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RUN RESIST KNIT WEAR AND PROCESS

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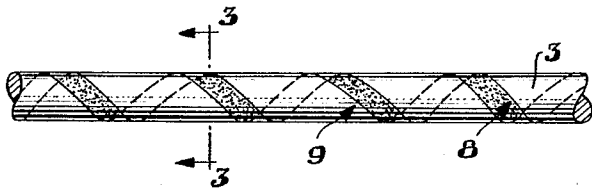


*Fig. 2.*

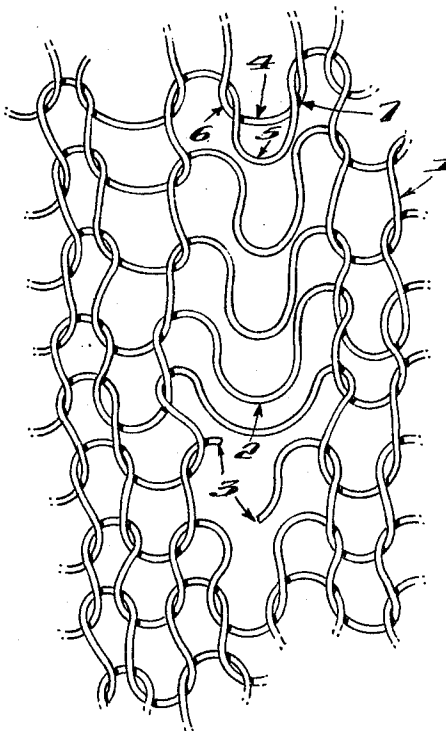


*Fig. 1.*



*Fig. 3.*

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## RUN RESIST KNIT WEAR AND PROCESS

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This invention relates to textiles and, more particularly, to run-resist knit wear.

Conventional sheer circular knit goods, prepared with a plain, or Jersey stitch (e.g., ladies' stockings) have a limited life because of the relative ease with which runs are produced in the fabric. The breaking of a single filament in one course of such a conventional stocking releases the engaged stitch in an adjacent course which in turn allows successively engaged stitches to be dropped, thereby propagating a run over the length of the stocking.

Attempts to solve this problem have resulted in stockings which are much less sheer (because of additional material required), have poor fit, and are more expensive than conventional stockings of limited life. The expense arises from the requirement for extensive modification of the knitting machine, and for the additional yarn and machine time required.

It is therefore an object of this invention to provide novel run-resist knit wear.

Another object is to provide a run-resist stocking without sacrificing the desirable properties of stockings such as good fit, i.e., stretch-conformability, and sheerness.

A still further object is to provide a process for manufacturing run-resist stockings which will not require modification of conventional knitting machines.

These and other objects will become more apparent in the course of the following specification and claims.

These objects are accomplished in the present invention by providing a textile article comprising a knitted fabric composed of filaments of synthetic, linear, fiber-forming polycarbonamide composition having first and second components in adhering side-by-side relationship, said first component being a copolycarbonamide having a selective sensitivity to tack-inducing agents and occupying from about 5% to about 60% of the periphery of said filaments, said second component being a homopolycarbonamide, said filaments being self-bonded between said first components at from about 5% to about 65% of the knit cross-over contacts.

In order that the invention can be more readily understood, the accompanying FIGURES 1, 2, and 3 are provided.

Referring to FIGURE 1, a section of knitted fabric 1 is shown with a run 2 propagated as a result of a break in filament 3. The run 2 advances upward from the break until stopped at loop 4 due to the bonding of loop 4 with loop 5 at crossover contacts 6 and 7. In a conventionally knitted fabric, the run would advance unimpeded along the entire length of the fabric. Referring to FIGURES 2 and 3, an expanded side view and cross-section view along line 3, respectively, of filament 3 are shown. Filament 3 has a first component 8 and a second component 9 in adhering side-by-side relationship.

By fiber-forming filament is meant a filament which has an intrinsic viscosity of at least about 0.4 where intrinsic viscosity is defined as

$$\frac{\log_e N_r}{C}$$

in which  $N_r$  is the viscosity of a dilute solution of the polymer in metacresol divided by the viscosity of metacresol in the same unit and at the same temperature (e.g., 25° C.) and C is the concentration in grams of polymer

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per 100 cc. of solution. Polymers having this intrinsic viscosity of at least about 0.4 are capable of being extruded into fibers.

By "tack-inducing agent" is meant any agent, such as heat or a chemical compound, which will cause the surface of one component of the two-component filaments to become tacky or soft, thus imparting to the surface the ability to bond to a contiguous surface also made bondable by the agent.

Two-component, man-made, filaments for the fabric of this invention may be either melt-spun or solution-spun and may be either synthetic or regenerated fibers. The composition of the synthetic fiber is one of the class consisting of polyamides, polyesters, polyvinyl derivatives, and polyolefines.

By synthetic, linear, side-by-side, two-component polycarbonamide is meant those disclosed, for example, in Belgian Patent No. 621,472. The preparation and spinning of such polycarbonamides into filaments is also disclosed in Belgian Patent No. 621,472. In addition, both components of the filaments employed in the stockings, of this invention are limited to fiber-forming filaments for, inter alia, to avoid processing difficulties.

The actual bonding of the filaments at the knit cross-over contacts is effected by the combination of pressure with at least one tack-inducing agent, preferably either heat or a reagent which is either an adhesive, a softener, or a solvent for only one of the two components which comprise the filaments used in the production of the fabric. When heat is used in combination with pressure, the temperature must be such as to impart bondability to only one component of the filament if selective bonding is to be accomplished. In this regard, it has been considered advantageous for the purpose of more clearly defining the invention, to use the term "stick temperature" to define that temperature at which a particular polymer surface becomes bondable. The stick temperature is determined by moving a particle of the polymer to be tested over a progressively warmer surface. The temperature at which a deposit is observed on said surface is the stick temperature of the polymer. The stick temperatures of the two components of the filaments herein employed should differ by at least about 10° C. The lower stick temperature should preferably be within the range of from about 160-230° C. By heating the fabric to the temperature at which one component of the two-component filaments becomes tacky, and then applying pressure to the fabric, bonding at those knit cross-overs where the tacky components are contiguous can be effected.

When the combination of pressure and reagent is employed, a reagent which will impart tackiness to only one of the components of the two-component filaments is used. Here again, the final bond is effected by the application of pressure to the fabric. Both of the tack-inducing agents herein described are effective only for one of the components.

The application of pressure to effect the final bonding of the knit crossovers can be accomplished in several ways. The preferable method is to compress the stocking to be bonded between a pair of platens. Where a reagent is used in combination with pressure, the reagent has preferably been previously applied to the stocking. The pressure then completes the process. Where heat is used in combination with pressure, the preferred method is to compress the stocking between the platens and then apply heat, for example, by placing the platens in an autoclave to effect the final bond.

As will be seen in Example III below, when the clamping surfaces are indented and a program bonding effected, the component sensitive to the tack-inducing agents can occupy a greater percentage of the periphery of the

two-component filaments. This is true because by programming the surface of the clamps, selectively of the number and location of the bonds can be accomplished whereas when the clamping surfaces are flat, a random bonding results. For this reason, program bonding is the preferred embodiment.

The following examples are given below to illustrate the invention, and are not intended to limit the scope thereof in any manner.

#### Example I

A medium length, seamless ladies' stocking is conventionally knit with a two-component side-by-side round filament comprising about 80% of polyhexamethylene adipamide (stick temperature=236° C.), and 20% of a 50/50 copolymer (stick temperature=190° C.) of hexamethylene adipamide with hexamethylene sebacamide. The copolymer occupies approximately 27% of the periphery of the filament. The production of such filaments is taught in Belgium Patent No. 621,472. The leg and foot region is knit of 15-denier monofilament; and the welt, heel, and toe are knit of 45-denier, 7-filament yarn. The knitting machine is a single feed, 396 needle, 4½ inch cylinder machine. The greige stocking is cut open to secure a piece of knit fabric 9" x 12" which is placed between paired grooved platens with lands 0.030" x 0.030" and with a 0.030" space between lands. These lands are unidirectional in each platen and perpendicular to the lands in the pairing platen. These platens are clamped together with 6" C clamps which compress the sample between the platens with 22 p.s.i. pressure. These platens (containing the stocking) are placed for 2 minutes in an autoclave fed with saturated steam at 40 p.s.i.g. to bond the knit crossovers of the stocking. This bonded fabric is removed from between the grooved platens and is observed to be attractively sheer, run-resistant, and to have a soft hand and a desirable stretch-conformity. Under magnification, about 27% of the knit crossovers of copolymer surfaces are seen to be bonded in a uniform pattern in conformity with the platens used, and 225 bonds are counted in each square inch of the fabric. This example specifies program bonding. In the manufacture of stockings, this novel process is carried out by putting the stocking on a board form constructed with the required program of lands and spaces. Then an appropriately programed platen is placed on each side of the stocking, and the platens (containing the stocking and board) are clamped together and are placed in an autoclave as specified above.

#### Example II

A greige fabric identical with the fabric of Example I, except that it comprises 50% of polyhexamethylene adipamide and 50% of a 50/50 copolymer of hexamethylene adipamide with hexamethylene sebacamide, is subjected to program bonding by placing it between a sheet of silicon elastomer and a steel wire belting comprising 25-gauge wires, ⅜" apart in a herringbone pattern. These three, silicon elastomer, fabric, and wire belting, are placed between platens of a hydraulic press and 20,000 pounds pressure is applied for 15 seconds while the platens are at 187° C. The fabric is then removed and it is determined to be run-resistant and to have an attractive stretch-conformity.

#### Example III

A greige stocking identical to the one knit for Example I is placed between two flat 9" x 12" brass plates which are clamped with 6" C clamps to compress the sample between the plates with 22 p.s.i. pressure. These plates (containing the stocking) are placed for 2 minutes in an autoclave fed with saturated steam at 40 p.s.i.g. to random bond the knit crossovers of the stocking. This stocking has a soft hand, a desirable stretch conformity, is attractively sheer, run-resistant, and is observed under mag-

nification to have a random pattern of run stops or bonds at about 50% of the points where the surface of a copolymer component crosses over and contacts an adjacent surface containing that component.

A control stocking, identical in construction to the test stocking of this Example III but knit from a two-component, side-by-side filament comprising about 50% of polyhexamethylene adipamide and about 50% of a 50/50 copolymer of hexamethylene adipamide with hexamethylene sebacamide so that the copolymer occupies approximately 50% of the periphery of the filament, is knit, and steam bonded as is the above test stocking. This control stocking is sheer, but quite stiff, and has such poor stretch conformity that it does not fit the leg and is, therefore, unsatisfactory. Under magnification, the knit fabric is observed to have bonds at more than 85% of the knit crossovers.

The preferred filaments used in the fabrics of this invention are continuous monofilaments with polycarbonamide components, particularly one with a first component of a copolymer of hexamethylene adipamide with hexamethylene sebacamide with a second component of polyhexamethylene adipamide, as well as one with a first component of a copolymer of hexamethylene adipamide with hexamethylene isophthalamide, and a second component of polyhexamethylene adipamide and in such combination with these copolymers the second component may alternatively be polyheptanamide, polyundecanamide, polyoctamethylene oxamide, polytetramethylene suberamide, polyhexamethylene suberamide, polydecamethylene decanamide, polyxylylene azelamide, and poly-2-methylhexamethylene terephthalamide.

When one component of the two-component filaments is a copolymer of hexamethylene adipamide and hexamethylene sebacamide, the preferred bonding reagent for said copolymer is one of the following: (1) a solution at about 25° C. of 95% dimethylacetamide and 5% lithium chloride, (2) a solution at about 25° C. of 60% formic acid and 40% water, (3) a solution at about 80° C. of 98% dimethylacetamide and 2% lithium chloride, and (4) a solution at about 80° C. of 40% formic acid and 60% water.

In order to insure an acceptable run-resist fabric, it has been determined that at least about 5% to as much as about 65% of the filament crossovers must be bonded. Less than 5% bonding does not provide adequate run-resistance. If more than about 65% are bonded, the fabric is also inadequate, because of poor stretch conformability or fit, and loss of other comfort and aesthetic properties. To accomplish the required bonds, the component of the filaments which is sensitive to the tack-inducing agents should occupy from about 5% to about 60% of the periphery of the filament. Below this range, insufficient bonding will result, above the maximum amount, too great a bonding will result.

As stated above, program bonding permits control of the number and location of the bonding sites. Whereas 40% of the periphery occupied by the component sensitive to the tack-inducing agents is the maximum which can be tolerated when random bonding is employed, up to 60% of the periphery may be occupied by said component when program bonding is used.

Although this invention has been exemplified for round monofilaments, it is obvious to one skilled in the art that utility is also derived for fabrics knit with monofilaments of non-round cross-section such as multilobed, particularly trilobal, ribbon, dog bone, cruciform, and Y shapes and for these cross-sections the amount of the periphery to be occupied by the filament component with the lower stick temperature shall be within a range to provide a knit fabric comprising from about 5% to about 65% knit crossovers.

The preferred deniers for these monofilaments are within the range from 5 to 20. A moderate amount of filament twist, crimp, texture, or bulk aids to randomize the

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location of the bond at the knit crossovers for the fabric of this invention, so that a more desirable fabric is attained.

Many other equivalent modifications will be apparent to those skilled in the art and, therefore, this invention is not intended to be limited except as indicated in the appended claims.

What is claimed is:

1. A textile article comprising a knitted fabric composed of filaments of synthetic, linear, fiber-forming polycarbonamide composition having first and second components in adhering side-by-side relationship, said first component being a copolycarbonamide having a selective sensitivity to tack-inducing agents and occupying from about 5% to about 60% of the periphery of said filaments, said second component being a homopolycarbonamide, said filaments being self-bonded between said first components at from about 5% to about 65% of the knit cross-over contacts.

2. The textile article of claim 1 wherein said first component is an approximately 50/50 by weight copolymer of hexamethylene adipamide and hexamethylene sebacamide and said second component is poly(hexamethylene adipamide).

3. The textile article of claim 1 wherein said article is a ladies' stocking.

4. A textile article comprising a knitted fabric composed of filaments of synthetic, linear, fiber-forming polycarbonamide composition having first and second components in adhering side-by-side relationship, said first component being a copolycarbonamide and said second component being a homopolycarbonamide, said first component occupying from about 5% to about 60% of the periphery of said filaments and having a stick temperature at least 10° C. lower than the stick temperature of said second component, said filaments being self-bonded between said first components at from about 5% to about 65% of the knit cross-over contacts.

5. The textile article of claim 4 where said first component is an approximately 50/50 by weight copolymer of hexamethylene adipamide and hexamethylene sebacamide and said second component is poly(hexamethylene adipamide).

6. The textile article of claim 4 wherein said article is a ladies' stocking.

7. A process for manufacturing an improved run-resistant textile article which comprises knitting said textile article from filaments of synthetic, linear, fiber-forming, polycarbonamide composition having first and second components in adhering side-by-side relationship, said first component being a copolycarbonamide having a selective sensitivity to tack-inducing agents and occupying from about 5% to about 60% of the periphery of said filaments and said second component being a homopolycarbonamide, then inducing tack in said first component only, and thereafter selectively compressing said textile article to effect self-bonding between said first components at from about 5% to about 65% of the knit cross-over contacts.

8. The process of claim 7 wherein said first component is an approximately 50/50 by weight copolymer of hexamethylene adipamide and hexamethylene sebacamide and said second component is poly(hexamethylene adipamide).

9. A process for manufacturing an improved run-resistant ladies' stocking which comprises knitting said stocking from filaments of synthetic, linear, fiber-forming polycarbonamide composition having first and second components in adhering side-by-side relationship, said

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first component being a copolycarbonamide having a selective sensitivity to tack-inducing agents and occupying from about 5% to about 60% of the periphery of said filaments and said second component being a homopolycarbonamide, then inducing tack in said first component only, and thereafter selectively compressing said stocking while drawn over a form substantially the shape of the finished article to effect self-bonding between said first components at from about 5% to about 65% the knit cross-over contacts.

10. The process of claim 9 wherein said first component is an approximately 50/50 by weight copolymer of hexamethylene adipamide and hexamethylene sebacamide and said second component is poly(hexamethylene adipamide).

11. A process for manufacturing and improved run-resistant textile article which comprises knitting said textile article from filaments of synthetic, linear, fiber-forming, polycarbonamide composition having first and second components in adhering side-by-side relationship, said first component being a copolycarbonamide having a selective sensitivity to tack-inducing agents and occupying from about 5% to about 40% of the periphery of said filaments and said second component being a homopolycarbonamide, then inducing tack in said first component only, and thereafter compressing said textile article to effect self-bonding between said first components at from about 5% to about 65% of the knit cross-over contacts.

12. The process of claim 11 wherein said first component is an approximately 50/50 by weight copolymer of hexamethylene adipamide and hexamethylene sebacamide and said second component is poly(hexamethylene adipamide).

13. A process for manufacturing an improved run-resistant ladies' stocking which comprises knitting said stocking from filaments of synthetic, linear, fiber-forming polycarbonamide composition having first and second components in adhering side-by-side relationship, said first component being a copolycarbonamide having a selective sensitivity to tack-inducing agents and occupying from about 5% to about 40% of the periphery of said filaments and said second component being a homopolycarbonamide, then inducing tack in said first component only, and thereafter compressing said stocking while drawn over a form substantially the shape of the finished article to effect self-bonding between said first components at from about 5% to about 65% the knit cross-over contacts.

14. The process of claim 13 wherein said first component is an approximately 50/50 by weight copolymer of hexamethylene adipamide and hexamethylene sebacamide and said second component is poly(hexamethylene adipamide).

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**UNITED STATES PATENT OFFICE**  
**CERTIFICATE OF CORRECTION**

Patent No. 3,286,490

November 22, 1966

Bruce E. Martin

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 29, after "platen" insert a period;  
column 6, line 16, for "and" read -- an --; line 18, strike  
out "which comprises knitting said textile article"; line  
38, for "comopsition" read -- composition --.

Signed and sealed this 12th day of September 1967.

(SEAL)

Attest:

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