METHOD OF PRODUCING YARNS WHICH BEHAVE AS IF THERMOPLASTIC

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This application is a continuation-in-part of application Ser. No. 401,315 filed Oct. 5, 1964, now abandoned.

This invention relates to a method of modifying natural fiber yarns by a two-stage treatment involving first impregnating the yarns with chemicals and, then, at a time which may be widely separated from the impregnation, causing the chemicals to react with the yarn.

It has been known for some time that certain chemicals which are identified in the trade as fiber reactants, cross-linkers and resin finishes, when applied to cotton or cellulosic fibers under certain conditions, will make the yarns or fabrics treated with these materials "remember" their physical condition during cure. This is the method by which the so-called wash-wear fabrics are made, and the methods for the application of these chemicals to fabrics are commonly known and well standardized in the industry. There are numerous patents which relate to the chemistry involved and to the various materials used.

One of the recent innovations in the field of resin finishing of fabrics has been the advent of a process popularly known as "defeer-cure." This was made possible by the discovery of resins which have the ability to cure at a time long after the time of application to the fabric. It has been well known for a long time that a resin, which requires a catalytic agent to cause the chemical reaction to take place with the hydroxy groups in cellulose, can be cured at temperatures in excess of 300 degrees F. for a minute or more. If this is not done, the reaction will still take place at lower temperatures but over a longer period of time. The defeer-cure resins, on the other hand, do not cure until they are brought up to a specific cure temperature, which is considered by many to be seven minutes above 325 degrees F.

While the foregoing processes have been applied to fabrics, no satisfactory method has been known for the applications of these defeer-cure resins to yarn as opposed to fabrics. A common way of liquid treating yarns is to pass a warp of parallel yarns through treating baths. This operation is known as slashing. It is not feasible, however, to use a slasher for resin impregnating yarns because, in the first place, the yarns have only short exposure time to the liquid and the linear speed is very slow. An inherent difficulty with the slasher is that when one end breaks it is necessary to shut down the entire equipment. The mechanical treating and drying of multiple ends is inherently cumbersome and costly.

Yarns have been liquid treated in package form but an attempt to impregnate yarn packages with resins has resulted in failure because of the inability everly to extract the unused resin solution from the package. Drying is also a serious problem because the driers normally used in processes of this type will cause migration of the resin with resulting lack of uniformity of treatment. While high-frequency drying will avoid the migration problem, the equipment is costly and the productivity is low by reason of the fact that the number of packages which can be treated per unit time is small.

It is an object of the present invention to overcome the foregoing difficulties and to provide a process for treating yarns with resins which can be defeer-cured and to produce a yarn consistently and evenly impregnated with a defeer-cure type resin under conditions of efficiency and high uniformity.

A further object of the present invention is to provide a resin-treated, natural-fiber yarn characterized by a high percentage of retained breaking strength and a method of preparing the same.

Other objects and advantages of the invention will be apparent upon consideration of the following detailed description of an embodiment thereof in conjunction with the annexed drawings wherein:

FIG. 1 is a schematic side view of thread-storage, thread-advancing apparatus as it appears during the application of the setting agent and drying thereof; and

FIG. 2 is a view taken on the line 2-2 of FIG. 1 illustrating the application of the setting agent to the helices of yarn running between the rollers of the thread-storage, thread-advancing device.

Referring first to FIG. 1, cotton yarn is led from a source such as the yarn body 10 through guides 11 and 12 to the inner cylinders 13 and 14 of a cantilever thread-storage, thread-advancing device which also includes two outer cylinders 15, only one of which shows in FIG. 1. Thread-storage, thread-advancing devices of the type shown in schematic FIG. 1 are well-known in the textile arts. The principle involved is fully described and illustrated in Patent No. 2,688,663. The axes of the shafts 16 and 17 are arranged in a slightly non-parallel relationship. These shafts are supported in bearings, not shown, from the right-hand end as viewed in FIG. 1. Due to the slight convergence of the axes of the shafts 16 and 17, thread wound around the cylinders mounted thereon is driven thereby progresses in the direction of axis convergence in the form of substantially helical loops. The thread leaving each cylinder passes over to the next one going on to each cylinder at right angles to its axis.

The convergence of the axes in the practice of the present process is so slight that the yarn is laid up as a continuous body with the adjacent yarns touching one another.

In the lower run of the yarn between cylinders 13 and 14, the yarn is engaged by a padding roller 18 mounted on a shaft 19 and rotating with its lower portion immersed in a bath 20 which contains a solution or suspension of the setting agent to be applied. By comparing the axial length of the padding roller 18 to the lengths of the cylinders 13 and 14, it can be seen that an individual length of yarn in running from the right to the left end of the cylinders 13 and 14 will be contacted by the padding roller a considerable number of times. After each contact with the padding roller and before the next one, the yarn is subjected to a squeeze by the left of cylinders 13 mounted on a shaft 22 and turning in bearing relation in tangential contact with the surface of cylinder 14 on the horizontal radius opposite the one which extends toward the cylinder 13. After undergoing the squeezing effect produced by the roller 21, the coils of yarn pass under a bar 23 which acts on the yarn courses running between the top of cylinder 14 and the cylinder 13. The bar 23 is mounted so that it may be disposed at a horizontal angle by operation of the screw 24. It is usually disposed so that it tends to bias the thread to the right of FIG. 1 back toward the starting end of the cylinders 13 and 14. This action tends to close the yarns into a tight contact of adjacent coils and at the same time tends to roll the yarn a little, thereby kneading the liquid into all parts of the yarn.

The bath 20 is maintained fresh by a constant recirculation effectuated by a pump 25 which circulates the material on a reservoir 26 through a pipe leading to trough 20 and back to reservoir 26.

After repeated passage under cylinders 13 and 14 the yarn leaves that pair of cylinders, passes through guides 27 and 28, and goes on to a pair of coaxial cylinders 15 also mounted on shafts 16 and 17 but to the left of coils of cylinders 13 and 14 as seen in FIG. 1. These cylinders (15) are very uniformly, internally heated and effect the drying of the
yarn quite slowly as it runs from one end of the system to the other. Drying temperatures are in the range of 140 to 180° F., and these are below the curing temperature of the setting agent. Because the cylinders 15 are mounted on shafts 16 and 17, they have the same axial convergence as the cylinders 13 and 14. This will thus cause the thread to progress in a tight helix from the left end to the right end of the cylinders 15 and, drying will be effected as this takes place. The dry thread is led over a guide 29 to a point of collection 30 which is diagrammatically indicated at 31 as a ring twister. A bar 23 in similar structure to bar 23 acts on the upper course of yarns running between the cylinders 15. The means of heating the cylinders 15 are not shown but the system employed in Patent No. 2,834,860 may be used.

Yarns which have been impregnated by the foregoing method can be utilized in many ways. One such utilization is to impregnate and dry a sewing thread with a defuer-cure resin by the method described above. Such a thread finds important utility in connecting fabrics because of the reduced tendency to produce puckering. Wash and wear, permanent press fabrics are themselves usually treated with defuer-cure resins, dried, assembled into garment form, pressed to the desired shape and, finally, cured in an oven. The cure having the effect of making the press permanent and stable through normal wear and normal laundry cycles. If such a garment is sewed with untreated thread, the thread is not stabilized and is subject to normal shrinkage of one to three percent. This can and does produce some puckering. By the present invention, if the garments are connected with thread which has been treated with a defuer-cure resin, then the thread will cure at the same time the fabric is cured, and the entire garment will have stability and uniform resistance to shrinkage.

Threads which have been defuer-cure treated according to the present invention are useful in preventing puckering even in connecting fabrics which are not defuer-cure resin treated. This is believed to be due to the fact that some puckering is caused by slippage of the thread through the fabric after stitching. Such slippage may be caused by the manipulations of washing or other application of stresses to the garment. If the thread of the present invention is used and the resin is cured after the sewing operation is complete, the configuration of the thread in its loops and its normally out-of-straight-line shape is set by the curing of the resin, therefore stabilizing the seam as a whole structure.

According to the present invention, reduction in the tensile strength of the thread after curing by reason of the application of the resin is sharply reduced. It has been discovered as a part of this invention that subjecting cotton yarns or threads to stretching during the application of the defuer-cure resin results in a gain in retained tensile strength after curing. This may be accomplished by the apparatus of FIGS. 1 and 2 where it was stretched two percent and dried. Breaking Percent Strength, oz. Retained

| Control no resin or heat | 28.46 | 25.48 |
| Skein treated slack | 20.53 | 72.1 |
| Skein treated stretched on SS machine | 24.23 | 85.1 |

From the foregoing example it can be seen that by stretching the yarn while it is resin impregnated, a substantial percent, namely about eighty-five percent, of the original strength is retained.

The use of defuer-cure resins according to the present invention makes it possible to apply to natural fiber yarns many of the texturing processes already known for yarns such as nylon and polyesters. These processes include false twisting, knitting about the use of stuffing boxes and the use of air jets. In all of these processes the physical disposition of the yarns is modified and, while it is modified, heat is applied so that there is elastic memory and a tendency of the yarn to return to the configuration or position which it occupied during the heating. It has been found that with defuer-cure resins this same tendency to go back to a configuration or position occupied during the curing of the resin can be made permanent. While the prior art has attempted to extend false twisting to natural fiber yarns, as taught by Herberlein Patent No. 2,463,618, the resins taught by that patent are not of the defuer-cure type. Consequently, the entire operation has to be conducted at speeds in the neighborhood of 20 to 60 yards per minute, which are the limiting speeds imposed by false twisting. According to the present invention, the resin can be applied at speeds in excess of 500 yards per minute, giving a production advantage, and the efficiency of the wet application is not tied to another slower operation such as the false twisting, and it is possible to prepare efficient inventories of defuer cure resins. Yarns impregnated with resins of the type disclosed by Herberlein cannot be stored, since once the resin is applied the reaction goes to completion in a short time under ordinary room storage conditions. Furthermore, Herberlein dries and cures the resin simultaneously, which makes temperature control difficult, because in the early stages of the operation most of the heat is used to evaporate moisture and is not present as sensible heat. This requires that the residence time in the heating zone be increased and this, in turn, imposes a speed restriction on the movement of the yarn through the false twisting-heating curing zone.

If, as in the present case, the yarn is dry as fed to the false twister, then the speed may be somewhat higher because all of the heat is effective because of the fine mist to make deposits in the machinery, and also, the resulting obnoxious odors are considerably less present when running dry yarn. It can also be seen that maintenance of even temperature in the heater zone of a false twister will be easier if there is no cooling due to evaporation occurring in the heater.

The present invention is valuable in the production of laces which, by reason of their delicate nature, cannot be resin treated after they are made but which can be
made in the ordinary way from yarns treated with defcurcure resins according to the invention.

It can then be seen that if the yarn had been impreg-
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nated prior to the textile operation which produced the fabric, it would then be possible to cure the fabric in the as made form, which means that it would have lost nothing of the aesthetic value, but would be stabilized against shrinkage and wrinkling due to laundering.

Yarns made in this way can, of course, be used in many operations where the properties of a natural fiber yarn should resemble those of a thermoplastic material, but where impregnation would be better done in yarn form.

In the following claims the term “stress” is used gen-
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erically as covering any stress which produces a strain. A point in applicant’s defcurcure method is that the curing can take place after a stress has been imposed on the yarn.

What is claimed is:

1. A process for increasing the retained tensile strength of a natural fiber yarn which comprises stretching the yarn while wet-treating the same with a defcurcure resin, drying the yarn so treated, and thereafter heat-curing the same.

2. A process for increasing the retained tensile strength of a natural fiber yarn which comprises stretching the yarn in tension to a value equal to about one-third to one-half of the tensile stress which will produce breakage while wet-treating the yarn with a defcurcure resin, drying the yarn so treated, and thereafter heat-curing the same.

3. A method of modifying the physical properties of a yarn made of natural fibers which comprises repeatedly applying to succeeding lengths of yarn in a heat-curable setting agent in a liquid carrier, stretching the yarn during said applications, kneading the yarn between each application, vaporizing said carrier by repeatedly heating said successive lengths of yarn to a temperature above normal room temperature but substantially below the curing temperature of the setting agent, thereafter stressing the yarn and curing it.

4. The method of modifying the physical properties of a yarn made of natural fibers that comprises repeatedly applying to succeeding lengths of yarn a heat-curable setting agent in a liquid carrier, evaporating said carrier by repeatedly heating said successive lengths of yarn to a temperature above ordinary room temperature but substantially below the curing temperature of the setting agent, thereafter stressing the yarn and curing it.

5. The method of modifying the physical properties of a yarn made of natural fibers that comprises repeatedly applying to succeeding lengths of yarn a heat-curable setting agent in a liquid carrier with kneading of the yarn between each application, evaporating said carrier by repeatedly heating said successive lengths of yarn to a temperature above ordinary room temperature but substantially below the curing temperature of the setting agent, thereafter stressing the yarn and curing it.

6. The method of increasing the elasticity of a cotton yarn that comprises repeatedly applying to succeeding lengths of yarn a heat-curable setting agent in a liquid carrier, evaporating said carrier by repeatedly heating said successive lengths of yarn to a temperature in the range of 140–180° F, but below the curing temperature of the setting agent, thereafter stressing the yarn, heat curing the yarn at a temperature above 300° F, while the stress is applied.

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