PUBLISHED
APRIL 27, 1943.
BY A. P. C.

S. SORDELLI

MANUFACTURE OF ARTIFICIAL TEXTILES

Filed Oct. 21, 1936

Serial No.
106,911

2 Sheets-Sheet 1

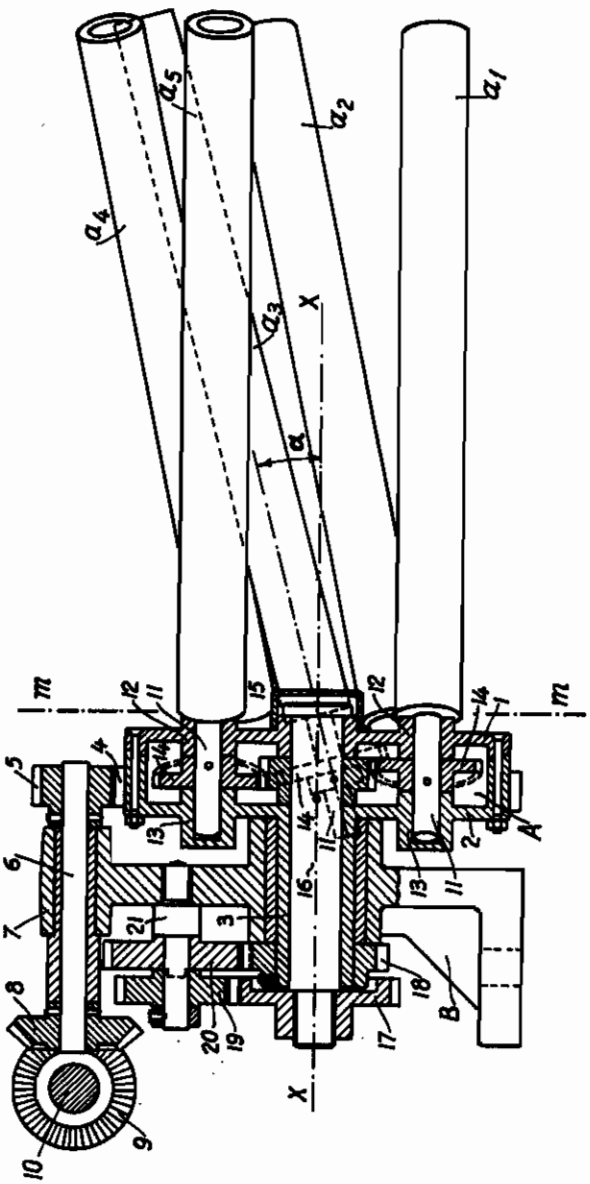


Fig. 1

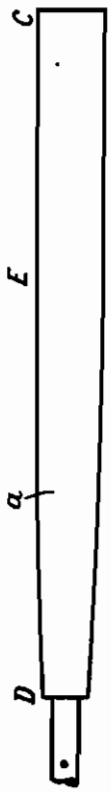


Fig. 4

INVENTOR
Stefano Sordelli
BY Robert F. Davis
ATTORNEY

PUBLISHED
APRIL 27, 1943.
BY A. P. C.

S. SORDELLI

MANUFACTURE OF ARTIFICIAL TEXTILES

Filed Oct. 21, 1936

Serial No.
106,911

2 Sheets-Sheet 2

Fig. 2

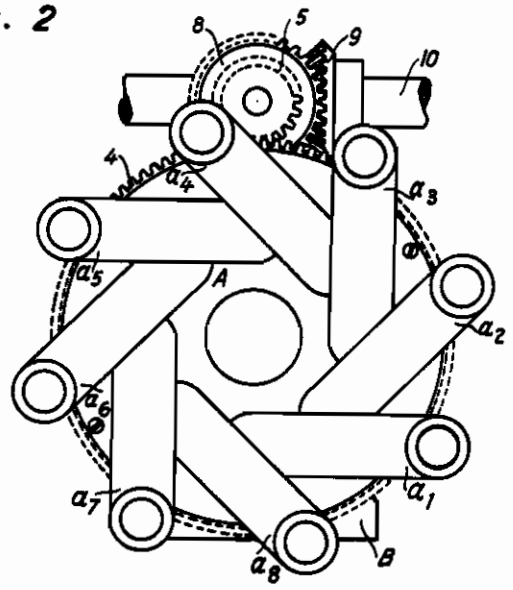
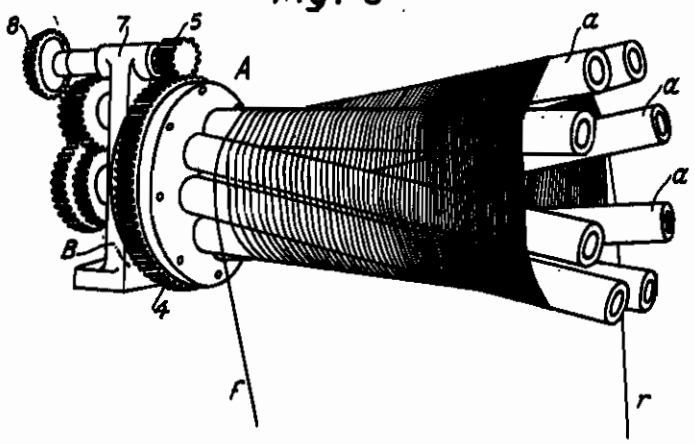


Fig. 3



INVENTOR
Stefano Sordelli
BY
Robert F. Davis
ATTORNEY

Published Apr. 27, 1943 Serial No. 106,911

ALIEN PROPERTY CUSTODIAN

MANUFACTURE OF ARTIFICIAL TEXTILES

Stefano Sordelli, Turin, Italy; vested in the Alien Property Custodian

Application filed October 21, 1936

My invention relates to the manufacture of artificial textiles, and has for its object, in the first place, to provide a spinning process which allows of obtaining products having both in the dry and more especially in the moist state, mechanical properties which are materially superior to those which have been hitherto obtained, and approximate very closely, for instance, in the case of textiles of cellulose obtained from regenerated viscose, to the mechanical properties of cotton.

Although the process of the present invention is applicable to the various processes in the manufacture of artificial textiles, it has been more particularly investigated and is herein described with reference to the viscose process.

A further object of the invention is to provide a device for carrying the said process into effect.

The above mentioned enhanced mechanical properties of textiles, together with the correlated property of a smaller degree of swelling in passing from the dry to the moist state, are derived from a peculiar structure owed to the method of spinning according to the invention, said structure being characterized, in addition to a certain degree of directional arrangement of the micelles, also and especially by the presence of residual internal tensions of increasing strength from the centre towards the periphery of the cross section of each single filament of the textile.

The process according to my invention consists broadly in subjecting the filaments to a continuous, gradual stretching during the whole or a great part of the period of time necessary for their complete formation in the course of spinning, that is to say for each filament to undergo the change from the initial state of a colloidal solution enclosed in a thin film, as assumed at the issue from the holes in the spinning nozzle, to the final state of thorough coagulation and setting, as proved by the fact that when freed from the stretching device the filaments would have none or a very little tendency to shrink.

In order to better explain the principle of the invention let each filament be considered as ideally composed of concentric elementary layers successively formed by the progression of the coagulation from the surface towards the centre of the filament; then it will be understood that on account of the gradual stretching action being simultaneously exerted upon the layers, each of these will not only be formed under such conditions of tension as are generally considered as favourable to the directional arrangement of the micelles, but will also undergo a total longitudinal deformation which will be respectively less or greater that that of the preceding or following neighbouring layers, such deformation giving rise in the finished product to the aforementioned internal residual tensions of increasing value from the centre towards the periphery of the cross section.

It is also evident that the increase in the strength of said residual tensions, from the centre to the periphery, and consequently the physical properties of the thread, will depend upon the total amount of longitudinal deformation, and that it will therefore be possible by a suitable choice of the percentage of stretching, to control the tensile strength and correlatively the elongation of the finished products, in order to suit the particular requirements of their use in the manufacture, particularly according to whether it is desired to obtain continuous filament textiles (rayon) for which the elongation should not be reduced below given limits, or short fibre textiles (staple fibres) as obtained by cutting the bundle of filaments forming the thread in short lengths, for which textiles it is desirable to obtain high tensile strength even with a low elongation, as in the case of natural vegetable fibres (cotton for instance).

While the possibility of increasing the tensile strength of artificial textiles by subjecting the filaments, during the spinning operation, to a certain degree of stretching has already been considered in several methods of spinning artificial silk, there is no evidence that any reference had ever been made either to the desirability of exerting the stretching action gradually during the comparatively very long time required for the filaments to reach the final state of setting or to the correlated advantage of rendering them capable of supporting a comparatively very high percentage of stretching.

On the contrary, any such correlation between stretching and coagulation appears to be precluded, in all the known methods, considering the exceedingly short duration of the stretching action which reaches at the maximum a few seconds, for the usual spinning speeds, this action being exerted on lengths of thread of not more than a few metres.

Considering for instance the viscose process, wherein usual speeds of 55–65 metres per minute are used, since the stretching devices of known methods generally act on lengths of thread of not more than two metres, the stretching action is completely ended within two seconds at the maximum, whilst according to the invention, in the particular case which has been cited below, as an

example, the stretching action is gradually exerted on a length of thread as great as 38 metres, corresponding to a duration of about 40 seconds, say twenty times more than in known methods. This striking difference, together with that concerning the amount of stretching, which generally is limited to 30% in the known methods, whilst it reaches according to the present invention, in the example cited below, for instance, the unprecedented value of 70%, clearly define the novelty of the invention over the previously known methods.

From the foregoing it will be understood that in order to obtain the best results the duration of the stretching action shall be checked according to the elements affecting the duration of the coagulation, that is the count of the filaments and the physico-chemical properties both of the colloidal solution and the coagulating agent. In the case of the viscose, for instance, the duration will depend upon the cellulose and soda contents of the viscose and its degree of ripening, as well as upon the nature and concentration of the spinning bath. Considering particularly the great number of formulae which have been proposed for spinning baths, it will be understood that it would be almost impossible to give exact limits for the duration; however, a duration of stretching of from 15 to 60 seconds appears to cover all the conditions that can be industrially met with.

As to the amount of stretching which, as previously stated, allows of controlling the correlated values of tensile strength and elongation of the thread, the same may easily be chosen, in the case of the viscose process, between 40% and 80%, the higher value referring to the production of short fibre textiles similar to natural vegetable fibres such as cotton.

The device for carrying out the process of the invention consists substantially of a kind of winder frame, of a particular structure, on which the thread while being wound in helical turns is at the same time subjected to progressive stretching; this winder frame is interposed, in the spinning machine, between the spinning nozzle and the thread receiver (bobbin, centrifugal box, conveyor belt or other means), so that the thread, unwinding itself from the device after having travelled through a certain number of turns, passes to the receiver.

A preferred embodiment of this device is hereafter described with reference to the attached drawings, in which:

Fig. 1 is a side view of the device partially in section through its longitudinal axis;

Fig. 2 is an end view along the axis of the device;

Fig. 3 is a perspective view of the device, showing the thread wound on it, and

Fig. 4 is the representation of a detail.

The device comprises a hollow drum generally indicated in the drawing by the reference A, formed of two parts substantially in the form of discs 1 and 2 joined together so as to form a single piece, the second of which is fitted with a long hollow spindle 3, coaxial with the drum mounted, with the interposition of a bronze bush, in a bored seating in a frame B. The drum A is thus free to revolve about its axis x—x, being driven in the following manner. The periphery of the drum is provided with a toothed ring 4, which engages with a pinion 5, carried by a spindle 6 whose axis is parallel to x—x, mounted in a bearing 7 formed in the frame B. The opposite end of the spindle 6 carries a bevel pinion 8 which engages with a second bevel pinion 9, keyed to a shaft 10 whose axis is at right angles to the axis x—x of the device. This shaft runs right along the spinning machine parallel to the series of spinning nozzles, and may receive the movement in any conventional manner by the drive of the machine itself. The shaft 10 transmits the rotary motion to the drum A through the gears just described, and so on in exactly the same manner for each of the devices relative to the different spinning nozzles in the machine.

The drum A acts as a support for eight cylindrical rollers, a_1 . . . a_8, pivoted on it and whose axes are at an angle to the axis x—x and spaced at equal intervals around a circumference. These axes meet a plane perpendicular to the axis x—x, on the front of the drum A, whose trace is indicated in fig. 1 by m—m, at points at 45° one from another on a circumference having its centre on the axis x—x; they are, however, askew with regard to the axis x—x, being tangential to an imaginary cylinder whose axis is the axis x—x and whose base is the above mentioned circumference, and form with the generating lines of said cylinder an angle α.

The rollers a_1 . . . a_8 are mounted overhanging from the drum A by means of end pins 11 which are free to revolve in bearings 12 and 13, provided respectively in the front part 1 and in the rear part 2 of the drum. Of course the axes of these bearings are askew with respect to the axis x—x in the way described above; it should, however, be noted that the axes of the rollers a_1 and a_8 are shown in fig. 1 in a conventional manner, for the sake of simplicity, as if they were contained in the plane of the drawing. It should further be noted that the pins 11 for the rollers a_4 and a_2 are not shown in the drawing in order to render it clearer.

Each of the pins 11 is fitted with a toothed wheel 14 which engages, through a suitable helical gearing, with a central gear wheel 15; this receives, in consequence of the rotation of the drum A, a rotary motion in the same direction, but at a slower speed, through the effect of the following gearing. The gear wheel 15 is keyed to a spindle 16 which is free to rotate within the hollow spindle 3 and carries a gear wheel 17 keyed to its end projecting from the hollow spindle 3. This latter also carries, on its end near the gear wheel 17, a toothed wheel 18. The gear wheels 17 and 18 engage respectively with two other gear wheels 19 and 20, locked together but both free to rotate about a fixed stud 21 carried by the frame B. If the ratio of transmission between the gear wheels 17 and 18 is suitably chosen, so that it be less than unity, the gear wheel 15 will turn, as has been mentioned, in the same direction as the drum A, but at a slower speed.

Through the effect of the engagement between the gear wheels 14 of each single roller a and the central gear wheel 15, the rollers, besides being driven round as a whole with the drum A, each receives a separate rotating movement about its own axis in the same direction. The nearer the rotational speed of the gear wheel 15 is to that of the drum A, the slower will be the individual rotation about its own axis of each separate roller, and the same may be suitably set by varying the number of teeth in the gear wheels 17 . . . 20. The rollers a are suitably covered with rubber or other suitable material.

In the operation of the device the set of rollers a carried by the drum A and revolving with it

may be regarded as a winding frame, on which the thread coming from the spinning nozzle in the form of a bundle of filaments is caused to wind itself. It is evident that a consequence of the simple rotation of the device around the axis x—x the thread would tend to wind itself according to a polygon lying in a plane at right angles to the said axis. However, through the effect of individual rotation of each of the rollers a, it will come about that the thread, along the small arc it embraces on each roller, will be drawn by the movement of the roller along a circumference at right angles to the axis of the roller and passing through the point at which the thread makes its first contact with its surface. Owing to the obliquity of the axis of the roller with respect to the axis of rotation of the device this displacement of the thread will therefore have the effect of causing the thread to leave the plane perpendicular to the axis of the device, in a direction depending upon that of the obliquity of the roller. The direction of such obliquity having been suitably chosen, the turns of thread will be displaced starting from the side next the drum A towards the free end of the rollers. This will result in causing the thread to assume, in general, a helical direction, so that there will be formed on the system of rollers a series of turns side by side, spaced one from the other a small distance and carried on the device as on a winding frame (Fig. 3). Beginning from the last turn towards the right, the thread r will be led to the receiver, for example, the box of a centrifugal spinning machine, for the final winding.

The direction of the rollers a, diverging from the axis x—x towards their free ends, is such that their envelope may be considered as roughly trunco-conical; therefore the length of a helical turn wound in a polygon on the set of rollers will increase progressively as its distance from the drum A increases.

It must be considered that each turn of thread, after it has been wound on the roller system, by the effect of the general rotation of the device, near the inner end of the rollers (f in Fig. 3), is gradually shifted along these, towards their outer end by the effect of their individual rotation; at the same time, owing to the general rotation of the device a new turn is wound on at every revolution, beginning at f, and another is cast off, at r. In this operation the adherence between the thread and the surface of the rollers is, however, such as substantially to prevent any slipping of the turns at their points of contact, and as a consequence each turn, in passing from the point in which winding on the device begins, to the point where it is cast off, will be obliged to increase its length by a certain amount depending upon the degree of divergence between the rollers.

The device thus, according to the process of the present invention, subjects the filaments of the thread, over a considerable length, such as the total length wound on the device, to a gradual and continuous stretching process, the thread being first wound on the device in its initial state of formation immediately after it leaves the spinning nozzle, and being cast off the device in a state of complete coagulation and setting, or nearly so.

As a demonstration of the results which can be attained with the process of the present invention, there are given below by way of example the data drawn from comparative tests made on textiles produced according to the invention and according to known processes.

From a viscose prepared in the usual way containing 8.1% of cellulose and 6.9% of soda, having a viscosity of 32 (ball viscosimeter), index of coagulation 13 (Hottenroth), issuing from a spinning nozzle with holes of 80 microns diameter, immersed to a depth of 18 cm. in a spinning bath containing 11.5% of sulphuric acid and 27% of sodium sulphate, threads were produced composed of elementary filaments of 1.5 den. grade, in the following two ways, namely

(a) Under ordinary conditions of spinning, that is to say, winding the thread issuing from the spinning nozzle directly on to a bobbin, and

(b) Following the process of the present invention, that is to say interposing between the spinning nozzle and the bobbin the device described, and winding the thread on it. With the actual device used in the cited case, 70 turns of thread were wound on, equal to a total length of about 38 meters of thread, which remained on the device for a period of about 40 seconds, and with a total stretching of 70%.

Samples of the threads obtained respectively under the condition (a) or (b) where subjected to tensile and elongation tests; they were found to have the following mechanical properties.

Samples	(a)	(b)
Specific strength in dry state ..... gr/den..	1.65	2.75
Specific strength in moist state ..... do....	0.68	1.60
Elongation in dry state ..... per cent..	24	10.5
Elongation in moist state ..... do....	43	15

While these figures are quoted as an example, solely with the object of giving an idea of the effect deriving from the application of the process, it is to be understood that further improved results may be obtained by suitably varying the physico-chemical properties of the viscose and of the spinning bath. It will be also understood that the increase in tensile strength, with the consequent decrease in elongation, may be suitably controlled, limiting it in the case of rayon, in such a manner as to suit the mechanical properties of the thread to the requirements of its various uses (weaving, knitting, fabrics for pneumatic tyres etc.) while amplifying it in the case of short fibre textiles, thus bringing their properties into line with those of natural textiles of vegetable fibres, such as coton, which usually show a high degree of tensile strength with a low degree of elongation.

An idea of the mechanical properties of threads spun from artificial filaments previously cut to short lengths, as obtained by the methods known heretofore and the method of the present invention, respectively, in comparison with mechanical properties of a thread spun from best vegetable fibres can be acquired by an inspection of the following data. Threads of the same count (English count 20) were spun respectively from: (1) American middling cotton; (2) the best short fibre artificial textile material, 1.5 den. 32 mm. at present manufactured in Italy by cutting in the wet state bundles of filaments obtained under similar conditions to (a) in the previous example; and lastly, (3) the same artificial textile material, but produced under conditions identical with those cited in (b), in the foregoing example.

Samples of each of the above threads were subjected to tensile and elongation tests, and the fol-

lowing average mechanical properties were ascertained.

Samples		(1)	(2)	(3)
Breaking length	dry ..... meters..	11.700	8.600	14.200
	moist ..... do ...	13.200	4.400	10.100
Elongation	dry ..... per cent..	6.9	11.6	9.8
	moist ..... do	8.7	13.3	12.3

Also in this case the breaking lengths given for the sample (3) are susceptible of further increase.

It must be understood that the object of the present invention is, in the first place the process which has been described, and that this process can be carried out, without departing from the scope of the invention, by any device or apparatus different from the one described, provided it allows of the execution of the process in the manner described.

The device for carrying out the process of the invention, as has been particularly described and illustrated, also forms one of the objects of the invention, and it must be understood that its constructional form may be even considerably altered without going beyond the scope of the invention.

The shape of the rollers, in particular, may be other than cylindrical, with a view to obtain the desired clearance between the successive turns of the winding and consequently the desired rate of stretching of the thread at different points along the rollers. The rollers may be conical, for instance, or they may be shaped as represented in fig. 4, wherein the outline of the portion from D to E, near the inner end of the roller, is an arc of circle while the subsequent portion from E to C is cylindrical. This shape allows of a stretching at decreasing rate being obtained, such as has been found to be convenient in the practice.

STEFANO SORDELLI.