

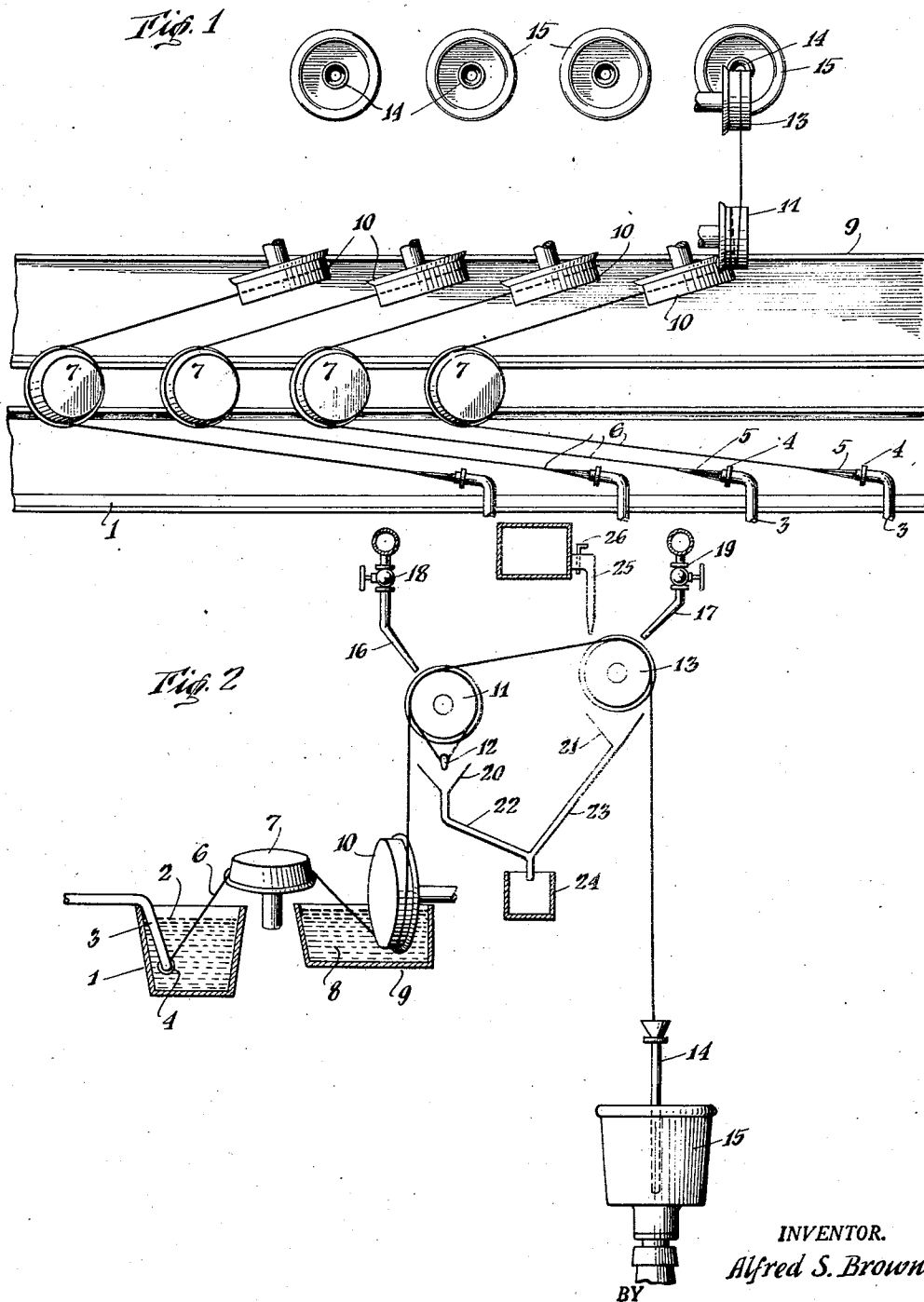
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PROCESS OF MANUFACTURING VISCOSE RAYON YARN

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PROCESS OF MANUFACTURING VISCOSE  
RAYON YARN

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This invention relates to the manufacture of rayon by the viscose process and more particularly to the manufacture of viscose yarn of improved textile characteristics.

It has long been known that the strength of viscose rayon yarn is increased by stretching the yarn during spinning, this increase in strength being enhanced if the stretching is performed while the yarn is being treated with hot water. In all viscose spinning systems, the viscose solution is extruded through a plurality of holes in a spinneret which is immersed in a bath containing perhaps eight to ten percent of sulfuric acid. The action of this bath on the extruded viscose forms a thread comprising a plurality of individual filaments, the thread being drawn through and out of this bath by some mechanical means. In two-bath viscose spinning systems the young thread emerging from the highly acid bath is then subjected to the action of a second bath containing perhaps one percent of sulfuric acid, this bath being maintained at an elevated temperature in the range of 60° C. to 100° C. The thread is often stretched as much as 100 percent during its exposure to this second bath.

Numerous disclosures in the prior art are concerned with the details of the operation of two-bath viscose spinning systems, as these details are of utmost importance in determining the textile qualities of the resultant yarn.

The provision of a viscose spinning process which improves the yarn's textile qualities is a primary object of this invention.

Another object of this invention is the provision of a viscose spinning system which improves the yarn's textile qualities and still requires only a moderate exposure of the running yarn to the several baths.

A further object of this invention is the provision of a process for making a viscose rayon yarn the filaments of which are substantially homogeneous.

An additional object of this invention is the provision of a process for improving the effectiveness of the hot bath in two-bath viscose spinning.

An additional object of this invention is the provision of a process for retaining in the running thread the improved qualities imparted by this novel spinning system.

The attainment of these objectives is described in the following specification which also discloses still further objects of this invention.

I have found that the textile quality of viscose

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yarn is materially improved when the two-bath spinning system is so operated as to restrict the stretching of the yarn to the time immediately after the yarn's emergence from the bath of the hot dilute acid, this improvement in quality being particularly great when a substantial length of the running yarn in a relaxed state is wholly enclosed by the hot dilute acid of the second bath prior to any stretching of the yarn. I have found, furthermore, that the accurate localization of the stretching operation is reflected in the yarn's textile qualities in a surprisingly critical manner.

These findings may be explained in terms of the cross-sectional homogeneity of the individual filaments in the yarn, although I do not wish to be limited to any particular theory of the observed effects of this invention. It is apparent that the reaction between the acid of the first bath and the viscose extruded through a spinneret hole must take place at the surface of the filament, producing a skin of regenerated cellulose. Reaction between the acid and the generally interior regions of the filament must await either the slow process of diffusion through this skin or the continued exposure of new surfaces by the slippage of the skin over the liquid interior of the filament, such slippage being the result of applying tension to the filament. Consequently the young filament has a chemical heterogeneity inherent in the presence of a skin and a generally unreacted interior, and has also a physical heterogeneity in that the skin has been strained in carrying the running tension. The production of a homogeneous filament must concern itself with the elimination of both chemical and physical strain differences.

The action of a very hot dilute acid on a young filament appears to be chiefly a relatively rapid regeneration of the cellulose in the interior of the filament. Hence a short exposure of the young filament to such a bath tends to make the filament chemically homogeneous in that the whole filament rapidly becomes regenerated cellulose. If this completion of the spinning reaction takes place on substantially relaxed yarn, there will be only a minimum of localized straining of the filament's cellulose, and subsequent stretching will operate uniformly over the cross-section of the filament to produce a stretched filament that is physically as well as chemically homogeneous. As far as I have been able to ascertain the critical factors are: first, to keep the dilute acid bath very hot and in uniform contact with the filaments; and second, to restrict

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any stretching of the filaments to a time after substantial completion of the action of the hot dilute acid.

This invention, then, may be described as a process of spinning viscose rayon wherein the filaments are formed in a first bath containing about 7 to 10 percent sulfuric acid; wherein the bundle of filaments is transferred to a second bath of hot dilute acid by positively driven means exclusively, viz., without contacting any stationary or idling guide which would create any frictional tension in the thread; wherein the filaments are then subjected freely and in a relaxed state to the action of the hot dilute acid; wherein the filaments are lead from the second bath by positively driven means; and wherein after emergence from the second bath the filaments are given a first stretching. According to the practice of this invention the run of the filaments in each bath need only be moderate, distances of about 6 inches to about 25 inches generally being sufficient, so that the need of elaborate and perhaps even harmful thread storage devices is eliminated. Furthermore, the amount of stretch imparted to the filaments is relatively low; a stretch of 55 percent generally sufficing to produce a yarn with a tenacity of more than 3 grams per denier; even though the viscose is prepared from wood pulp and the first spinning bath is of the simple, low zinc ion type.

Insofar as I am able to ascertain, the theory explained above is substantiated in that yarn made according to this new process is exceptionally tough, and, on dyeing, appears to have exceptional cross-sectional homogeneity.

The practice of my invention is more fully explained with reference to the accompanying figures, wherein I also show certain additional process features that I sometimes prefer to add to the steps already described.

In the accompanying drawings there is shown in more or less diagrammatic form a portion of a spinning machine, the details of which form per se no part of the present invention. In the drawings:

Figure 1 is a diagrammatic view, principally in plan, of a rayon yarn spinning machine, illustrating the passage of the yarn through the two baths above referred to; and

Fig. 2 is a diagrammatic view principally in vertical section as seen from the right of Fig. 1.

Referring now to the accompanying drawings, I have shown a trough 1 for liquid, comprising a first or spinning bath 2. Into this bath extends a plurality of pipes or goosenecks 3, each of which has a spinneret 4 at its end beneath the surface of the spinning bath 2. As indicated in Fig. 1, there are a number of similar units arranged side by side along the length of the machine, which may have any desired number of such units. It will be understood that viscose is forced through the pipes or goosenecks 3 and thence through the apertures in the spinnerets 4 in the usual manner and by any suitable means such as those now conventional in the art. The viscose is extruded through the several holes in each spinneret 4 to form a plurality of filaments as indicated at 5 beneath the surface of the spinning bath 2; these filaments collecting together to form a single thread or strand of yarn as shown generally at 6. The yarn 6 passes for a substantial distance through the spinning bath 2 to regenerate some of the cellulose of the filaments thereof, then emerges therefrom and passes around a Godet wheel 7. These wheels are disposed with their

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axes in a vertical plane extending inside and parallel to the tank or trough 1, and longitudinal of the machine, the axes being, however, at a relatively small angle, in the order of magnitude of about 8° to 25° to the vertical, so as to provide a substantial distance of travel through the spinning bath 2 prior to the emergence of the thread 6 therefrom. The wheel 7 is positively driven at a desired speed by any suitable mechanism which is not shown herein and which per se forms no part of the present invention.

The thread 6 passes thence into a second bath 8, which is contained in a longitudinally extending trough 9 parallel to and at about the same level as the bath 2 and the tank 1. The liquid of this second bath may contain substantially the same chemicals as that of the spinning bath 2, but is more dilute than such spinning bath and, further, is preferably maintained at a temperature in the range of about 85° to 100° C. No heating means for the liquid in the bath 8 are shown in the accompanying drawings, but it will be understood that the liquid thereof may be heated and maintained within a desired temperature range by the use of any suitable means (not shown). Within the bath 8 the running thread 6 passes thence around a second Godet wheel 10, which is arranged with its axis substantially horizontally, and at a suitable angle to the bath so that the thread may be maintained thereon, and is positively driven at a speed the same as or slightly slower than that of the wheel 7. The mechanism for supporting and driving the wheel 10 of each unit is not shown herein and per se forms no part of the present invention. The wheels 7 and 10 of each unit are so disposed and arranged in respect to each other and in respect to the bath 8 that the thread 6 will have a substantial period of travel which I sometimes prefer to have about 10" to 20" through the liquid of the bath 8 prior to contact with any solid body including the wheel 10, so as to permit free access of the liquid in the bath 8 to all of the filaments of the yarn passing therethrough in a uniform manner and thereby substantially to complete the regeneration of the cellulose of the filaments. The maintenance of the liquid of the bath 8 at elevated temperatures supplies heat to the thread or yarn during its passage therethrough and tends to accelerate the chemical and physical reactions or operations taking place, so that the cellulose will be substantially completely regenerated and, at the same time, will be swelled to a certain extent which may tend to cause a shrinkage of the yarn in length. To compensate for this shrinkage, the wheel 10 may be run at a somewhat lower peripheral speed than that of the wheel 7. However, it is desired as far as possible to prevent any substantial stretching of the yarn between its emergence from the liquid of the spinning bath 2 and its emergence from the liquid of the bath 8. To this end, the thread is preferably not passed around any non-rotating guides by which its direction is changed, nor is it passed around any non-positively driven rollers in the form of idlers as has been customary with many prior art arrangements.

Once the regeneration of the cellulose has been substantially completed in a uniform manner as just described, it is now possible to stretch it uniformly. For the purpose of this stretching, the yarn is passed from the Godet wheel 10 around a third Godet wheel 11, about which it passes twice in a so-called "double wrap," passing around an intermediate guide 12 to prevent crossing of the

thread on this wheel. While I have chosen to show herein a double wrap around the Godet wheel 11, this is not always essential in practice. It will be understood that if but one turn is taken around the wheel 11, the guide 12 may be dispensed with. Again, the Godet wheel 11 is positively driven at a predetermined speed by suitable means (not shown).

The yarn passes from the wheel 11 around a fourth Godet wheel 13 and thence downwardly through the usual funnel 14 to a spinning pot 15 operated by a motor (not shown) in the conventional manner, this being for the present purposes a collecting point for the yarn. So far as the present invention is concerned the means 14-15 may be considered as the conventional and known means now in commercial use in the pot or cake spinning of rayon, the pot 15 being rotated at a relatively high speed, and the funnel 14 being substantially vertically reciprocated by suitable means (not shown) so as to build up a yarn bundle or cake within the pot 15 which is removed from time to time by the machine operator.

Intermediate the arrival of the yarn onto the periphery of the Godet wheel 11 and its point of leaving the fourth Godet wheel 13 the yarn may be washed and cooled by the provision of suitable means such, for example, as spray nozzles 16 and 17 directed toward the path of the yarn over wheels 11 and 13, respectively, and adapted to supply sprays of cold water or other washing or treating liquids onto the yarn at these points in its travel. The flow of water or other liquid through the spray nozzles 16 and 17 may be respectively controlled by suitable valves 18 and 19. I have also shown diagrammatically a collecting system for liquid sprayed onto the wheels 11 and 13, comprising funnel means 20 and 21, drain tubes 22 and 23 and a receptacle 24 from which the liquid may be led off in any desired manner (not shown).

I also contemplate and under certain circumstances I may desire to effect a certain amount of drying of the yarn during this portion of its travel and thus preferably provide for this purpose an air nozzle generally indicated at 25, shown as directed onto the path of the yarn as it approaches its point of tangency with the periphery of the wheel 13. The air stream through the nozzle 25 may be controlled by a suitable valve generally indicated at 26. This air is preferably controlled as to temperature and humidity, to predetermined points or ranges and may be at a temperature of about 75° F. and at a humidity substantially below its saturation point, so as to effect a drying of the yarn. This drying involves the evaporation of water from the yarn which has an inherent effect of cooling the yarn to a certain extent due to the latent heat of vaporization of the water evaporated. It will be understood, of course, that in the event the air nozzle 25 is used for drying and/or cooling, the valve 19 will usually be cut off so that no water will be sprayed onto the yarn through the spray nozzle 17; although the spray nozzle 16 may be in operation simultaneously with the air nozzle 25. One way which I now propose to use this phase of the present invention is to employ the air nozzles 25 of each unit for supplying to the spinning room the air which is normally supplied to such rooms, thus not only humidifying the air in the spinning room, but also blowing this air directly onto the yarn for the aforesaid purpose.

From the above, it will be seen that I have provided a process by which the yarn is moved con-

tinuously along its path, passing solely over and around positively driven wheels, rather than idlers or stationary guides, with the single exception of the guide 12 used incident to the double wrap around the Godet wheel 11. I have further provided a process by which the stretching of the yarn is specifically and substantially solely allocated to a desired part of the process, viz., after the substantial completion of the regeneration of the cellulose. The present process further provides for the regeneration of the cellulose to be carried substantially to completion in a uniform manner by exposing the yarn for a substantial period of time in its path of travel between the spinneret and the collecting point to the action of a heated dilute second bath, during a major part of this action the yarn being out of contact with any solid body, which might tend to interfere with the uniform chemical, physical, and thermal action of the liquid of this second bath upon the yarn. I further provide for the process steps of washing and/or partial drying of yarn while cooling it subsequent to the stretching operation and prior to its being passed to the collecting point. In this step of the process it may in some instances be preferred to provide for a certain amount of shrinkage in the length of the yarn. For this purpose the wheel 13 may be run at a somewhat lower peripheral speed than that of the wheel 11.

It will be understood by those skilled in the art that certain of these features have independent utility and some may be used without the others, while some may be varied by the substitution of other means or process steps within the knowledge of the art. I do not wish to be limited therefore, except by the scope of the appended claims, which are to be construed validly as broadly as the state of the prior art permits.

What is claimed is:

1. In the manufacture of viscose rayon, the process which comprises the steps of extruding at least one jet of viscose into a spinning bath, comprising not over about 10% sulphuric acid, drawing the resultant bundle of at least one filament through said spinning bath by positively driven means to form a thread, passing this thread freely through a second bath by positively driven means at substantially the same rate at which the thread is withdrawn from said spinning bath, whereby substantially no stretching takes place between said baths and during the passage of the thread through said second bath, said second bath comprising a dilute acid bath which is at a temperature of about 60° to about 100° C., and stretching the thread as it emerges from said second bath.

2. The process in accordance with claim 1, wherein said spinning bath comprises from about 7% to about 10% sulphuric acid, and wherein the cellulose is but partially regenerated in said spinning bath, and wherein said second bath comprises not over about 1½% sulphuric acid.

3. The process in accordance with claim 1, wherein the temperature of said second bath is maintained at about 85° to about 100° C.

4. In the manufacture of viscose rayon, the process which comprises the steps of extruding at least one jet of viscose into a spinning bath, comprising not over about 10% sulphuric acid, drawing the resultant bundle of at least one filament through said spinning bath by positively driven means to form a thread, passing this thread freely through a second bath by positively driven means at a speed substantially the same as the rate at which the thread is with-

drawn from said spinning bath, whereby substantially no stretching takes place between said baths and during the passage of the thread through said second bath, said second bath comprising a dilute acid bath which is at a temperature of about 60° to about 100° C., and stretching the thread by a predetermined proportion of its length as it emerges from said second bath by passing it thereafter around a third positively driven means operating at a peripheral speed a predetermined proportion greater than that of the second named positively driven means by which the thread is drawn through said second bath.

5. In the manufacture of viscose rayon, the process which comprises the steps of extruding at least one jet of viscose into a spinning bath, comprising not over about 10% sulphuric acid, drawing the resultant bundle of at least one filament through said spinning bath by passing it around a positively driven Godet wheel and thereby forming a thread, passing this thread freely through a second bath by passing it around a second positively driven Godet wheel, which is rotated at a speed such that the peripheral speed of said second Godet wheel is a predetermined proportion less than that of the first named Godet wheel, whereby the thread is permitted to shrink somewhat during its travel through said second bath, said second bath comprising a dilute acid bath which is at a temperature of about 60° to about 100° C., and thereafter passing the thread from said second Godet wheel to and around a third Godet wheel driven at a peripheral speed a predetermined proportion faster than the peripheral speed of said second Godet wheel to provide a predetermined controlled stretching of the thread during its passage from said second to said third Godet wheel.

6. The process in accordance with claim 1, comprising the additional step of washing the yarn subsequent to the stretching thereof aforesaid, and then passing the yarn to a collecting point.

7. The process in accordance with claim 1, comprising the additional step of washing the yarn with cold water subsequent to the stretching thereof aforesaid and then passing the yarn to a collecting point.

8. The process in accordance with claim 1, comprising the step of predetermining the stretching of the thread as it emerges from said second bath as aforesaid to limit such stretching to not more than about 55% to about 60% of the length of the thread prior to such stretching.

9. In the manufacture of viscose rayon, the process which comprises the steps of extruding at least one jet of viscose into a spinning bath, comprising not over about 10% sulphuric acid, drawing the resultant bundle of at least one filament through said spinning bath by positively driven means to form a thread, passing this thread freely through a second bath by positively driven means at substantially the same rate at which the thread is withdrawn from said spinning bath, whereby substantially no stretching takes place between said baths and during the passage of the thread through said second bath, said second bath comprising a dilute acid bath which is at a temperature of about 60° to about 100° C., stretching the thread as it emerges from said second bath by passing the thread from the second named positively driven means to a third

positively driven means operating at a higher peripheral speed than that of said second positively driven means, and controllably relaxing the thread subsequent to the stretching aforesaid by passing the thread from the said third positively driven means to a fourth positively driven means operating at a peripheral speed less than that of said third positively driven means so as to relax the thread by a predetermined controlled amount.

10. The process in accordance with claim 9, comprising the additional step of washing the thread with cold water during that portion of its travel between its arrival on the third positively driven means and its passage from the fourth positively driven means.

11. In the manufacture of viscose rayon, the process which comprises the steps of extruding a plurality of jets of viscose into a spinning bath, comprising from about 7% to about 10% sulphuric acid, drawing the resultant bundle of filaments through said spinning bath by passing it around a first positively driven Godet wheel and thus forming a thread, passing this thread freely through a second bath which is at a temperature of about 85° to about 100° C. and which comprises not over 1½% sulphuric acid by passing the thread around a second positively driven Godet wheel partially immersed in said second bath, maintaining the speed of rotation of said second positively driven Godet wheel such that its peripheral speed is a predetermined proportion less than that of said first Godet wheel so as to permit of a predetermined shrinkage in the length of the thread during its passage through said second bath, controllably stretching the thread after it emerges from said second bath by passing it directly from said second Godet wheel to a third positively driven Godet wheel operating at a peripheral speed of not more than about 55% to about 60% greater than the peripheral speed of said second Godet wheel, controllably relaxing the thread subsequent to the stretching thereof as aforesaid by passing it from said third Godet wheel to a fourth positively driven Godet wheel operating at a peripheral speed a predetermined proportion less than that of the third Godet wheel, cooling the thread during the controlled relaxing thereof by subjecting it to the action of cold water between its point of arrival on said third Godet wheel and its point of leaving said fourth Godet wheel, and thereafter passing the thread to a collecting point.

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