced more at the tip part of said end portion of the fiber bundle than at the upper part thereof, and then immersing the thus treated fiber bundle in a second liquid so as to elutriate the melted and/or swollen portions of fibers in said bundle. The fore end portion of each fiber filament thus treated is tapered in a preferred form.

For a better understanding of the present invention, as well as further objectives and features thereof, reference is made to the following detailed description to be read in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagrammatic illustration showing a preferred form of operation for practicing the method of the present invention;

FIG. 2 is a perspective view, partly shown in section, of the principal parts of an apparatus used in another preferred form of operation for practicing the method of the present invention;

FIG. 3 is a sectional view of the principal parts of another apparatus used in still another preferred form of operation for practicing the method of the present invention; and

FIG. 4 is an enlarged illustration of FIG. 1 showing a taper forming at the end portions of the individual filaments.

Now, the method of the present invention is described in detail in accordance with its operating steps.

First, the synthetic fiber filaments are bound into bundle and then its fore or lower end portion, on which tapering work is to be performed, is dipped in a solvent solution (hereinafter referred to as first liquid) which has ability to dissolve said synthetic fibers, thereby to dissolve or melt the surfaces of the fibers in said end portion of the fiber bundle in such a manner that the dissolving or melting is advanced more at the tip part of said end portion of the bundle than at the upper part thereof. Here, the fore end portion of the fiber bundle consists of a tip part and an upper part. In a preferred embodiment, this operation may be performed by dipping the fore end portion of the fiber bundle to be tapered in a container filled with a first liquid and frictionally abrading said end portion by rubbing it against a solid face in said liquid. Then, before the first liquid is penetrated deep into each individual filament to cause swelling or dissolving of the entire filament, the dissolved portions of the respective filament surface layers are elutriated successively into the liquid, and while controlling sharp rise of viscosity within the fiber bundle which may be caused by dissolving on each filament surface, the liquid surrounding each filament surface is joggled or shaked to let the liquid pass through between the filaments such that there is produced difference in the degree of dissolving which advances more at the parts where ingress and egress of liquid through filaments take place frequently than at the parts where such ingress and egress of liquid take place slowly, and this, coupled with the abrasive action performed against a solid surface stronger at the tip part than at the upper part of the end portion of the fiber bundle, can provide a desired taper accomplishment. Sharp rise of viscosity within the fiber bundle due to dissolving on the filament surfaces may cause adhesion or coagulation of filaments in the bundle.

The solid surface for abrading the fiber bundle may be provided by the inner bottom wall of the container of the first liquid, in which case the fore or lower end portion of the fiber bundle is frictionally rubbed against said wall surface by moving said end portion to and fro repetitively. It is also possible to use a roller assembly or a grinder. In this case, the end portion of the fiber bundle to be tapered is contacted with the abrasive rotating surface of said roller assembly or grinder while supplying the first liquid to said rotating surface. Or otherwise, said end portion of the fiber bundle may be frictionally contacted against a plate planted with a plurality of needles on its surface, said plate being continuously swayed horizontally in the first liquid.

In another preferred form of this operation, a jet of the first liquid, directed transversely to the lengthwise direction of the fiber bundle, is hit against the portion of the bundle to be tapered. According to this method, it is possible to arrest any sharp rise of viscosity that would otherwise be caused during dissolving of the fibers and to produce difference in the degree of dissolving on the fiber surface in proportion to strength of the liquid jet exerted in the filament direction of the fiber bundle, thereby to dissolve or melt the fibers into desirously tapered form.

The synthetic fibers that can be tapered according to the method of the present invention are acryl, nylon, polyester and other like synthetic fibers, and their size may be optionally selected according to the purpose of use. For instance, when they are used for brushes for painting or fine drawing, the preferred fiber size is about 5/100 to 15/100 mm in diameter.

The treating time and density of the first liquid are suitably determined according to the size of the syntehtic fibers subjected to the tapering work. In case of treating the relatively thick fibers, it is preferred to use a liquid having relatively high fiber solvency and to intensify the physical abrading action, while allowing an ample time for the treatment, because such thick fibers have usually strong rigidity and require longer time until the liquid penetrates to the center of each fiber. In the other hand, in case of treating the relatively thin fibers, it is desirable to use a liquid having relatively low fiber solvency and to perform the treatment under such a condition as to permit passage of liquid into and from the inside of the fiber bundle, because such thin fibers are weak in strength and allow rapid penetration of liquid into the inside of each fiber, and hence coagulation or mutual adhesion of the fibers is likely to take place with resultant sharp rise of viscosity at the dissolved parts of the fibers, resulting in insufficient physical abrading action to the individual fibers.

Used as the first liquid in the method of the present invention is a solvent which has sufficient solvency to dissolve the synthetic fibers used but which does not cause dissolving or swelling of the entire fiber during the operating period and which has also no possibility of retarding frictional rubbing of the fibers against one another due to rapid rise of viscosity at the dissolved parts of the fibers or for other reasons. Preferred examples of the first liquid, when using nylon fibers, are mixture of *m*-cresol and methanol solution of calcium chloride; heated methanol solution of calcium chloride; *p*-toluenesulphonic acid; formic acid; acetic acid; alcohol solution of zinc chloride; phenol; xylenol; hot benzyl alcohol; ethylene chlorohydrin; hydrochloric acid; sulfuric acid; nitric acid; phosphoric acid; etc., which may be used either singly or in admixture of more than two of said substances. In case of using acryl fibers, it is preferred to use hot dimethylformamide, hot dimethylsulfoxide and the like either singly or in admixture. Preferred for use with polyester fibers are phenol; dichloroacetic acid; mixture of trichloroacetic acid with ethane tetrachloride, methylene chloride, trichloroethylene, acetic acid, acetone or such; and other like substances, either singly or in admixture.

The fiber bundle which has undergone the substantial tapering treatment with the first liquid is now subjected to an additional treatment with a second liquid. This treatment is intended to elutriate and disperse the dissolved or swollen portions of the fibers produced in the first liquid treatment, and to make even and smooth the tapered fiber surfaces treated with the first liquid. If the operation is completed only with the treatment with the first liquid which has synthetic fiber solvency, there can remain unremoved the dissolved fiber portions in the fiber bundle and also the first liquid may be left over in the bundle, so that the liquid is excessively raised in concentration and viscosity to cause congregation or adhesion of the fibers or unnecessary melting of the fibers, thus making it unable to obtain desired gentle taper form. In order to remove such impediment, it needs to elutriate the dissolved and swollen portions of the fibers remaining in the fiber bundle. To this end, treatment with the second liquid is indispensable.

The second liquid used in the present invention is one which is inter-soluble with the first liquid and has smaller synthetic fiber solvency than the first liquid. The second liquid may be prepared for instance by diluting the first liquid with a liquid having no synthetic fiber dissolving ability or by reducing the temperature of a liquid, which is used as first liquid in a heated condition, to the normal or lower temperature. The former type liquid may be obtained by diluting the first liquid used for treatment of nylon fibers, acryl fibers or polyester fibers. The diluent used for diluting the first liquid may be alcohols such as methanol or ethanol; ketones such as acetone or ethylmethylketone; esters such as methyl acetate or ethyl acetate; aromatic hydrocarbons such as toluene or xylene; or water. Examples of the latter type liquid are methanol solution of calcium chloride with normal or lower temperature for treatment of nylone fibers, and dimethylformamide, dimethylsulfoxide or such with normal or lower temperature for treatment of acryl fibers.

Also usable as the second liquid is a liquid which is soluble with the first liquid and which, although having no synthetic fiber dissolving ability, is able to disperse the dissolved and/or swollen portions of the fibers produced by treatment with the first liquid and also able to separate these portions in granular form. Examples of such liquid are lower alcohol such as methanol or ethanol and dimethylformamide for use with nylon fibers; methanol for use with acryl fibers; and methylene chloride and trichloroethylene for use with polyester fibers.

The treatment in the second liquid may be performed by shaking the lower end portion of the fiber bundle in the second liquid such as to separate and elutriate the dissolved and/or swollen portions of the fibers deposited or otherwise left over between the fibers in the bundle, or by abrasively rubbing said end portion against a solid face or spraying a jet of second liquid against the fiber bundle as in the first liquid treatment. Such treatment proves helpful to arrest any extra dissolving on the fiber surfaces and to dilute and elutriate the high-concentration solution of fibers which have been already dissolved by the first liquid and remaining between the undissolved fibers. With completion of these treatment, there can be obtained a bundle of filaments which are not adhesive to one another nor conglomerated together and are tapered at the ends.

In practicing the above-described method of the present invention, it is possible to perform, if desired, some pre-treatments such as applying an adhesive insoluble to the first liquid up to a desired position of each filament in the bundle or impregnating the fiber bundle with a liquid having no fiber dissolving ability, and in some cases, using said both treatments together, so as to regulate the fiber length to be tapered.

Also, the fiber bundle, which has been treated with the first and then with the second liquid, may, if desired, be further washed with a third liquid which has no fiber dissolving ability, such as for example alcohols such as methal or ethanol; ketones such as acetone or ethylmethyl ketone; esters such as methyl acetate or ethyl acetate; aromatic hydrocarbons such as toluene or xylene; and water. Such washing treatment ensures perfect prevention of conglomeration or adhesion of fibers and more smooth tapering accomplishment. Such washing liquid can be used for any type of synthetic fibers to be worked.

Now, the present invention is further described by way of some practical examples thereof, but the following examples are intended as merely illustrative and not restrictive to the present invention.

Example 1

The apparatus used in this example is diagrammatically shown in FIG. 1.

The 6,10-nylon filaments, about 8/100 mm in diameter, were bound into a bundle **1**, and the end portion of this bundle was dipped in a mix solution **2** (first liquid) of normal temperature composed of 100 parts of methanol, 30 parts of *m*-cresol and 75 parts of calcium chloride, and was frictionally swayed to and fro at the bottom of a container **3** containing the first liquid, such that the filaments rub abrasively against one another. This treatment in the first liquid was continued until the dissolved portions of the filament surfaces wear away and a taper is formed at the end portion of the bundle (see FIG. 4). Upon completion of this treatment, the fiber bundle was withdrawn from the first liquid and transferred into another container containing a solution (second liquid) prepared by dissolving 60 parts of calcium chloride in 100 parts of methanol. The bundle portion treated with the first liquid was shaked in the second liquid to elutriate away the dissolved filament portions left over attached on the non-dissolved portions of the filaments in the bundle. As a result, there were obtained tapered fibers which were sharpened at ends like animal hair.

Example 2

The filaments made of 6, 10-nylon with a size of about 12/100 mm in diameter were bound into a bundle, and the end portion of this bundle was treated in the same manner as Example 1 but by using as the first liquid a solution prepared by dissolving 85 parts of calcium chloride in 100 parts of methanol and heating the mixture to about 60° C and as the second liquid a solution obtained by cooling the first liquid to about 20° C. Then the thus treated fiber bundle was immersed in water to effect sufficient washing. Resultantly obtained were tapered fibers sharpened at ends just like animal hair.

Example 3

The procedure of Example 1 was repeated by using same filaments and same first liquid for producing a general taper configuration, and the similar treatment was further continued in the second liquid prepared by adding 25 parts of methanol to the first liquid to dilute it, thereby to elutriate the dissolved filament portions remaining in the bundle. There were consequently obtained tapered fibers similar to those of Example 1.

Example 4

The 6, 6-nylon filaments of about 6/100 mm in diameter were bound into a bundle and the same treatment as Example 1 was performed on said bundle by using as the first liquid an about 25° C mix solution consisting of 100 parts of methanol, 20 parts of *m*-cresol and 75 parts of calcium chloride to thereby form taper. Then the thus treated fiber bundle was dipped in the second liquid composed of methanol which is soluble with the first liquid and which, though unable to directly dissolve 6, 6-nylon, is able to disperse such of the filament surfaces that were dissolved or swollen by treatment with the first liquid. The bundle was shaken in said second liquid, whereby the dissolved filament parts remaining in the bundle were elutriated in granular form. Each of the fibers in the bundle thus treated was tapered in a desired form with its end sharpened.

Example 5

Acryl fibers with daimeter of about 8/100 mm were bound into a bundle, which was then treated after the procedure of Example 1 by using dimethylsulfoxide of about 45° to 60° C as the first liquid and a normal temperature solution consisting of 100 parts dimethylsulfoxide and 20 parts water as the second liquid. Consequently obtained were sharply tapered fibers resembling animal hair.

Example 6

The apparatus used in this example is shown diagrammatically in FIG. 2.

Acryl fibers of about 7/100 mm in diameter were bound into a bundle **10** having a thickness of about 3 mm and the bundle was placed on support block **12** having a slit **11**. Then a pressing plate **14** extended like a wing on both sides of the outlet of a nozzle **13** was pressed on the fiber bundle to hold it between said pressing plate and support block. Then, 55° C dimethylformamide, as the first liquid, was jetted from the nozzle **13** by using a pump **15** so that the liquid jets impinge against the fiber bundle **10**. This liquid, after applied to the fiber bundle **10**, was circulated through slit **11** back to the pump **15** for repeated use. After about 5-minute circulation, the fiber bundle **10** was turned the front side back, and the same treatment was conducted for another 5 minutes. Thereafter, the fiber bundle **10** was taken out and transferred into the second liquid which is a normal temperature solution prepared by adding 10 parts of water to 90 parts of dimethylformamide, and was immersed in this second liquid for 3 minutes to elutriate away the dissolved portions of fibers and other deposits on the remaining fibers in the bundle, followed by washing with water. As a result, there were obtained tapered fibers which are sharpened at ends like animal hair.

Example 7

The apparatus used here is diagrammatically shown in FIG. 3.

6, 10-nylon fibers with diameter of about 5/100 mm were bound into a bundle **20** and inserted into a narrowed throat portion **22** of a container **21**. Then the first liquid comprising a mixture of 100-part methanol and 85-part calcium chloride was fed to the top spread-out portion **23** of the container **21** by using a pump **25**. The liquid used was sucked out through a bottom opening **24** of the container **21** and recirculated. After about 10 minutes of such operation, the fiber bundle **20** was removed from the container **21** and immersed in the second liquid of about 30° C composed of 100-part methanol and 200-part *m*-cresol to elutriate the dissolved fiber portions, followed by washing with methylethylketone. As a result, tapered fibers sharpened at ends like animal hair were obtained.

Example 8

About 10/100 mm diameter polyester fibers were bound into a boundle, and the first liquid was poured into a container planted over its entire inner bottom surface with brass-made needles having length of 3 mm and diameter of 1.5 mm at a density of about 9 pieces/cm^2, such that the liquid level in said container is about 10 mm above the top ends of the needles. The first liquid used here was a normal temperature mix solution of trichloracetic acid and ethane tetrachloride mixed at equal ratio. Said fiber bundle was first impregnated with ethane tetrachloride and then immersed in said first liquid in such a manner that the end portion of the bundle contacts the needles planted at the bottom of the container. Said end portion was abrasively swayed to and fro as well as circularly for 15 minutes to thereby form taper at the treated end of each individual fiber. Thereafter, said first liquid was discharged out from the container and the second liquid composed of ethane-tetrachloride was charged thereinto, and the end portion of the fiber bundler was dipped into this second liquid and swayed to abrasively rub against the needle faces in the same manner as said above, thereby to elutriate and disperse the dissolved parts of the fibers remaining in the bundle. The thus treated fibers were then washed with acetone. Obtained as a result were tapered fibers which are not adhesive to one another and sharpened at ends like animal hair.

What is claimed is:

1. A synthetic fiber end tapering method comprising the steps of:

binding the synthetic fiber filaments into a bundle,

immersing the end portion of said bundle in a first liquid having the ability to dissolve said synthetic fibers, thereby subjecting the bundle to said dissolving treatment for a sufficient time period to permit ingress and egress of the liquid through filaments to take place more frequently at the tip part of said end portion of the bundle than at the upper part thereof, so as to dissolve the surfaces of the individual filaments in said bundle in such a way that the degree of dissolving will be greater at the tip part of said end portion of the individual filaments than at the upper part thereof; and then

immersing the thus treated end portion of said fiber bundle in a second liquid thereby to elutriate the dissolved and/or swollen portions of the filaments remaining in the bundle.

2. A method according to claim 1, in which said dissolving step is performed by frictionally abrading the end portion of said fiber bundle against a solid face in the first liquid which has the ability to dissolve the synthetic fibers.

3. A method according to claim 1 in which said dissolving step is performed by ejecting the first liquid having synthetic fiber dissolving ability against the end portion of said fiber bundle in a liquid jet such that said liquid jet impinges against said end portion transversely to the lengthwise direction of said fiber bundle.

4. A method according to claim 1, which said second liquid is a liquid which is soluble with the first liquid and has slightly lower ability to dissolve said synthetic fibers than the first liquid.

5. A method according to claim 4, in which said second liquid is prepared by diluting said first liquid with a liquid which has no ability to dissolve the synthetic fibers.

6. A method according to claim 4, in which said second liquid is the normal temperature cooled version of a liquid which, in a heated condition, is used as the first liquid.

7. A method according to claim 1, in which said second liquid is a liquid which is soluble with the first liquid and which, although having no ability to directly dissolve said synthetic fibers, is capable of dispersing the dissolved and/or swollen portions of the fiber surfaces produced by the treatment with the first liquid.

8. A method according to claim 1 in which an adhesive insoluble to the first liquid is beforehand applied up to a desired position of each filament in the bundle and then the filaments, formed as a bundle, are subjected to dissolving treatment with the first liquid below the said position which is uncoated by said adhesive, thereby to regulate the filament length to be tapered.

9. A method according to claim 1 in which the fiber bundle is first impregnated with a liquid having no ability to dissolve the synthetic fibers and then subjected to dissolving treatment with the first liquid, thereby to regulate the filament length to be tapered which occurs at the end portion of the fiber bundle where said liquid having no ability to dissolve the synthetic fibers is replaced with the first liquid.

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