March 6, 1934. H. DREYFUS ET AL 1,950,025

MANUFACTURE OF ARTIFICIAL FILAMENTS OR THREADS

Filed June 25, 1930

FIG. 1.

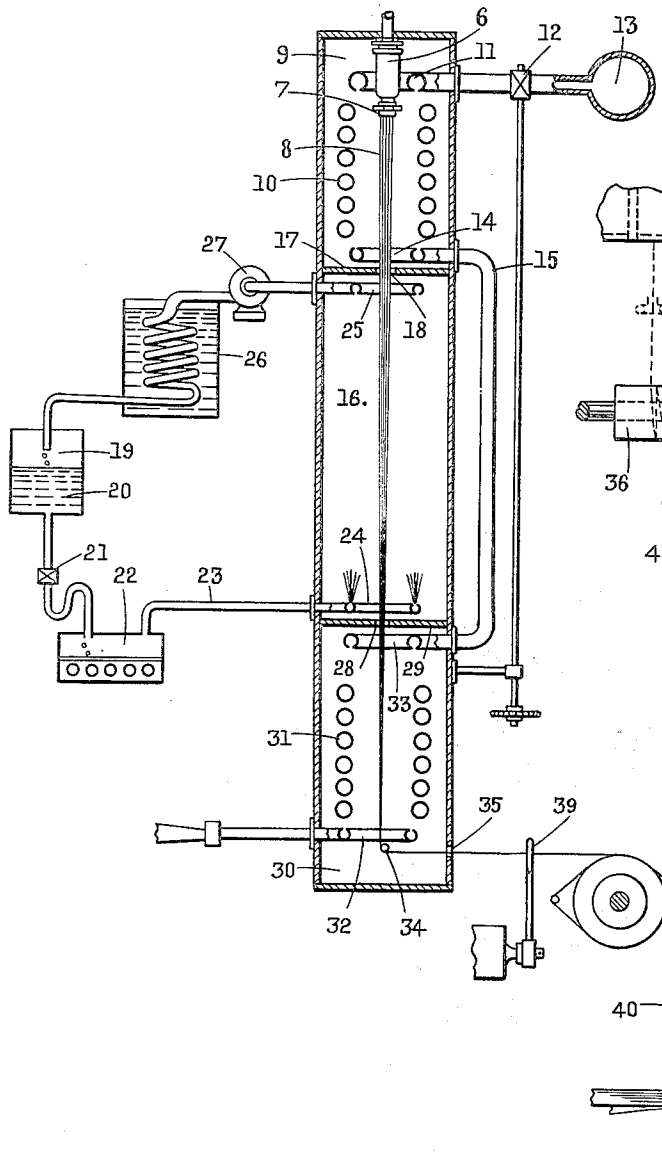
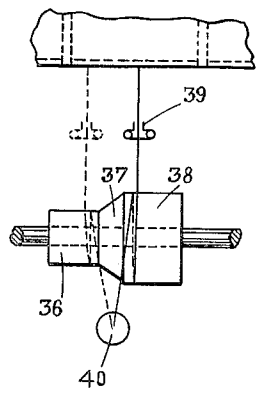


FIG. 2.



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Patented Mar. 6, 1934

1,950,025

UNITED STATES PATENT OFFICE

1,950,025

MANUFACTURE OF ARTIFICIAL FILAMENTS OR THREADS

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Application June 25, 1930, Serial No. 463,658
In Great Britain July 2, 1929

15 Claims. (Cl. 18—8)

This invention relates to the production of artificial filaments or threads of cellulose acetate or other cellulose derivatives by the dry or evaporative method, i. e. by the extrusion of spinning solutions of the cellulose derivatives in volatile solvent liquids into an evaporative atmosphere.

In U. S. patent application S. No. 378,684 filed 16th May, 1929, a process is described in which the filaments of cellulose acetate or other organic derivatives of cellulose are given a permanent extension beyond the elastic limit while they are travelling (e. g. as they are proceeding to a winding or twisting and winding device continuously with their production by the dry or evaporative method) for the purpose of increasing their strength and at the same time reducing their denier, the invention not being limited to the treatment of any particular denier of filament, but applicable to filaments of any denier whatsoever. In this operation, assisting agents, such as solvents or softeners for the cellulose derivative, or mixtures thereof, are employed, these agents being contained in the solution from which the filaments are spun, or applied, in liquid or gaseous form, to the filaments before or during the stretching operation.

A further instance of the application of stretch to filaments of cellulose acetate silk is given in British Patent No. 277,089, according to which such filaments are rendered resistant to the action of hot or boiling aqueous liquors by stretching them beyond their elastic limit after they are in a fully set and finished condition, the operation being carried out, if desired, after wetting the filaments with water or after treatment of the filaments with an agent or agents that facilitate the stretching, which agent or agents may be applied in liquid or vapour form.

In the production of filaments or threads of cellulose acetate or other organic derivatives of cellulose by dry-spinning methods, it is customary to pass the filaments or threads round a feed roller which rotates at a peripheral speed greater than the speed of extrusion of the filaments or threads, whereby the filaments are stretched and under the tension thus imparted are reduced in denier, the extension of the filaments or threads in this manner being described in U. S. Patent No. 1,601,125, and U. S. patent application S. No. 615,682 filed 29th January, 1923. The latter specification which relates to twisting the filaments by means of cap-spinning devices continuously with extrusion, also indicates that the threads may be extended during the twisting and that the tension of the thread may be modified so as to be greater than the elastic limit of the thread.

It has now been found that by stretching filaments of cellulose acetate or other organic derivatives of cellulose under certain conditions during their manufacture by the dry or evaporative method, filaments of fine or extremely fine denier can be obtained.

According to the invention, the spinning solution is extruded into an evaporative atmosphere in the passage through which of the filaments a substantial proportion of the volatile solvent is removed, the removal of solvent being to such an extent that the filaments then consist of a somewhat skin-like outer layer surrounding a softer or more plastic core. The filaments having been brought to this condition are then caused to pass through an atmosphere of solvent or other vapour which has a softening action on the above mentioned outer layer, stretch being imparted meanwhile to the filaments to draw them out to the required degree of fineness, it being found that the action of the solvent vapours on the filaments enables them to withstand the stress of stretching without breakage, probably because it releases strains set up in the outer skin during hardening, and at the same time renders them capable of receiving a considerable reduction in denier. By these means, very low deniers such as 1.5, 1.0, 0.5, or even less, may be obtained.

Following the softening and stretching of the filaments, they may be passed through a further evaporative atmosphere for the removal of solvent remaining in the filaments.

The softening and stretching to which the filaments are submitted may be applied to any desired extent, based on the spinning conditions prevailing, and the degree of fineness which it is desired to produce, the invention not being limited to any precise amount of softening and stretching.

After the filaments have been treated in the manner indicated above to reduce them to a low denier, they may be subjected to further stretching when they have reached an elastic condition, it being found that the filaments are particularly adapted to receive such further stretch, whereby they are given still lower denier, together with an increased strength. This further stretching may be applied to any desired degree, and may be effected by the presence on or in the filaments of an agent that facilitates the stretching, as described in U. S. patent applica-

tion S. No. 378,684 filed 16th May, 1929, previously referred to.

Apparatus suitable for carrying out the invention comprises a spinning cell in which a substantial proportion of the solvent is removed on extrusion of the spinning solution, means being provided to introduce evaporative medium into the cell and to withdraw it, together with solvent vapours produced by evaporation of the spinning solution, from the cell in controlled amounts. The evaporative medium may be introduced to the cell in the vicinity of the spinning jet, or it may be introduced at some lower point of the cell and caused to flow in countercurrent to the flow of the extruded filaments. For the purpose of introducing the evaporative medium, devices such as the slotted or perforated tubular ring or pipe described in U. S. patent application S. No. 382,907 filed 2nd August, 1929, may be employed. When the evaporative medium flows in countercurrent to the extruded filaments there may be employed collector devices such as those described in U. S. patent application S. No. 236,448 filed 29th November, 1927, whether the collector devices extend across the entire cross-section of the cell or chamber with the exception of the area above, round, or below the spinning nozzle or nozzles, or do not necessarily so extend across the entire cross-section of the cell or chamber but are connected directly with an exhaust system. The solvent laden air withdrawn from the cell may be led to any suitable plant for the recovery of the solvent.

A further chamber or compartment is provided in which the softening of the skin of the filaments is carried out, an atmosphere of vapours having the required softening influence being maintained inside this chamber or compartment. Preferably vapours of the solvent used in the spinning solution are employed, and are supplied from a vapourizer which is fed gradually from a solvent container. The excess solvent vapour produced in the chamber or compartment may be withdrawn, led to a condenser where they are brought again into liquid form and fed to the supply container for re-use, or the vapours may be led away together with the solvent-laden evaporative medium of the other compartment to a recovery plant.

A roller or other stretching device or devices, is or are provided, over which the filaments pass and by means of which the required reduction in denier is effected, the linear speed imparted to the filaments by the device or devices bearing the necessary relation to the speed of extrusion of the filaments.

In order to facilitate starting up, means may be provided to draw the filaments from the jet at a comparatively slow rate and afterwards to increase the rate to give the desired amount of stretch. Thus, for example, a stretching roller may be provided with a change-speed device, or a conical stretching roller may be used whose smaller diameter runs at a comparatively low speed and whose larger diameter runs at a speed corresponding to the highest degree of stretch which it is desired to impart. Such means may be used to vary the degree of stretch applied.

In order to avoid the possibility of the filaments sticking together while they are soft and being stretched, it is preferred to use a jet having a wide spacing of the extrusion orifices.

A further chamber or compartment may be provided for the removal by evaporation of residual solvent from the filaments. The stretching roller may be located to receive the filaments either before or after they enter this evaporative chamber or compartment. It is more convenient, however, to apply the stretch to the filaments after their passage through the drying atmosphere of this chamber or compartment, and in this case part of the applied stretch may fall on the length of the filaments within the drying atmosphere.

A preferred form of spinning apparatus comprises a cabinet divided into three compartments, the upper one of which constitutes the spinning cell proper and contains the spinning jet, the middle one constitutes a softening chamber, and the third one a drying chamber. Evaporative medium drawn from the drying chamber is led to the spinning cell and removed therefrom by a draw-off device connected to an exhaust system. Means are provided for supplying solvent vapour to and circulating it through the softening chamber, and a stretching roller is arranged to receive the filaments which have passed through the drying chamber and are proceeding to a collecting device.

The spinning chambers or compartments may further be arranged horizontally and the filaments pass horizontally along the compartments so arranged. One or more doors may be provided in such apparatus to facilitate the handling of the filaments.

In order to facilitate the stretching of the softened filaments and produce filaments of increased strength, plasticizers or high boiling solvents may be added to the spinning solutions. Thus, for example, with spinning solutions containing cellulose acetate, higher boiling solvents, such as cyclobutanone, acetyl acetone, di-acetone alcohol, dimethyl ethylene glycol, monomethyl ethylene glycol, monoethyl ethylene glycol, or plasticizers such as methyl or ethyl xylene sulphonamides, or mixtures thereof may be added to the solutions. Such plasticizers can afterwards remain in the filaments or, if necessary, they may be removed, e. g. by extraction with a solvent for the plasticizer, which at the same time is not a solvent for the cellulose derivative or otherwise.

Examples of organic derivatives of cellulose from solutions of which the filaments or threads may be produced, in addition to cellulose acetate, are cellulose formate, propionate, or butyrate, methyl, ethyl or benzyl cellulose, and the corresponding condensation products of cellulose and glycols or other polyhydric alcohols.

The invention will now be described in greater detail with reference to the accompanying drawing, but it is to be understood that the following description is given by way of example only and is in no way limitative.

Fig. 1 is a sectional elevation of a dry-spinning cell and a cap-spinning device.

Fig. 2 is a plan view of the dual diameter feed roller.

A spinning solution is supplied in controlled amount under pressure to a candle fitting 6 and extruded through a disc, line, or other type of jet 7 into filaments 8. It is preferred to use a jet with wide spacing of the extrusion orifices in order to keep the filaments apart while they are soft. The cell 9 into which the filaments are extruded is heated to a selected temperature by steam heating elements 10, in order to stimulate a fairly rapid removal of solvent from the extruded filaments. A current of air is caused to flow through the cell 9 to aid in the evaporation

of the volatile solvent and to carry solvent vapour out of the chamber. The rapid evaporation in the cell 9 produces a skin-like outer layer on the filaments and proceeds until the filaments contain an amount of solvent such as for example 25 or 50%.

The air together with the evaporated solvent is led out through a perforated or slotted tubular suction ring 11 near the jet 7 and a control valve 12 to a header 13 of a recovery system. It is also preferred to supply the air to the cell 9 by means of a ring 14 similar to the draw-off ring 11.

After their passage through the cell 9 the filaments 8 are led into a softening chamber 16, which may be separate from the spinning cell 9 but is preferably formed as a compartment of the spinning cell by the provision of a partition 17. An orifice 18, preferably adjustable, affords a passage for the filaments through the partition 17.

Solvent vapour is supplied to the chamber 16 from a solvent reservoir 19 connected through a pipe and cock 21 to a vapourizer 22 from which the solvent vapour passes through a pipe 23 to a ring 24 similar to the ring 14 arranged at the lower end of the chamber 16. Any solvent vapour evolved from the filaments themselves in the chamber 16 assists in maintaining the softening atmosphere. Surplus vapour is led from the top of the chamber 16 through a suction ring 25 either by means of a fan 27 to a condenser 26 from which the condensate is returned to the reservoir 19, or to an exhaust system provided with control valves or other devices, and with or without flow meters or other devices, as described in U. S. Patent No. 1,541,104.

The filaments 8 pass from the chamber 16 through an orifice 28 in a partition 29 separating the chamber 16 from a third chamber 30. This chamber 30, which is provided with heating coils 31, and serves as a drying chamber for the softened filaments, is preferably formed as a unit with the chambers 9 and 16. Hot or cold air is introduced into the chamber 30 through an inlet ring 32 and withdrawn through a ring 33.

The solvent laden air extracted through the draw-off ring 33 may be led to a recovery system, or may be conducted through a pipe 15 to the inlet ring 14 of the spinning cell 9, the suction of the draw-off 11 effecting the circulation of the air through the chamber 30 and the cell 9. If desired, the air may be heated in its passage through the pipe 15. Instead of connecting the chamber 30 and the cell 9 in this way, a separate supply of hot or cold air, which may contain a proportion of solvent vapour, may be provided for the cell 9.

The sizes of the orifices 18 and 28 in the partitions 17 and 29 are preferably such as to retard or prevent the passage of vapour or vapour-laden air from one compartment of the apparatus to another. By suitable adjustment of the rate of flow of air and vapour from the several compartments, such pressure conditions may be maintained in the compartments as entirely or almost entirely to prevent flow of air or vapour between the compartments or to control the amount of any flow taking place. For effecting this control, it is preferred to use the means described in U. S. Patent No. 1,541,104, for drawing off both the vapour-laden air from the cell 9 and the solvent vapour from the chamber 16.

The filaments 8 are taken round a guide 34 and pass through a slot 35 in the wall of the chamber 30 to a cap spinning device 40.

Outside the chamber 30 there is arranged a feed roller having a small diameter 36, a tapered portion 37, and a larger diameter 38, and a guide 39 is provided to direct the filaments on to any desired part of the roller.

The small diameter of the feed roller is used in starting up to draw the filaments through the apparatus at a comparatively slow rate, so as to apply little or no stretch or "draw-down" to the filaments. When stretching of the filaments is to commence, and preferably after the filaments have been led to the cap-spinning bobbin, the guide 39 is used to direct the filaments up the slope 37 to the large diameter 38 of the feed roller. The rate at which the filaments are drawn through the apparatus is thus increased, and stretch is applied to the part of the filaments which, by being softened because of the passage through the chamber 16, is capable of withstanding the stress occasioned by the stretching. Operations such as lubricating, moistening, sizing, or dyeing are performed on the filaments or threads continuously with their production, if desired, either prior to their encountering the feed roller or afterwards.

What we claim and desire to secure by Letters Patent is:—

1. Process for the production of artificial filaments of cellulose derivatives by the evaporative method, said process comprising extruding a solution of a cellulose derivative in a volatile solvent into an evaporative atmosphere to form a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the cellulose derivative in order to soften said outer layer, and stretching the filaments thus softened.

2. Process for the production of artificial filaments of cellulose acetate by the evaporative method, said process comprising extruding a spinning solution of cellulose acetate into an exaporative atmosphere to form a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the cellulose acetate in order to soften said outer layer, and stretching the filaments thus softened.

3. Process for the production of artificial filaments of cellulose derivatives by the evaporative method, said process comprising extruding a solution of a cellulose derivative in a volatile solvent into an evaporative atmosphere to form a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the cellulose derivative in order to soften said outer layer, stretching the filaments thus softened, and passing the softened and stretched filaments through a further evaporative atmosphere.

4. Process for the production of artificial filaments of cellulose derivatives by the evaporative method, said process comprising extruding a solution of a cellulose derivative in a volatile solvent into an evaporative atmosphere to form a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the cellulose derivative in order to soften said outer layer, stretching the filaments thus softened, withdrawing evaporative medium from said second named atmosphere and supplying it to the first evaporative atmosphere.

5. Process for the production of artificial filaments of cellulose derivatives by the evaporative method, said process comprising extruding a solution of a cellulose derivative in a volatile sol-

vent containing a plasticizer for the cellulose derivative into an evaporative atmosphere to form a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the cellulose derivative in order to soften said outer layer, and stretching the filaments thus softened.

6. Process for the production of artificial filaments of cellulose derivatives by the evaporative method, said process comprising extruding a solution of a cellulose derivative in a volatile solvent into an evaporative atmosphere to form a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the cellulose derivative in order to soften said outer layer, stretching the filaments thus softened and submitting them to further stretching when they have reached an elastic condition.

7. Process for the production of artificial filaments of cellulose derivatives by the evaporative method, said process comprising extruding a solution of a cellulose derivative in a volatile solvent into an evaporative atmosphere to form a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the cellulose derivative in order to soften said outer layer, stretching the filaments thus softened and submitting them to further stretching when they have reached an elastic condition, in the presence of an agent to facilitate such further stretching.

8. Apparatus for the production of artificial filaments, comprising a spinning cell, a spinning jet contained therein, a chamber into which the filaments are adapted to pass from said spinning cell, means for passing evaporative medium through said cell, means for supplying solvent vapor to said chamber, and means for applying stretch to the filaments passing through said cell and chamber.

9. Apparatus for the production of artificial filaments, comprising a spinning cell, a spinning jet contained therein, a chamber into which the filaments are adapted to pass from said spinning cell, an evaporative cell adapted to receive the filaments after leaving said chamber, means for passing evaporative medium through said spinning and evaporative cells, means for supplying solvent vapor to said chamber, and means for applying stretch to the filaments passing through said cell and chamber.

10. Apparatus for the production of artificial filaments, comprising a spinning cell, a spinning jet contained therein, a chamber into which the filaments are adapted to pass from said spinning cell, perforated tubular rings disposed within said cell and chamber for admitting and withdrawing gases and vapors, means for passing evaporative medium through said cell, means for supplying solvent vapor through said tubular rings, and means for applying stretch to the filaments passing through said cell and chamber.

11. Apparatus for the production of artificial filaments, comprising a spinning cell, a spinning jet contained therein, a chamber into which the filaments are adapted to pass from said spinning cell, an evaporative cell adapted to receive the filaments after leaving said chamber, said cells and chamber being part of one cell divided by partitions having apertures therein for the passage of the filaments, means for passing evaporative medium through said spinning and evaporative cells, means for supplying solvent vapor to said chamber, and means for applying stretch to the filaments passing through said cell and chamber.

12. Apparatus for the production of artificial filaments, comprising a spinning cell, a spinning jet contained therein, a chamber into which the filaments are adapted to pass from said spinning cell, an evaporative cell adapted to receive the filaments after leaving said chamber, means for passing a current of evaporative medium first through said evaporative cell and then through said spinning cell, means for supplying solvent vapor to said chamber, and means for applying stretch to the filaments passing through said cell and chamber.

13. Apparatus for the production of artificial filaments, comprising a spinning cell, a spinning jet contained therein, a chamber into which the filaments are adapted to pass from said spinning cell, means for passing evaporative medium through said cell, means for supplying solvent vapor to said chamber, a condenser and vaporizer adapted to receive and condense such solvent vapor on leaving said chamber and to revaporize it for recirculation in said chamber, and means for applying stretch to the filaments passing through said cell and chamber.

14. Process for the production of artificial filaments by the evaporative method, said method comprising extruding a solution of a filament forming substance in a volatile solvent into an evaporative atmosphere to form by evaporation a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the substance of the filaments in order to soften said outer layer, and stretching the filaments thus softened.

15. Process for the production of artificial filaments by the evaporative method, said method comprising extruding a solution of a filament forming substance in a volatile solvent into an evaporative atmosphere to form by evaporation a skin-like outer layer on the extruded filaments, then passing the filaments into an atmosphere containing solvent vapor for the substance of the filaments in order to soften said outer layer, stretching the filaments thus softened, and passing the softened and stretched filaments through a further evaporative atmosphere.

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