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DRY SPINNING APPARATUS AND METHOD FOR THE PRODUCTION OF ARTIFICIAL FILAMENTS

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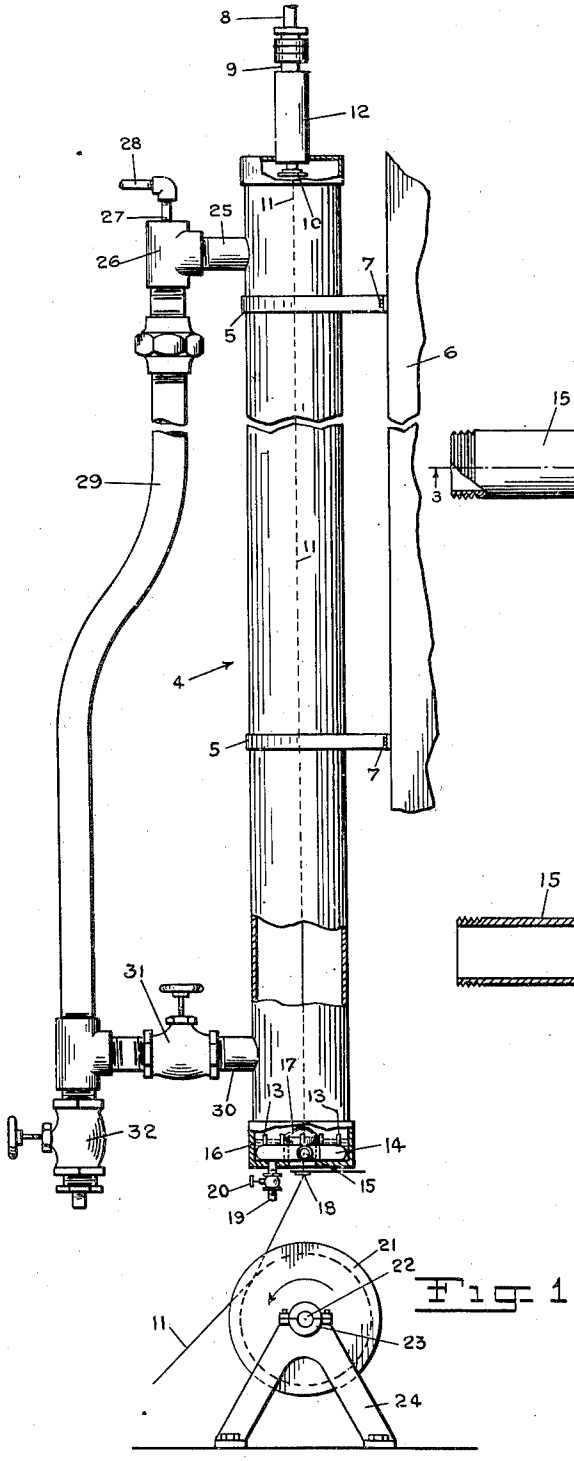


Fig. 1

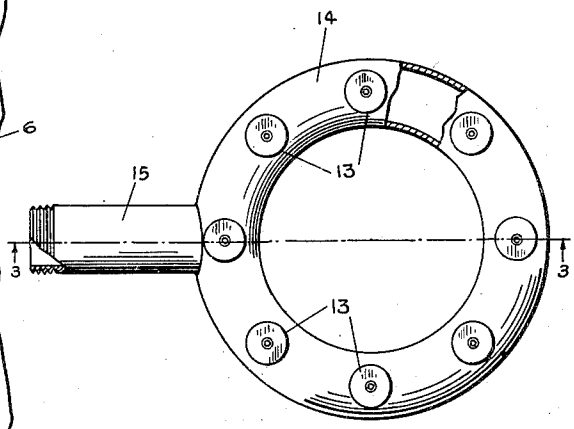


Fig. 2

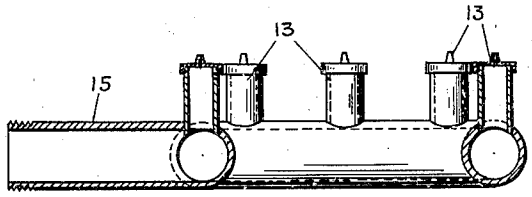


Fig. 3

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## DRY SPINNING APPARATUS AND METHOD FOR THE PRODUCTION OF ARTIFICIAL FILAMENTS

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This invention relates to the production of artificial materials such as filaments, threads, yarns, ribbons, foils, films and the like, and relates more particularly to the production of artificial filamentary materials by extruding a solution of a filament-forming material in a volatile solvent into a solvent-removing atmosphere.

An object of this invention is to provide an improved apparatus for the production of artificial filamentary materials by operations involving the extrusion of a solution of a filament-forming material in a volatile solvent into a solvent-removing medium.

Another object of this invention is the provision of a novel process for the production of improved artificial filaments at high speed.

Other objects of this invention will appear from the following detailed description and the accompanying drawing.

In the drawing,

Fig. 1 is a side-elevational view, partly broken away, of the novel spinning apparatus of our invention showing the spinning cabinet and means for removing the volatile solvent in which the filament-forming materials are dissolved.

Fig. 2 is a plan view of a liquid spray manifold employed in connection with our novel spinning apparatus, and

Fig. 3 is a sectional view of said spray manifold taken along the line 3—3.

Like reference numerals indicate like parts throughout all the views of the drawing.

Artificial filaments or threads having a basis of a filament-forming material, such as, for example, cellulose acetate or other organic derivative of cellulose, are usually prepared by extruding a solution of said filament-forming material in a volatile solvent therefor through a jet or spinneret provided with a plurality of orifices, into an atmosphere of warm air circulating through a spinning cabinet. The filaments which form on extrusion become solidified on evaporation of the solvent, are then associated to form a yarn or thread and by employing suitable yarn winding means are then taken up on a yarn holder to form a yarn package. To eliminate the extensive auxiliary system necessary for the efficient recovery of the volatile solvent from the warm air employed to vaporize the solvent and convey the vapors from the cabinet, it has been proposed that the filaments be formed by wet-spinning operations employing an aqueous coagulating medium in which the volatile solvents are soluble. Excellent filaments may be obtained by such processes. However, the spinning

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speeds at which said filaments may be spun are limited and speeds of 60 to 100 meters per minute are normally the maximum at which the filaments may be formed satisfactorily by wet spinning.

To retain the advantages of wet-spinning processes and yet to enable the filaments to be spun at commercially feasible speeds, it has been proposed to extrude the solution of the filament-forming material in a volatile solvent through a jet or spinneret into an enclosed chamber filled with a fog or mist comprising a spray of droplets of a liquid in which the volatile solvent is soluble but in which the filament-forming material is insoluble. The filaments which form during such a process become solidified in the chamber and the volatile solvent is satisfactorily extracted therefrom and recovered in solution in the liquid extractant which is sprayed into the chamber. Substantially increased spinning speeds, e. g. speeds of 300 meters per minute, or more, may be achieved by this process. These speeds are substantially higher, as stated, than the speeds attainable employing the usual wet spinning processes, wherein the filaments formed enter a liquid coagulating medium directly. In attempting to increase the spinning speeds by the spray spinning process, above those indicated, an increased volume of liquid extractant in the form of a mist of droplets must be introduced into the spinning cabinet to remove the increased quantity of volatile solvent entering at such increased spinning speeds. A maximum in spinning speed is soon reached because the back pressures and currents formed in the chamber at the higher spray and spinning speeds create a physical interference with the proper formation of the filaments.

We have now found that substantially increased spinning speeds may be employed in connection with spray spinning processes by aspirating the volatile solvent from the upper portion of the spinning chamber where said filaments are extruded by means of a jet or spray of extractant liquid operating at a point adjacent thereto while substantially equalizing the pressure throughout the spinning cabinet or chamber. This is done by communicating said aspirating jet with the lower portion of the cabinet wherein the extractant liquid spray is introduced. The jet acts to draw the solvent vapors out of the upper portion of said cabinet and the vapors, dissolving in the liquid jet, are carried off in solution. This action enables the increased volume of mist or spray introduced at the base of the

cabinet to complete the solvent removal in the spinning cabinet without causing the formation of localized back pressures or currents therein to hinder the suitable formation of the yarns or filaments. Accordingly, the filaments may be spun at substantially increased speeds and the volatile solvent effectively and economically removed therefrom.

In carrying out the spinning process described, employing our novel spinning apparatus, optimum results are obtained employing cellulose acetate as the filament-forming material dissolved in acetone as the volatile solvent, the filaments being extruded into a fog or mist of water droplets and acetone vapors being removed by an aspirating jet which is formed by a stream of water forced through a nozzle under pressure. Preferably, the spinning solution employed, namely, cellulose acetate dissolved in acetone, is heated prior to extrusion. Suitable heating means may be provided and the temperature at which it is extruded may be from 80° F. to 206° F. The water sprayed and atomized in or into the cabinet to form the fog or mist of water droplets through which the filaments pass may be any temperature above the freezing point of water or may even be preheated, but preferably the temperature is from 33° F. to 60° F. so that temperatures of 40° F. to 60° F. are maintained in the cabinet. The temperature of the water forming the aspirating jet may be from 33 to 60° F.

In order further to illustrate our invention, reference may be had to the accompanying drawing.

Referring now to the drawing, and more particularly to Fig. 1, there is shown an enclosed spinning cabinet or chamber, of any suitable cross-sectional shape, generally indicated by reference numeral 4, supported by a pair of brackets 5 which are attached to a support 6 comprising a beam, or the like, by bolts 7. At the top of cabinet 4 is a tube 8 through which the spinning solution is introduced. Tube 8 is connected to a candle filter 9 which carries at the lower end thereof a spinning jet or nozzle 10 from which the spinning solution is continuously extruded to form filaments 11, shown diagrammatically. Candle filter 9 is provided with a jacket 12 through which a suitable heating medium may be circulated to heat the spinning solution to the particular temperature at which it is desired to effect extrusion.

The filaments 11 travel downwardly along a vertical path through a fog or mist of water droplets formed by a series of spray nozzles 13 communicating with a manifold 14 into which water at the desired temperature and pressure is introduced. The water enters through a threaded nipple 15 connected to a source of water supply (not shown). The mist of water droplets formed by the nozzles dissolves the volatile solvent and the falling spray collects at the base of cabinet 4 in a well 16. Well 16 is closed by means of a tapered circular neck 17 extending upwardly and surrounding the orifice 18 through which filaments 11 issue from cabinet 4. The taper of neck 17 prevents any liquid from falling through orifice 18. The aqueous solution of volatile solvent which collects in well 16 is discharged through a pipe 19 provided with a valve 20 whereby the discharge rate may be controlled. Filaments 11 are withdrawn from the cabinet 4 by means of a rotating take-up roller 21 mounted on a shaft 22 journaled in bearings 23 supported by a bracket 24 and driven in any convenient manner.

In order to aspirate the volatile solvent vapors from the top of cabinet 4, the latter is provided with a pipe 25 which is connected to an internally constricted T-nipple 26 in which is mounted a jet 27 connected to a suitable source of water under pressure by means of a pipe 28. Jet 27 discharges downwardly through T-nipple 26 into a pipe 29 and the movement of the stream of water through the nipple 26 creates the desired suction for removing the volatile solvent vapors. To enable the pressure in cabinet 4 to be equalized throughout a pipe 30 opening into the cabinet and provided with a valve 31 is connected to pipe 29. The water jet discharge coming down pipe 29 empties through a discharge valve 32 and may be combined with the aqueous discharge leaving well 16 through pipe 19, the volatile solvent being recovered from the aqueous solution by suitable distillation operations.

While our invention has been more particularly described in connection with the production of filaments having a basis of cellulose acetate from solutions thereof in acetone, it is to be understood, of course, that the filament-forming material employed may be any other organic derivative of cellulose or any other suitable filament-forming material. Suitable organic derivatives of cellulose are, for example, cellulose esters, such as cellulose propionate or cellulose butyrate, mixed esters such as cellulose acetate-butyrate or cellulose acetate propionate, or cellulose ethers, such as ethyl cellulose or benzyl cellulose. Other materials from which filaments may be formed by extrusion of said filament-forming material in a volatile solvent may also be employed in the preparation of artificial filaments by our novel wet-spinning process. As suitable volatile solvents which may be employed in lieu of acetone there may be mentioned ethyl ether-alcohol mixtures, di-chlor-methane, carbon disulfide, etc., while suitable liquids in which the volatile solvents are soluble but in which the filament-forming material is insoluble and which may be employed to form the mist and the aspirating jet are methanol, hexane, etc.

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 desire to secure by Letters Patent is:

1. Apparatus for the production of artificial filaments, comprising in combination, a vertical spinning chamber and a spinning nozzle in said chamber for the extrusion of artificial filament-forming material, means for spraying a mist of liquid droplets into said chamber, a duct effecting communication between the upper and lower portion of said spinning chamber to equalize the pressure obtaining in said spinning chamber, and liquid jet aspirating means set within said duct and adapted to act at a point adjacent to the spinning nozzle.

2. Process for the production of artificial filaments, which comprises extruding a solution of a filament-forming material in a volatile solvent into an enclosed space wherein the pressure is equalized containing an atmosphere comprising a mist of droplets of a liquid in which said volatile solvent is soluble, whereby said extruded material is solidified, and simultaneously removing unabsorbed volatile solvent vaporized from the

solidifying filaments by drawing the same into an aspirating jet comprising a stream of the same liquid as that employed in forming the mist of liquid droplets.

3. Process for the production of artificial filaments, which comprises extruding a solution of an organic derivative of cellulose in a volatile solvent into an enclosed space wherein the pressure is equalized containing an atmosphere comprising a mist of droplets of a liquid in which said volatile solvent is soluble and said cellulose derivative is insoluble, whereby said extruded material is solidified, and simultaneously removing unabsorbed volatile solvent vaporized from the solidifying filaments by drawing the same into an aspirating jet comprising a stream of the same liquid as that employed in forming the mist of liquid droplets.

4. Process for the production of artificial filaments, which comprises extruding a solution of cellulose acetate in a volatile solvent into an enclosed space wherein the pressure is equalized containing an atmosphere comprising a mist of droplets of a liquid in which said volatile solvent is soluble and said cellulose acetate is insoluble, whereby said extruded material is solidified, and simultaneously removing unabsorbed volatile solvent vaporized from the solidifying filaments by causing said vapors to be absorbed by drawing the same into an aspirating jet comprising a stream of the same liquid as that employed in forming the mist of liquid droplets.

5. Process for the production of artificial filaments, which comprises extruding a heated solution of a filament-forming material in a volatile solvent into an enclosed space wherein the pressure is equalized containing an atmosphere comprising a mist of droplets of a liquid in which said volatile solvent is soluble and said filament-forming material is insoluble whereby said extruded material is solidified, and simultaneously removing unabsorbed volatile solvent vaporized from the solidifying filaments by drawing the same into an aspirating jet comprising a stream of the same liquid as that employed in forming the mist of liquid droplets.

6. Process for the production of artificial filaments, which comprises extruding a heated solution of an organic derivative of cellulose in a volatile solvent into an enclosed space wherein the pressure is equalized containing an atmosphere comprising a mist of droplets of a liquid in which said volatile solvent is soluble and said cellulose derivative is insoluble, whereby said extruded material is solidified, and simultaneously removing unabsorbed volatile solvent vaporized from the solidifying filaments by drawing the same into an aspirating jet comprising a stream of the same liquid as that employed in forming the mist of liquid droplets.



7. Process for the production of artificial filaments, which comprises extruding a heated solution of cellulose acetate in a volatile solvent into an enclosed space wherein the pressure is equalized containing an atmosphere comprising a mist of droplets of a liquid in which said volatile solvent is soluble and said cellulose acetate is insoluble, whereby said extruded material is solidified, and simultaneously removing unabsorbed volatile solvent vaporized from the solidifying filaments by drawing the same into an aspirating jet comprising a stream of the same liquid as that employed in forming the mist of liquid droplets.

8. Process for the production of artificial filaments, which comprises extruding a solution of cellulose acetate in acetone into an enclosed space wherein the pressure is equalized containing an atmosphere of water droplets, whereby said cellulose acetate filaments are solidified, and simultaneously removing unabsorbed vapors by drawing said vapors into an aspirating jet comprising a stream of water.

9. Process for the production of artificial filaments, which comprises extruding a heated solution of cellulose acetate in acetone into an enclosed space wherein the pressure is equalized containing an atmosphere of water droplets whereby said cellulose acetate filaments are solidified, and simultaneously removing unabsorbed acetone vapors by drawing said vapors into an aspirating jet comprising a stream of water.

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