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TREATMENT OF CELLULOSE DERIVATIVES

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FIG. 1.

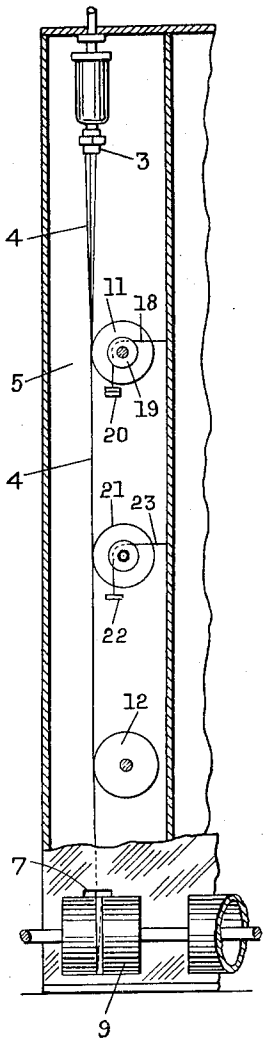
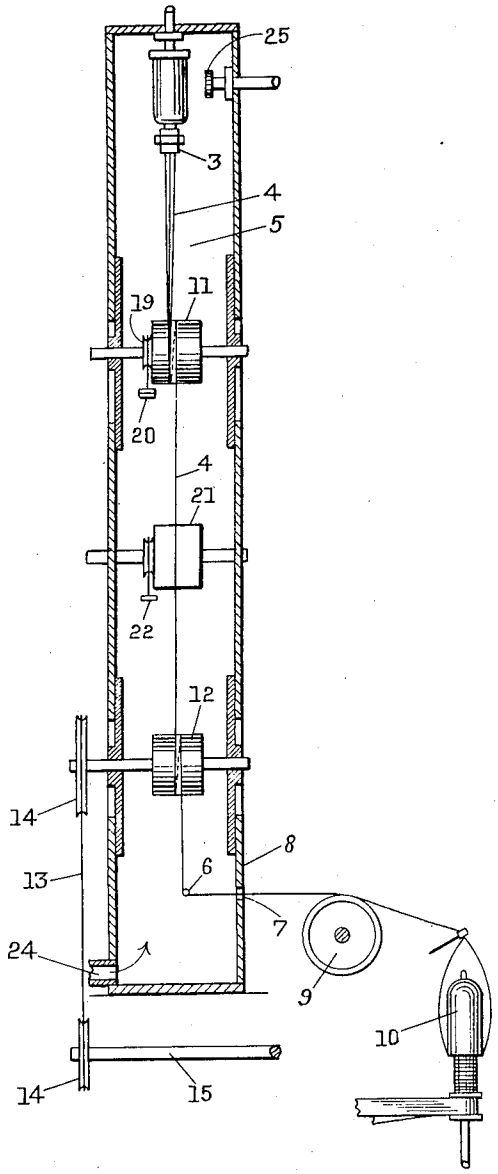


FIG. 2.



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1,935,203

TREATMENT OF CELLULOSE DERIVATIVES

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Application November 30, 1929, Serial No. 410,776, and in Great Britain December 20, 1928

6 Claims. (Cl. 18—54)

This invention relates to the manufacture of filaments or threads of organic derivatives of cellulose, such as organic esters of cellulose, and cellulose ethers.

It is well known in the production of such filaments or threads by the dry or evaporative method to employ what is known as the "stretch-spinning" process, i. e., to impart to the filaments as they are proceeding to winding or other packaging devices a linear speed in excess of that at which they are extruded from the spinning orifices, the draft thus imparted to the filaments extending the filaments in the course of formation, and, of course, reducing their denier, to an extent corresponding to the differences of the two speeds above-mentioned. Thus, United States patent specifications Nos. 1,602,125 and 1,731,317 describe such a drawing-down of the filaments by means of a feed-roller from which they proceed to winding or twisting and winding devices. It will be readily understood that when the filaments are stretched in this manner the extension of the filaments is greatest where they contain the greatest proportion of solvents, and that the stretch falls, therefore, mainly on to the part of the filaments in the neighbourhood of the spinning orifices.

United States patent specification No. 1,731,317 describes also the extension of the filaments or threads while they are travelling from the feed-roller to the twisting and winding device, which in that specification comprises a cap-spinning apparatus, various methods of obtaining a desired amount of stretch being indicated.

In a further United States patent application S. No. 378,684 filed 16th July, 1929, a method is described of stretching filaments or threads of organic derivatives of cellulose after they have become elastic, in the absence or presence of an agent or agents that facilitate the stretching. This latter process while being applicable to the treatment of the filaments or threads in their passage from, for instance, bobbin-to-bobbin, or hank-to-bobbin, may be applied to filaments or threads continuously with their production by the dry or evaporative method.

By limiting this stretching of the filaments to parts which are semi-solid or plastic, the filaments are given an extension which persists during the setting of the filaments after stretching and is not removed in subsequent textile operations performed on the filaments. The filaments are, of course, reduced in denier by an amount depending on the amount of stretch applied, and, also depending on the amount of stretch as well as on the quantity of solvent remaining in the filaments when the stretch is imparted, the strength of the filaments is increased beyond that of similar filaments spun by the usual stretch-spinning process, and the filaments present advantages over filaments which have been stretched when in an elastic condition beyond their elastic limit, as described above. Accurate control over the incidence and the amount of the stretching is possible according to the process, resulting in a uniform treatment over the whole length of the filaments.

The solvent content of the part of the filaments to which stretch is applied ranges from the point at which the filaments can just be handled, say when they contain 50% or somewhat more of solvent, and have just ceased to be sticky or tacky on their surface, to the point where they have not quite reached an elastic condition, say when the solvent content of the filaments is about 10%. The actual amount of stretch will vary according to the degree of stretch and the desired increment of strength to be imparted, but it is preferred to stretch the filaments when their solvent content is between 20 and 40%. In processes of spinning where higher boiling solvents or plasticizers are used in the spinning solution in addition to the normal or low boiling solvent, the presence of higher boiling solvents, plasticizers, or diluents remaining in the spun filaments or threads in addition to the more or less substantial proportions of the normal or low-boiling solvent present in the filaments during the stretching operation may assist the stretching operation according to this invention.

Particularly beneficial results are obtained in the form of stronger filaments or threads if the process according to the invention is applied to the stretching of filaments spun from solutions of cellulose acetate or other cellulose esters of high viscosity.

Any suitable means may be employed for stretching the filaments, such means being suitably disposed with respect to the spinning cell or chamber and receiving the filaments at such a distance from the spinning orifices that the filaments are in a semi-solid or plastic condition. The plastic condition acquired by the filaments before the stretch is imparted may be regulated, as will be readily understood, by suitable control of the spinning conditions, such as for example, the temperature and rate of flow of the evaporative medium, and the distance covered by the filaments between extrusion and the application of the stretch.

A convenient arrangement of stretching appa-

ratus comprises two or more rollers over or round which the filaments pass in series, the first of the rollers receiving the filaments before the removal of the whole of the solvent, and the second roller (and subsequent rollers, if any) drawing the filaments at a speed greater than that of the first roller and sufficient to impart the required stretch.

The positions of the rollers are preferably adjustable in order that the stretch may be imparted at any desired distance from the spinning orifices (this distance determining to some extent the amount of solvent remaining in the filaments or threads) and also in order to control the length or lengths of filaments or threads receiving the stretch. The peripheral speeds of the rollers may also be adjusted according to the stretch to be imparted.

In order to reduce the denier as in the usual stretch-spinning process, the first roller may be rotated at any desired linear speed greater than that of the extrusion, the speed of the or each subsequent roller being, of course, correspondingly higher.

The use of a number of rollers the second and each subsequent roller rotating at a peripheral speed greater than that of each preceding roller enables the filaments or threads to be stretched in successive stages and to the same or different extents in each of the stages, the positions and/or the peripheral speeds of the rollers determining how the stretch is to be imparted.

The roller which determines at what distance from the spinning orifices the stretch is to be applied to the filaments may be positively driven at any desired peripheral speed equal to or greater than the speed of extrusion, or such roller may be idly mounted and caused to rotate by the movement of the filaments over or round it on their way to the stretching roller, drag or braking means such as those described in British patent application No. 37,632/28 filed 20th December 1928 being employed to resist the rotation of the roller and to cause it to move with any desired peripheral speed. Where two or more rollers are employed to intercept the filaments on their way to the stretching roller, the intermediate roller or rollers may similarly be positively driven, or mounted idly so as to rotate against drag or braking means adjusted to give the roller or rollers the desired peripheral speed.

The stretching process forming the subject-matter of this invention may be carried out outside the spinning cell or chamber, or it may be arranged to take place wholly or partially inside the cell or chamber, the stretching rollers or other devices being more or less near or remote from the spinning nozzle, as desired.

Any known or suitable means may be employed for the removal and recovery of residual volatile solvents in the filaments or threads, such means operating either independently of or in conjunction with the usual means for withdrawing the solvent-laden evaporative medium from the cell or chamber and recovering the solvent therefrom. Thus the stretching apparatus may be enclosed in a chamber or casing to which an evaporative medium is supplied and from which solvent-laden medium is removed by a suitable and preferably controlled draw-off, which may be connected to the exhaust of the spinning cell or chamber. The chamber or casing may form a compartment of the spinning cell into which the filaments are extruded or may be separate therefrom, and the chamber or casing may be heated if desired. The removal of the solvent may take place subsequently to the stretching operation, if it is desired to carry out the stretching while the threads are maintained in a more or less uniform condition as to solvent content. For example, the actual stretching operation, or a stage thereof, may be carried out in a closed or substantially closed chamber, and the absence of means for carrying off solvent vapour then keeps the filaments or threads in a substantially uniform plastic state during their passage through the chamber, the stretch being thereby imparted to the whole length of the filaments or threads in the chamber in a substantially uniform degree.

As a result of the above process, filaments or threads which, when spun by the normal process, have a strength of about, for example, 1.3 or 1.4 may have their strength increased to 1.8 to 2.0 according to the degree of stretch imparted, while with still higher degrees of stretch, their strength may be increased to 2.5 to 3.0 or more. Similarly, filaments or threads having a greater initial strength than that indicated above, for example strengths of 1.7 to 2.0, may receive a proportionate increase of strength by subjection to the stretching treatment according to the invention.

Filaments or threads of organic derivatives of cellulose spun by the wet or coagulation method may also receive a similar accession of strength if given a stretch under similar conditions to those described with reference to the dry-spun filaments or threads.

Examples of organic derivatives of cellulose from which the filaments or threads may be produced according to the invention are cellulose acetate, cellulose formate, cellulose propionate, and cellulose butyrate; methyl, ethyl, and benzyl cellulose; the thiocarbamic and alkoxy-alkacyl esters of cellulose; the mixed esters of cellulose (i. e. having two or more different ester groups attached to one cellulose molecule); the mixed ethers; the mixed ester-ethers; and the condensation products of cellulose and glycols or other polyhydric alcohols.

The accompanying drawing shows one form of apparatus which may be employed in carrying out the invention, but it is to be understood that the following description is given by way of example only and is in no way limitative.

In the drawing:—

Figs. 1 and 2 are front and side views respectively in section of a form of apparatus according to the invention.

3 is a spinning jet from which filaments 4 proceed down the length of the cell 5 to a guide 6 and emerge through an opening 7 in the front wall 8 of the cell on their passage to a feed roller 9. The filaments are twisted and wound by a cap-spinning device 10.

Rollers 11, 12 are arranged for rotation in the cell 5, the roller 11 at some distance below the jet 3 and the roller 12 in the lower part of the cell. The arrangement is such that the filaments between the rollers 11 and 12 are in a soft or plastic condition and the distance of the roller 11 from the jet is governed by the ability of the soft or plastic filaments to pass round the roller without sticking thereto. The mountings of two rollers are preferably adjustable to enable both the distance of the roller 11 from the jet and the distance between the rollers to be regulated. The roller 12 is positively driven with a peripheral speed greater than the speed of extrusion of the filaments. Thus the roller 12 may be driven by a belt 13 and pulleys 14 from a shaft 15 geared

to any suitable part of the spinning machine. The roller 11 is caused to rotate at a speed equal to or somewhat greater than the speed of extrusion, but lower than the speed of the roller 12, so that stretch is imparted between the rollers 11 and 12 to the soft or plastic filaments. If desired, further stretch may be applied to the filaments between the roller 12 and the feed-roller 9.

Instead of employing a positive drive for the roller 11, it is preferred to mount the roller idly, so that it is rotated by the passage of the filaments over or round it and to adopt braking means such as those described in British patent application No. 37632/28, one such means being diagrammatically shown in the figures. The means illustrated consist of a brake band 18 anchored at one end and passing over a pulley 19 in driving connection with the roller 11, provision being made to apply a weight or weights 20 to the free end of the band 18. The braking action of the band 18 opposes the pull of the filaments 4 tending to rotate the roller 11, and causes this roller to rotate at a lower peripheral speed than the roller 12. If desired, the stretch of the soft or plastic filaments may take place in two or more stages; for example, a further roller 21 may be disposed between the rollers 11, 12, and may be driven positively at a speed intermediate between the speeds of the rollers 11 and 12, or this rotation may be governed by a drag or braking device such as that described with reference to the roller 11. In this latter case, a weight or weights 22 may be suspended from the free end of a brake band 23 in an amount less than the weights 20 to provide a diminished braking action, so as to allow the roller 21 to rotate at any desired speed greater than the speed of the roller 11.

Apart from the band-brake drag device illustrated, any frictional means engaging a rubbing surface on or in driving connection with the idle roller may be used, while centrifugal, air, or liquid brakes, or electro-magnetic braking means may also be used, the braking means preferably being adjustable.

The roller 11, whether positively driven or governed by a drag or braking device, may rotate at such a speed that in addition to stretch being imparted between the rollers 11 and 12 where the filaments are soft or plastic, stretch is also applied between the spinning jet 3 and the roller 11 to effect a reduction in the filament denier as in the normal stretch-spinning process.

Any suitable circulation may be employed for the medium by which the volatile solvent is evaporated from the filaments. In the drawing, the evaporative medium is introduced through an opening 24 near the bottom of the cell 5 and is withdrawn, preferably in controlled amount, through a draw-off device 25 set near the jet of the cell. If desired, the stretching may be performed in a separate compartment of the cell or in a separate chamber, distinct circulating means being provided for the stretching compartment or chamber and for the part of the cell into which the filaments are extruded. By suitable control of the passage of evaporative medium through the stretching compartment or chamber any desired solvent concentration can be maintained about the filaments while they are being stretched.

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

1. Process for the production of artificial filaments of organic derivatives of cellulose, said process comprising extruding a spinning solution containing an organic derivative of cellulose in the form of filaments into an evaporative medium and stretching the filaments to a controlled extent over a length in which they are in a semi-solid condition, the stretching being confined to the length by applying a frictional braking force which offers a resistance to the motion of the filaments entering the stretching zone.

2. Process for the production of artificial filaments of cellulose acetate, said process comprising extruding a spinning solution containing cellulose acetate in the form of filaments into an evaporative medium and stretching the filaments to a controlled extent over a length in which they are in a semi-solid condition, the stretching being confined to the length by applying a frictional braking force which offers a resistance to the motion of the filaments entering the stretching zone.

3. Process for the production of artificial filaments of organic derivatives of cellulose, said process comprising extruding a spinning solution containing an organic derivative of cellulose in the form of filaments into an evaporative medium, causing said medium to flow in a direction opposite to the direction of extrusion and stretching the filaments to a controlled extent over a length in which they are in a semi-solid condition, the stretching being confined to the length by applying a frictional braking force which offers a resistance to the motion of the filaments entering the stretching zone.

4. Process for the production of artificial filaments of cellulose acetate, said process comprising extruding a spinning solution containing cellulose acetate in the form of filaments into an evaporative medium, causing said medium to flow in a direction opposite to the direction of extrusion and stretching the filaments to a controlled extent over a length in which they are in a semi-solid condition, the stretching being confined to the length by applying a frictional braking force which offers a resistance to the motion of the filaments entering the stretching zone.

5. Process for the production of artificial filaments of organic derivatives of cellulose, said process comprising extruding a spinning solution containing an organic derivative of cellulose in the form of filaments into an evaporative medium and stretching the filaments in stages to a controlled extent while they are in a semi-solid condition, the stretching being confined to definite lengths of the filaments by applying frictional braking forces which offer resistance to the motion of the filaments entering the stretching stages.

6. Process for the production of artificial filaments of cellulose acetate, said process comprising extruding a spinning solution containing cellulose acetate in the form of filaments into an evaporative medium and stretching the filaments in stages to a controlled extent while they are in a semi-solid condition, the stretching being confined to definite lengths of the filaments by applying frictional braking forces which offer resistance to the motion of the filaments entering the stretching stages.

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