Patented Nov. 2, 1943

2,333,160

UNITED STATES PATENT OFFICE

2,333,160

PROCESS FOR FINISHING FABRIC ARTICLES

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No Drawing. Application June 16, 1939, Serial No. 279,449

2 Claims. (Cl. 8—115.5)

This invention relates to the treatment of shaped articles formed from plastic substances subject to being fabricated into a predetermined shape and maintained substantially in that shape by being placed in the presence of a suitable setting agent, and of which plastic substances synthetic linear condensation polymers capable of being formed into useful fibers are a group and of which fiber forming polyamides derived from polymerizable monoaminocarboxylic acids and their amide-forming derivatives and those derived from the reaction of suitable diamines with dicarboxylic acids or amide-forming derivatives of dibasic carboxylic acids are types.

In United States Letters Patent Nos. 2,071,250, 2,071,251 and 2,071,253, granted to W. H. Carothers, are described various types of fiber forming plastics; and in United States Letters Patent Nos. 2,157,117 and 2,157,119, granted to John B. Miles, Jr., are disclosed processes for treating shaped articles made from said yarns by means of saturated steam, in order to increase the crimp retentivity of said yarns.

It has been found that nylon yarn may be used in the production of knitted articles of wearing apparel, particularly stockings, since the yarn has most of the desirable characteristics of natural silk and, in addition, has greater tensile strength, elasticity and resistance to wear.

By knitted "crimp" I refer to the formation of the yarn into needle loops and sinker loops by the coaction of the needles and sinkers of the knitting machine. It is principally the shape of these loops, aided by the elasticity of the yarn, which give the fabric its elastic nature, the loops bending and sliding on each other and the yarn stretching to permit the fabric to fit the contour of the leg and to yield to its flexions on movement. Uniformity in such loops is of primary importance, especially for a woman's sheer stocking, in order to yield a smooth, uniformly appearing sheer fabric.

In the case of stockings knitted from the yarns which are the subject of this invention, the yarns, for example, nylon, have a resilient nature and plasticity not found in natural silk so that the loops have a tendency, under conditions of agitation, heat and moisture such as occur during the scouring and dyeing operations, to form distorted stitches and heavy fabric wrinkles.

The most important commercial factor in the production of a delicate and hence perishable lady's stocking is that the article must be of reasonable price as it is an article of popular consumption. By following the processes of Miles' Patent No. 2,157,119, the cost of, for example, a lady's stocking, is increased substantially since the treatment therein outlined requires additional apparatus and operations, and therefore greater time than would the comparative processes used for finishing hosiery of natural silk.

Patent No. 2,157,117 outlines the principle that nylon yarns, especially when knit into a fabric, may be set and their crimp retained by placing them in the presence of saturated steam, or other vapors, which acts as a swelling or setting agent. Patent No. 2,157,119 relates specifically to the treatment of nylon hosiery and emphasizes the need for so-called pre-boarding and so-called after-boarding operations. The first operation is done following the knitting, by drawing the undyed article to a stretched condition over a form substantially the shape of the finished article; subjecting it to the preferred setting agent; removing it from the form, scouring and dyeing the same, and then placing it over a heated form again to give the article a finished appearance. It is stated that the first boarding process is necessary in order that the crimp be initially set, otherwise the handling of the goods during the scouring and dyeing will put wrinkles therein which can not later be removed by a standard boarding operation as known to the art in connection with natural silk or rayon hosiery.

I have discovered that it is not necessary to preboard stockings of nylon by stretching them over a form to produce the initial set, thereby eliminating a substantial part of the prior method, decreasing the cost of labor and equipment, and producing an article of improved appearance without losing any of the inherent desirable characteristics of the yarn. This improved appearance is a result of pre-setting the fabric before scouring and dyeing which prevents the formation of deep fabric wrinkles and distortion of stitches during the said intermediate operations and then resetting the fabric to insure removal of the natural folds and soft wrinkles characteristic of a stocking after being knitted as well as relatively superficial wrinkles that develop in the scouring and dyeing processes.

It is therefore the principal aim of my invention in the manufacture of shaped articles or fabric articles comprising yarns and/or fibers as herein comprehended prior to any operations wherein deep fabric wrinkles and/or distorted stitches develop in the article, to subject said articles to the action of a suitable setting medium under suitable conditions of time, temperature and moisture with whatever variety of folds or

configuration said articles have by chance assumed from the preceding operations, so that the article will successfully resist further fabric wrinkling and/or stitch distortion in subsequent operations where such is likely to occur, and the article will generally retain the by-chance assumed folds or configuration until the article is set by a suitable setting medium under suitable conditions of time, temperature and moisture to the definite form the article is intended finally to assume, i. e. having utility and value as an article of commerce.

In the case of a knitted article, I attain this condition by subjecting a quantity of goods in bulk after they come from the knitting machines and while in an unstressed condition preferably to the presence of water vapor of a selected temperature, or immersing them in water of a selected temperature; then subjecting them to the scouring and dyeing operations and completing the finishing by boarding the stockings on forms of substantially the final shape of the article by subjecting them to saturated steam or other vapors. Other objects will become evident as the description proceeds.

By the term "water vapor" I refer to the vapor of water at or below its boiling point, and thereby distinguish from "steam," which is the vapor of water at or above the boiling point.

In putting my process into practice I prefer to arrange the stockings in bundles, say of one dozen pairs, as they come from the inspection, following knitting, in perforated trays which are placed in a cabinet. However, I do not intend to limit myself to an apparatus so constructed, since it may take other forms so long as the same is adapted to receive the stocking in a loose, unstressed condition. Preferably the goods should be arranged with the natural soft wave or roll of the knitted fabric undisturbed by crowding the stockings together, otherwise proper setting is inhibited. The cabinet is closed and water vapor at a temperature of 185° to 190° F. permitted to fill the cabinet. Live steam at atmospheric pressure of 212° F. may be used, in which event the heat absorbed by the cabinet and radiated therefrom to the air, will cool the steam to form water vapor. Such cooling action can be arrested at the preferred temperature, and that temperature retained, by controlling the steam feed valve and/or by venting the cabinet. The vapor entirely surrounds and penetrates the batches of goods and by its swelling action on the fibers initially pre-sets the knitted crimp, and hence the article as a whole.

Alternatively, but without limiting myself to the type of apparatus to be employed, I may use standard dyeing equipment as, for example, a dyeing machine which comprises a multiple compartment drum adapted to rotate inside a tub, but for this part of my process the tub would remain stationary. The quantity of goods, depending on the size of the machine and the density to which the goods pack down, is placed in each compartment.

After the steam is turned off, the pre-setting chamber is opened and the heat retained therein as well as evaporation to the air will dry out the goods or, if preferred, a hot air heater could be used to accelerate such action. When the goods are so dried out, they may be placed in bags and stored.

The goods are subjected to this vapor for a period of time varying from five to fifteen minutes, depending on the particular characteristics of the yarn and knitting. By stating a specific range of time I do not intend to so limit myself since it may be found that a shorter period may produce the desired result and that a slightly longer period may improve the result, nor do I intend to limit myself to the specific temperature range stated, since it may be found that an acceptably equivalent result may be obtained at a higher or lower temperature, a range of from 120° F. to 212° F. being comprehended. However, the essential part of the process is the subjecting of the goods in loose bulk, not in a stretched or stressed condition, to the penetrating action of water vapor. In this disclosure I use the phrases "unstretched," "unstressed," or "loose" in the sense that the stocking or other fabric is in a purely relaxed state and in this I distinguish from the said Miles Patent No. 2,157,119, in the elimination of a boarding form as emphasized and claimed in said patent. Therein it is obvious that the fabric article, when placed on the form has its weave or stitches, as the case may be, subjected to a stretching not comprehended in my invention.

Now, having had their knitted crimp pre-set by the first part of the process, the bundles of goods are untied and scoured and dyed. In the case of the alternative suggested, the scouring and dyeing may take place while the goods are still in the dyeing machine. Common practice is to scour and dye at the same time, but of course it is within contemplation that the scouring and dyeing operations may be performed separately. I prefer to conduct the scouring and dyeing at a temperature not to exceed approximately 180° F. For example, I bring the scouring and/or dyeing liquor up to 180° F. in 15 minutes and maintain it at that temperature for about 20 minutes, followed by a cold water rinse. It will be understood by those familiar with the art that this time may vary depending on the characteristics of the water, the dyestuff, the scouring material and the yarn. But it is preferable to conduct the operations aforesaid at a temperature less than the pre-setting temperature.

After the goods are dyed they are given a light "whizzing" in the usual type centrifugal extractor to leave more moisture in the goods than would be the case for natural silk. At this point the goods are not in a marketable condition, being loosely together in bulk and wrinkled in substantially the manner in which they left the knitting and dyeing machines. Accordingly, they must be subjected to a boarding or resetting operation to yield a flat lying, pressed fabric ready for the consumer. Due to the thermoplastic nature of nylon, I am able, by the resetting operation, to remove the initial set given the stocking in the presetting operation and reshape it to the contour of the form under such conditions of temperature and time as detailed herein. Such resetting operation is to be distinguished from a final boarding operation as presently recognized in the art, wherein a stocking which has been first preboarded, is dyed and subjected to any other ordinary intermediate wet process and is then placed on a form for drying only with the object of perhaps only evening any superficial wrinkles which may have been introduced during said intermediate wet processes. This is distinguished from the present invention in which the aim is to intentionally reset the fabric after the intermediate wet processes, the fabric by the final process being unset from the preset stage and then reset in its final form. For resetting it is

necessary that the stocking be placed over a form having a contour substantially the same as the finished article. Such form may be of wood, aluminum, steel or other material, and flat, oval or substantially oval in cross section, following types presently in use for boarding natural silk hosiery. The stocking is then subjected to the resetting operation, which may be capable of being performed in ways other than that to be presently described.

It has been found that the best final finish is given the goods by placing them in a closed chamber while on the forms and subjecting them to saturated steam at a temperature of approximately 225° F. for about five minutes. By stating a specific temperature and time I do not intend to so limit myself since it has been found that satisfactory resetting may be obtained at higher or lower temperatures and for greater or lesser times. Naturally, if the steam is not thoroughly saturated the time and temperature may have to be varied to produce the desired finish.

To effect the final operation I prefer to use a machine which comprises a plurality of forms normally in boarding position, swingably mounted on a common pivot so that one at a time may be moved to a position convenient for the operator to draw a stocking thereover, whereupon such form is moved back to boarding position and another form moved out and charged, and so on until the entire battery of forms carries a stocking. These forms, as a group, are then placed in a chamber, or may actually be mounted in the chamber, the chamber entirely closed and saturated steam admitted thereto. The chamber must be designed to withstand a pressure of four to five pounds per square inch, which is the gauge pressure corresponding substantially to 225° F. The steam should be saturated and in order to make certain that the steam is wet enough, water may be kept in the chamber so that it will evaporate and thoroughly saturate the steam if it is not wet enough when admitted.

After the goods have been left in the chamber for the required length of time, which may be from five to ten minutes, the pressure is released, the chamber opened and the goods removed from the forms, whereupon they are ready for final inspection, pairing and packaging.

A preferred form of apparatus for carrying out the final boarding operation is shown in application Serial Number 318,448, filed February 12, 1940, now Patent No. 2,309,659, but I do not desire to limit myself to that particular construction of apparatus as it forms no part of the present invention.

To illustrate the variance possible in the practice of this invention, goods have been pre-set at a temperature between 195° and 200° F. for ten minutes and scoured and dyed at 212° F., which necessitated a resetting operation at 228° F. for five minutes and with quite satisfactory results. This example shows that the pre-setting may be at a temperature lower than the dyeing temperature, although as mentioned hereinabove, it is preferred to pre-set at a temperature slightly higher than the dyeing temperature.

Water at 185° F. to 190° F. may be substituted for water vapor at that temperature, but I prefer vapor as there is then no danger of agitating the goods by its circulation therethrough. Hot water has convection currents which may agitate the goods and disturb the knitted crimp during the pre-setting thereof, resulting in distorted stitches which can not be removed during resetting.

It is also preferred that after the steam chamber is opened the stockings be permitted to lose their retained moisture due to the wet steam naturally in the air, and not forcibly dried by heating of the forms interiorly or applying heat exteriorly, although it is within contemplation to so heat the stockings and speed up the resetting operation.

The process herein disclosed has the important advantage of producing greater finished length to the stocking than by other processes heretofore known. All knitted hosiery has a natural tendency to shrink on the drying form and the use of holders to prevent such shrinkage is not practical in the case of ladies' stockings as they leave marks on the goods which detract from their saleability and, in addition, the use of holders while the stocking is undergoing the boarding process would cover a substantial area of the fabric and prevent proper contact with the steam. Accordingly, in order to obtain the maximum length of the stocking, the pre-setting operation must not be too rigorous as it will fix the crimp too well and the stocking will not then stay in the position on the form to which it is pulled, but will contract longitudinally a substantial amount. For this reason thought must also be directed to selecting a pre-setting time and temperature which will not only produce the maximum length of finished stocking, but which will not produce an irremediable stitch distortion and fabric wrinkling during the scouring, dyeing and/or extracting. If the pre-setting operation is not conducted at just the right temperature and for the right length of time, wrinkles will form in the fabric during subsequent handling that can not be removed by the resetting operation. Too high a pre-setting temperature has the effect of "tempering" the article so that the crimp can not be modified to the extent otherwise permissible when the stocking is drawn down upon resetting. I have also found that too high a pre-setting temperature will not give as smooth a finish to the fabric as a temperature within the preferred range. But when a proper presetting temperature has been selected for the particular goods, a much superior texture is imparted to the fabric.

Furthermore, a preboarding operation as recognized in the art, tends to render permanent any grease and oil stains inevitably present in the fabric after leaving the knitting machine and removal thereof by subsequent operations quite difficult. Contrasted, the milder action of my presetting operation does not have this permanizing effect and grease and oil spot removal is no more a problem than with conventional silk hosiery. Of further merit is the ease with which mending of runs, occurring during manufacture, is expedited and improved because the fabric is in a soft, relaxed condition and the re-knitting of the ladder to a normal stitch form is simplified over what would be the case in re-knitting a harsh or stiffened preboarded stitch structure.

In the finishing of a nylon stocking knit on a circular machine the conventional preboarding process can not be considered inasmuch as a preboarding operation as recognized in the art, sets the fabric in its permanent form, i. e., with a crease in the front and back. The general practice is to fabricate seamless nylon stockings without the inclusion of a mock seam, so that the stocking does not possess any aligning feature

with relation to the conventional relatively flat, sharp edged form. In other words, a stocking without a seam can occupy several different positions on the form with relation to the transverse dimensions thereof, so that when the stocking, preboarded as it is with permanent sharp creases, is later placed on an ordinary finishing form for the final drying, it is extremely difficult to relocate the creases carried over from the preboarding form, with reference to the creasing edges of the final form. Accordingly, a double crease would be imparted to the front and rear of the stocking with obviously objectionable appearance thereof.

By the use of my invention no form is involved in the presetting and hence no creases are imparted to the fabric to be later reckoned with. The only creasing the stocking is given will be on the final or re-setting form.

I have made no mention of any processes in addition to the pre-setting, scouring, dyeing and resetting, but as is common practice in the industry, certain finishing agents may also be used in order to make the stocking splash-proof, stronger against snagging and ravelling, etc. However, these are standard expedients and are not intended to be included as essential steps in the method herein described.

Another important advantage of my process over the prior method is the elimination of the adherence of the stocking to the form. Previously, the necessary initial step was to draw the stocking over a form and subject it to the swelling agent. However, at this stage the yarn still retains the sizing which is applied by the manufacturer to strengthen the same during knitting and to serve the same function as the sericin of natural silk. However, when the stocking on the form is subjected to the swelling agent, the sizing is dissolved and acts as an adhesive, cementing the stocking to the form, wherefrom it is dislodged with some difficulty. In my process the sizing is easily and quickly removed in the regular scouring bath, which duplicates the scouring operation now performed on natural silk goods.

It will be noted from a consideration of the foregoing that the principal distinction of my process over that known heretofore, is the elimination of the necessity for placing the shaped article on a form during the pre-setting and the ability to reset the article to a final shape. In substance, I am able to maintain the original knitted crimp by presetting while the article is in a loose unstressed condition, and keep undisturbed the pre-set crimp during subsequent operations prior to the resetting and without any wrinkles which may have existed during the process revealing themselves in the finally finished article.

Further, the exercise of the previously known process requires that the initial or pre-boarding be done on a form somewhat narrower than the form used for final boarding, which would require a substantially duplicate set of forms with consequent added equipment investment. My process requires only the one set of forms which may be the same as now used for finishing hosiery, except that they are mounted in a steam chamber as detailed.

It will be appreciated that the distinctive steps of my process are equally effective to produce the desired result when treating ingrain articles, that is, those fabricated from yarns which have been dyed prior to their introduction to the knitting or other machine. In other words, the step of pre-setting is performed and then any other processing such as a splash-proof treatment or the like, performed and then the article reset.

Inasmuch as polyamide articles are capable of being modified by the use of well-known agents, e. g., pigments, dyes, luster modifying agents, plasticizers, oils, resins and antioxidants, it is within comprehension to apply the process of my invention to polyamides so modified. Likewise it is applicable to yarns composed of a mixture of polyamide filaments, fibers or yarns and other textile fibers or yarns.

When I refer herein and in the appended claims to a "shaped article" or a "fabric article," I do not intend to limit myself to those which are knitted, although that type is referred to in the description by way of illustration, but the process steps may be applied to other articles formed by weaving, knitting, braiding, molding and the like, and whether in the form of piece goods or other articles of useful shapes, including articles of wearing apparel.

I claim:

1. In a process for manufacturing a fabric article comprising synthetic linear condensation polyamide fibers, the steps of presetting the article after it has been fabricated, and while it is in a substantially loose and unstressed condition and disassociated from any means for predetermining the shape of the article, with an aqueous medium at a predetermined temperature, subjecting the article to a hot liquid treatment at a temperature at or below said first mentioned temperature, and re-setting the article to final shape on a form by the action of an aqueous medium at a temperature higher than said first mentioned temperature.

2. In a process for manufacturing a fabric article comprising synthetic linear condensation polyamide fibers, the steps of presetting the article after it has been fabricated, and while it is in a substantially loose and unstressed condition and disassociated from any means for predetermining the shape of the article, with a substantially aqueous medium at a predetermined temperature, subjecting the article to scouring, dyeing, extracting and related intermediate processes at temperatures at or below said first mentioned temperature, and re-setting the article to final shape on a form by the action of an aqueous medium at a temperature higher than said first mentioned temperature.

GEORGE E. DUNN.