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PROCESS AND APPARATUS FOR MAKING ARTIFICIAL FILAMENTS

Filed Sept. 8, 1928

Fig. 1.

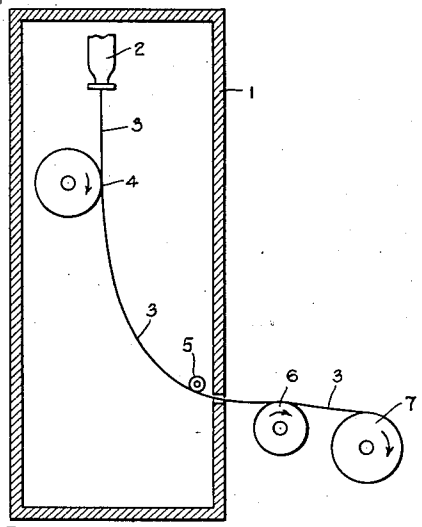


Fig. 2.

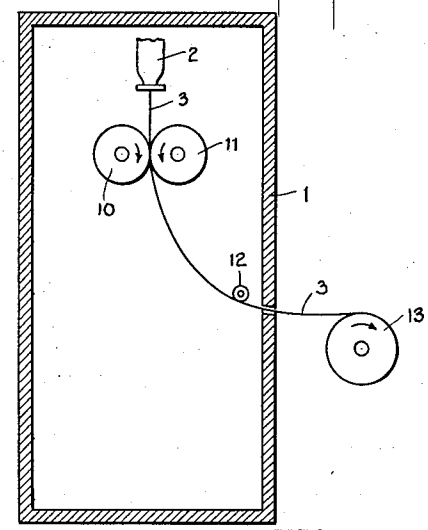


Fig. 3.

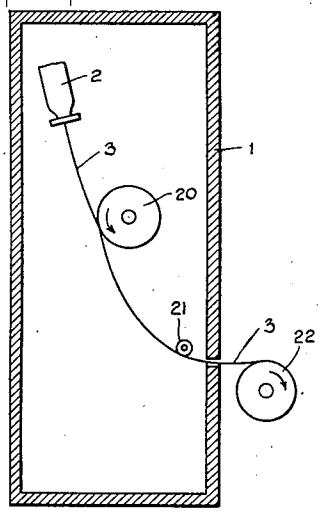


Fig. 4.

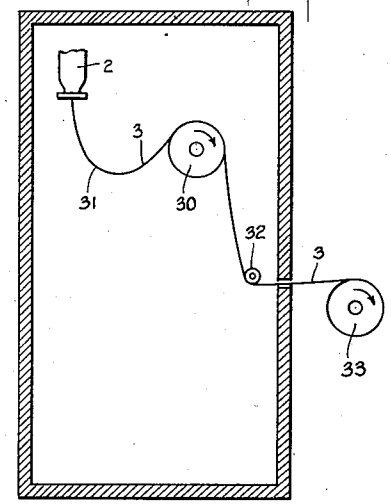
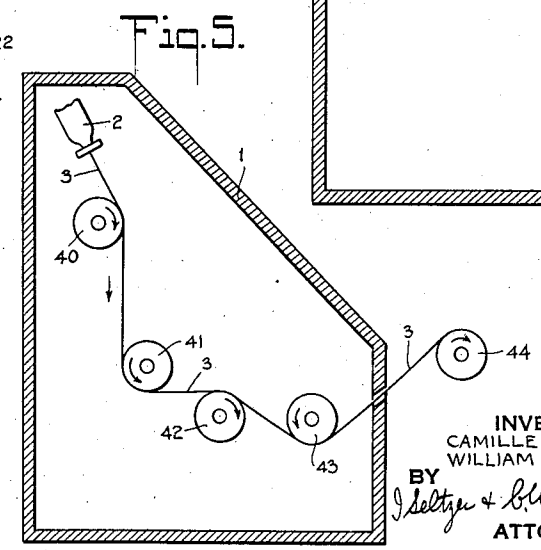


Fig. 5.



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PROCESS AND APPARATUS FOR MAKING ARTIFICIAL FILAMENTS

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Application September 8, 1928, Serial No. 304,807

11 Claims. (Cl. 18—8)

This invention relates to method of and apparatus for the production of artificial filaments such as bristles, horse hair, straw, films and the like from solutions containing the organic derivatives of cellulose.

An object of our invention is to provide a process of and apparatus for the production of artificial filaments from solutions of organic derivatives of cellulose in an economical and expeditious manner.

A further object of our invention is to provide a process of and apparatus for the production of heavy artificial filaments in such a manner that breakage of the filaments during their formation owing to their weight is avoided. Other objects of our invention will appear from the following detailed description.

The formation of comparatively heavy filaments such as bristles and the like for use in brushes by the dry spinning method has heretofore offered serious difficulty. This is due to the fact that as the solution of the cellulose derivative is extruded through the orifices of a spinnerette into the evaporative atmosphere, the filaments near the jet are not sufficiently strong to support the weight of the filaments, because of the fact that the filaments in the ordinary process are dried while suspended vertically for a substantial distance from the spinnerette, with the result that they break and continuous spinning is not possible. We have found that if the filaments are supported near the spinnerette, continuous spinning is possible.

In accordance with our invention, we prepare filaments from solutions of organic derivatives of cellulose. The solutions are made by dissolving the organic derivative of cellulose in a suitable solvent or solvent mixture to form solutions of suitable concentration. The solution may or may not be filtered and is then forced through orifices of a spinnerette of suitable size into the metier or casing of a dry spinning machine wherein a heated evaporative atmosphere is caused to flow. Within the spinning chamber, there is placed a suitable feed device positioned in close proximity to the spinnerette so as to support the weight of the filament that is formed.

While this invention may be employed for making of fine filaments such as from 1 to 10 denier for use in making artificial silk, the greatest advantages of our invention accrue when heavier filaments are formed. These heavier filaments may be in the form of bristles of 20 to 2000 denier or more for use in hair brushes, clothes brushes, nail brushes, sweeping brushes, scrubbing brushes or the like. Bristles for use in making braids and the like may also be made by our process. The filaments to be formed may be in the form of flat filaments for use as artificial straw in making of hats, trimmings, weaving of baskets, etc. Also other films may be formed by our invention. Another use of our process is for the making of artificial hair for use in making artificial fur and for other purposes.

The organic derivative of cellulose that may be employed in our process may be organic esters of cellulose or cellulose ethers. Examples of organic esters are cellulose acetate, cellulose formate, cellulose propionate and cellulose butyrate, while examples of cellulose ethers are ethyl cellulose, methyl cellulose and benzyl cellulose.

The organic derivatives of cellulose may be dissolved in any suitable solvent for making the spinning solutions. An example of a suitable solvent is acetone or mixtures of acetone and water varying in proportions from 90 parts of acetone to 10 parts of water, to 78 parts of acetone to 22 parts of water. Mixtures of acetone and ethyl or methyl alcohol in like proportions may also be used as the solvent. Examples of other solvents are ethylene dichloride, ethylene dichloride and ethyl or methyl alcohol, chloroform, chloroform and ethyl or methyl alcohol, methylene chloride and ethyl or methyl alcohol. The solutions may be made of any suitable concentration say 10 to 40% by weight of the organic derivative of cellulose of the total weight of the solution.

As stated before, the solution may or may not be filtered. When heavy filaments are formed, filtering is not absolutely necessary since the holes employed in the spinnerette are comparatively large. However, if desired, the solution may be filtered by hydraulic pressure or pump pressure, through filter presses or other filtering devices.

Any suitable gas may be used as an evaporative atmosphere in the spinning machine, examples of which are air, nitrogen, carbon dioxide, or other gas that has no detrimental action on the products produced. The atmosphere is preferably heated to about the boiling point of the solvent mixture, although temperatures below or above the boiling point of the solvent mixture may be employed advantageously.

The filaments formed are taken up by a suitable feeding device which may be in the form of a roll, wheel, belt-like conveyor, etc., rotating or moving in such a manner as to wind off and/or draw out the filament under formation. The fil-

ament is caused to pass over or around such device, and may be gathered up and wound into suitable packages, such as bobbins, hanks, cones, etc. The feed device is placed in close proximity to the spinning jet, but it should be sufficiently distant therefrom so that the filament does not adhere strongly to the jet. However, the feed device should be positioned at a distance that is not so great that the unsupported length of the filament is so heavy as to cause breaking off of the same at the jet. We have found that the filaments dry sufficiently within a short distance of the jet. As an example, it may be stated that in the spinning of heavy bristles or straws of say 250 to 2000 denier, while employing a spinning temperature of about the boiling point of the solvent or slightly less (e. g. 10° C.) and with a feed rate of 50 meters of length of filament per minute, the feeding device may be set from 1 to 3 feet from the spinnerette, depending on the solvent employed and the concentration of the spinning solution.

The feed device need not necessarily be placed so that its first contact with the filament is vertically or approximately so under the spinning jet. The feed device may be placed obliquely from the spinning jet, or may be even placed in the same horizontal plane with the jet. Where a tensional pull on the filament under formation is required between the spinnerette and the feed devices, the jet should be directed towards the feed device.

The feed device may be heated by any desired method such as by electrical resistances, steam (dry, superheated, or under pressure) hot liquids or gases to assist the further drying of the filaments.

We have found that on drying, the filaments tend to contract in length as well as in diameter, and that if two or more feed devices are used, which operate so as to feed the filaments at the same linear velocity, the contraction in length of the filaments on drying between two or more feed devices is prevented. We have found the surprising fact that the resulting product is stronger than would have been the case if the filaments had been permitted to contract in length. Further gains in strength may be obtained if the feed devices are caused to feed the filament at successively greater speed, drawing it out to a finer size as it dries between such feed devices. For example, the filament may be passed over or around three rolls successively, the first being 18" from the spinning jet, the second 1 ft. from the first and the third, one foot from the second. The first roller may be rotated at a rate to draw the filament at 20 meters per minute, the second at 22 meters per minute and the third at 23 meters per minute.

By way of illustration of a process wherein three rolls are employed, the following is given. A spinning solution, consisting of one part of an acetone soluble cellulose acetate in 3 parts of a solvent mixture comprising 90% of acetone and 10% of water, is spun through a round hole of 0.4 mm. in diameter. The solution is so extruded from the jet and the first roll is rotated at such a rate as to produce a bristle-like fiber of 400 denier. By rotating the second and third roller at successively higher speeds, a bristle of 348 denier is formed, which has a breaking strength approximately equal to that of a bristle of 400 denier that is spun with the use of only one feed roll. A bristle of 348 denier spun with the use of only one roller has a breaking strength of approximately 348/400 of that of a 400 denier bristle spun in like manner. Corresponding increases of strength are observed when finer filaments, such as are used in making artificial silks, are formed. It will be noted that in our process where two or more rollers are employed, the filaments are drawn between the feeding devices while they still contain appreciable amounts of solvent.

In order further to illustrate our invention, reference is had to the accompanying drawing, where examples of suitable devices are shown diagrammatical. In the drawing,

Fig. 1 is a diagrammatical view of a spinning machine embodying one form of our invention,

Fig. 2 is a similar view of another embodiment of our invention,

Fig. 3 is a similar view of still another form of our invention,

Fig. 4 is a similar view of still another form of our invention, and

Fig. 5 is a similar view of still another form of our invention.

Referring to all of the figures, 1 represents a metier or casing of a dry spinning machine for the spinning of filaments from solutions of the cellulose derivative. In this metier 1, a heated atmosphere is caused to flow. The solution of organic derivative of cellulose in a volatile solvent is extruded through the orifices of the spinnerette 2, and the stream of organic derivative of cellulose is caused to assume the form of a filament generally indicated at 3.

In the form shown in Fig. 1, the filament 3 passes from the spinnerette to vertically down to a feed roll 4 which is placed at a short distance below the spinnerette 2. The filament 3 passes around the roll 4 under the guide roll 5 to the feed roll 6 and thence to the winding device 7.

In the form shown in Fig. 2, the filament 3 passes from the spinnerette 2 vertically down between the rolls 10 and 11 which are rotating in opposite directions in light contact with each other. The filament is thus supported and drawn from the spinnerette and is caused to pass under the guide roll 12 to a suitable winding device 13.

In the form shown in Fig. 3, the feed device 20 is placed obliquely from the spinnerette 2, and the spinnerette is placed at an angle so as to direct the filament directly to the feed roll 20, and thus permit of a tensional pull on the filament by the feed roll 20. The filament passes around the feed roll 20, under the guide roll 21 and is wound into a suitable package by the winding device 22.

In Fig. 4, the feed roll 30 is placed laterally of the spinnerette 2, and the filament 3 is permitted to loop at 31 between the spinnerette and the feed roll. The filament passes around the roll 30, under the guide roll 32 to a winding device 33.

In Fig. 5, a modification is shown wherein the filament under formation is passed through the spinning chamber by means of a plurality of feeding devices. The filament 3 passes from the spinnerette 2, around the feed roll 40, then around the feed roll 41, then around the feed roll 42, and then around the feed roll 43, out of the metier casing 1 to the winding device 44. The rolls 40, 41, 42 and 43 may be rotated at the same speed or at progressively greater speeds in order to obtain filaments of increased strength as explained above. Instead of employing only one drying chamber, the filament may be passed to a plurality of drying chambers having feed devices, if so desired.

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 our invention.

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

1. Method of forming articles such as filaments, yarns, bristles, films and the like comprising extruding a solution of an organic derivative of cellulose in a volatile solvent through orifices into a heated evaporative atmosphere and relieving the weight of the articles formed by resting the same on a feeding device placed in proximity to said orifices, said feeding device rotating at such a speed as to prevent linear shrinkage of the articles.

2. In a dry spinning machine the combination of a casing through which a heated evaporative atmosphere is adapted to flow, a spinnerette having an orifice therein through which a spinning solution is adapted to flow, a feed device positioned within said casing in close proximity to said orifice and adapted to support the newly formed filamentary material, another feed device within said casing adapted to move at a speed at least equal to the first feed device, and adapted to carry the filament from the first feed device.

3. Method of forming articles such as filaments, yarns, bristles, films and the like comprising extruding a solution of cellulose acetate in a volatile solvent through orifices into a heated evaporative atmosphere and relieving the extruded solution of at least part of the weight of the articles formed by resting the same on a feeding device placed in proximity to said orifices and in the evaporative atmosphere, said feeding device rotating at such a speed as to prevent linear shrinkage of the articles.

4. Method of forming articles such as filaments, yarns, bristles, films and the like comprising extruding a solution of an organic derivative of cellulose in a volatile solvent through an orifice into a heated evaporative atmosphere and conveying the yarn by means of a roll near said orifice and in the evaporative atmosphere, said roll rotating at such a speed as to prevent linear shrinkage of the articles.

5. Method of forming articles such as filaments, yarns, bristles, films and the like comprising extruding a solution of cellulose acetate in a volatile solvent through an orifice into a heated evaporative atmosphere and conveying the yarn by means of a roll near said orifice and in the evaporative atmosphere, said roll rotating at such a speed as to prevent linear shrinkage of the articles.

6. In a dry spinning machine the combination of a casing through which a heated evaporative atmosphere is adapted to flow, a spinnerette having an orifice therein through which a spinning solution is adapted to flow, a feed device positioned within said casing in close proximity to said orifice and adapted to support the newly formed filamentary material, another feed device within said casing adapted to carry the filaments from the first feed device, and means to move the second named feed device at a speed greater than that of the first feed device.

7. In a dry spinning machine the combination of a casing through which a heated evaporative atmosphere is adapted to flow, a spinnerette having an orifice therein through which a spinning solution is adapted to flow, a roll positioned within said casing in close proximity to said orifice and adapted to support the newly formed filamentary material, another roll within said casing adapted to carry the filaments from the first roll and means for moving the second named roll at a speed greater than that of the first roll.

8. Method of forming filaments or films comprising extruding a solution of an organic derivative of cellulose through orifices into a heated evaporative atmosphere, taking up the filaments or films thus formed from said orifices on a feed device positioned in close proximity to said orifices and adapted to support the newly formed extruded products and conveying them to another feed device moving at a speed greater than that of the first feed device, while said filaments or films contain an appreciable amount of solvent.

9. Method of forming filaments or films comprising extruding a solution of cellulose acetate through orifices into a heated evaporative atmosphere, taking up the filaments or films thus formed from said orifices on a feed device positioned in close proximity to said orifices and adapted to support the newly formed extruded products and conveying them to another feed device moving at a speed greater than that of the first feed device, while said filaments or films contain an appreciable amount of solvent.

10. Method of forming artificial horsehair, bristles and like filamentary material of high denier which comprises extruding a solution of organic derivatives of cellulose through orifices into a heated evaporative atmosphere, supporting the filamentary material substantially immediately after the formation thereof upon a rotatable surface and conveying said material to another rotatable surface moving at a speed at least equal to that of the first rotatable surface.

11. Method of forming artificial horsehair, bristles and like filamentary material of high denier which comprises extruding a solution of cellulose acetate through orifices into a heated evaporative atmosphere, supporting the filamentary material substantially immediately after the formation thereof upon a rotatable surface and conveying said material to another rotatable surface moving at a speed at least equal to that of the first rotatable surface.

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