

July 8, 1969

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3,454,013

GIRDLE

Filed April 17, 1967

Fig. 1

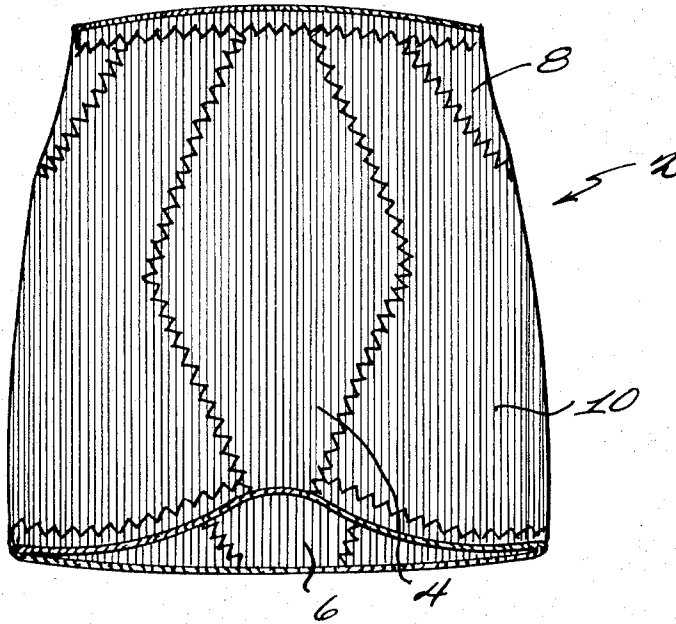
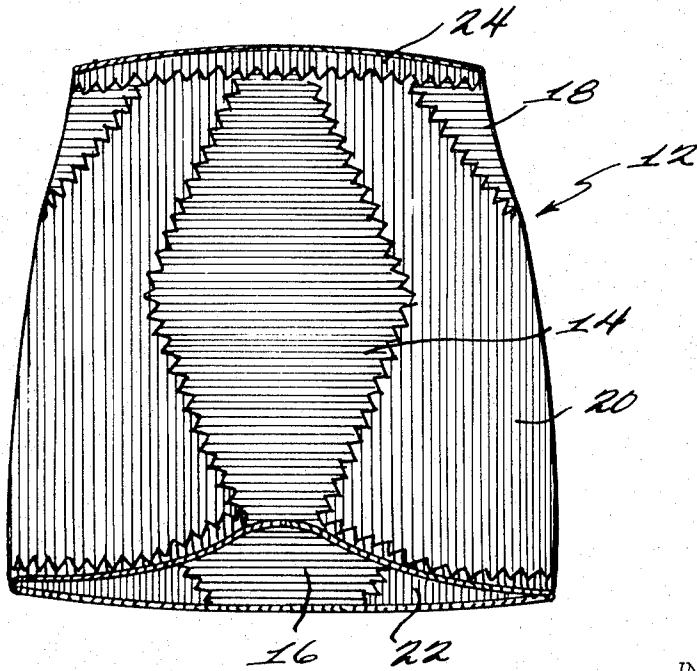


Fig. 2



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1

3,454,013
GIRDLE

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Filed Apr. 17, 1967, Ser. No. 631,359

Int. Cl. A41c 1/00

U.S. Cl. 128—540

10 Claims

ABSTRACT OF THE DISCLOSURE

Stretch clothing, specifically girdles, are prepared using spandex fibers which are made of a copolymer of epsilon caprolactone and methyl epsilon caprolactone. The garments are characterized by requiring a relatively low force to pull the fabric out while at the same time the fabric exerts a relatively high force to pull itself back.

The present invention relates to stretch clothing, specifically girdles.

Normally when a garment exerts considerable holding power, e.g. a girdle, considerable force is also required to pull out the garment at the time of application to the person.

It is an object of the present invention to develop a stretch garment which requires relatively low force to pull it out while at the same time it exerts a relatively high force to pull itself back.

Still further objects and the entire scope of applicability of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes or modifications within the scope of the invention will become apparent to those skilled in the art from this detailed description.

It has now been found that these objects can be attained by employing as the stretchable fibers in the garment spandex (polyurethane) fibers which are made from a hydroxyl terminated copolymer of epsilon caprolactone and methyl epsilon caprolactone and an organic polyisocyanate. The preferred methyl caprolactone is epsilon methyl epsilon caprolactone although less preferably there can be used beta methyl epsilon caprolactone, gamma methyl epsilon caprolactone, delta methyl epsilon caprolactone or a mixture of two, three or four of the various methyl epsilon caprolactones. It is critical that there be employed a copolymer since if epsilon caprolactone homopolymer is employed the polyurethane is too crystalline and does not have proper stretching properties while if methyl epsilon caprolactone homopolymer is employed the product loses tensile strength.

It has been found that 25% to 70% of the lactone copolymer should be methyl epsilon caprolactone and 75% to 30% epsilon caprolactone. When epsilon methyl epsilon caprolactone is employed it is preferably 35 to 45%, most preferably 40%, of the copolymer by weight.

The use of 50% mixed methyl epsilon caprolactone isomers has been found to be the equivalent of 30% of

2

epsilon methyl epsilon caprolactone in rendering the copolymer amorphous.

Unless otherwise indicated all parts and percentages are by weight.

In making the lactone copolymer as indicated it is hydroxyl terminated. A mixture of a diol and a polyol having at least three hydroxyl groups is employed to open the lactone ring and obtain the hydroxyl termination and to provide the requisite functionality for the lactone copolymer, namely in the range of 2.1 to 2.5. Thus to obtain a hydroxyl terminated epsilon methyl epsilon caprolactone-epsilon caprolactone copolymer (40:60) having an equivalent weight of 1,500 and a functionality of 2.3 there is added 2% of a mixture of glycerine and diethylene glycol (30:70). While the hydroxyl terminated lactone copolymer can have a molecular weight between 500 and 20,000 desirably it is between 600 and 7,000, most preferably about 1,000 to 4,500.

As the diol there can be used ethylene glycol, diethylene glycol propylene glycol, hexamethylene glycol, decamethylene glycol, tetramethylene glycol, 1,3-butylene glycol, p-xylylene glycol, o-xylylene glycol, dipropylene glycol, 2,2-dimethyl-1,3-propanediol, 2,2-diethyl-1,3-propanediol, 3-methyl-1,3-pentanediol, methyl diethanolamine, ethyl diethanolamine, 4,4'-isopropylidene biscyclohexanol, 4,4'-methylene biscyclohexanol. There can also be employed any of the other diols set forth in Hostettler Patent 3,186,971.

As the polyol having at least three hydroxyl groups there can be used glycerine, thimethylolpropane, trimethylololthane, sucrose, glucose, oxypropylated sucrose, pentaerythritol, glycerine-ethylene oxide adduct, 1,2,6-hexanetriol and other polyols having at least three hydroxyl groups as set forth in Hostettler.

The hydroxyl terminated lactone copolymer can be prepared by the procedure disclosed in the Hostettler patent but using the specific reactants and proportions which have been described above.

The polyurethanes are formed in conventional fashion by reacting the hydroxyl terminated lactone copolymer with an excess of an organic polyisocyanate. Usually the copolymer is capped with a diisocyanate using a considerable molar excess, commonly from a 20 to 250%, and preferably from a 50 to 200%, molar excess of the amount of diisocyanate required to react with all of the alcoholic hydroxyl groups. A preferred illustration is the use of 2.25 NCO groups for each available hydroxyl group. Thus for a hydroxyl terminated lactone copolymer of equivalent weight 1,500 and functionality of 2.3 there is employed 12.5 parts of toluene diisocyanate for each 100 parts of hydroxyl terminated lactone copolymer.

In the specific examples there was employed 2,4 toluene diisocyanate. However, there can be employed 2,6 toluene diisocyanate and mixtures of the 2,4 and 2,6 toluene diisocyanate isomers (such as 80:20 and 65:35) as well as other organic polyisocyanates such as methylene bis(4-phenyl-isocyanate), p,p'-diphenyl diisocyanate, 1,5-naphthalene diisocyanate, 3,3'-bitolylene-4,4'-diisocyanate, 2,4-tolylene diisocyanate dimer, dianisidine diisocyanate, 4-chloro-1,3-phenylene diisocyanate, 3,3'-dimethoxy-4,4'-bisphenylene diisocyanate and other diisocyanates such

as those set forth by Siefken in *Annalen* vol. 562, pp. 122-135 (1949).

The polyurethanes are cured by reaction spinning techniques such as those set forth in Cahill application Ser. No. 365,082, filed May 5, 1964. The lactone copolymers do not crystallize and in the curing process are cross linked. Thus the polyurethanes can be spun into a 2% ethylene diamine bath in toluene and the solvent and diamine removed at elevated temperature, e.g. at 175° C. for 30 seconds. The amine employed in the curing bath is a polyamine generally having two primary amino groups such as ethylene diamine, propylene diamine, trimethylene diamine, hexamethylene diamine, diethylene triamine, triethylene tetramine, tetraethylene pentamine, 1,4-diamino-cyclohexane, 3,3'-diamino-dipropyl ether, diamino dibutyl sulfide, m-xylylene diamine, piperazine, N-aminoethyl piperazine, N,N'-dimethyl ethylene diamine, 2-methyl piperazine, diamine prepared by reducing the diamide of dimerized linseed oil fatty acids.

The preferred solvents for the amines are aromatic hydrocarbons such as toluene, benzene, o-xylene, p-xylene, m-xylene, mixed xylene, ethyl benzene, 1,3,5-trimethyl benzene, propyl benzene, isopropyl benzene, butyl benzene and aromatic naphtha. Usually 1 to 10% of the diamine, preferably not over 4%, is dissolved in the aromatic hydrocarbon. As a diluent there can be employed aliphatic hydrocarbons such as hexane, pentane, heptane, octane, kerosene, gasoline, VM and P naphtha, mineral oils and cyclohexane.

There can also be employed non-hydrocarbon organic solvents such as ethylene glycol, 1,4-butanediol, 1,3-butylene glycol, propylene glycol, glycerine, 1,2,6-hexanetriol, methyl alcohol, ethyl alcohol, isopropyl alcohol, butyl alcohol, amyl alcohol, acetonitrile, propionitrile, dimethyl formamide, diethyl formamide, dimethyl acetamide. However, as indicated, the aromatic hydrocarbons are preferred. Thus the use of 4% of ethylene diamine in toluene is approximately equivalent to the use of 20% of ethylene diamine in isopropanol.

Curing is usually done at 65° C. to 220° C. for a time from a few seconds up to 30 hours. Thus at 175 to 220° C. curing times of 30 seconds to one minute are satisfactory while at lower temperatures, e.g. 80 to 150° C. longer cure times are employed, e.g. 30 minutes to 3 hours.

The cured threads obtained can be stretched in conventional fashion 10%, 50%, 100%, 200% 400% or even 700% of their original length by running a second spool 10, 50, 100, 200, 400 or 700% faster than a first spool.

While there can be employed 100% of such threads in the girdle normally they comprise 10 to 50%, usually 30% of the threads in the area customarily utilizing spandex threads. The balance of the threads in the garment can be cotton, cellulose acetate, nylon (e.g. polymeric hexamethylene adipamide or polymeric caprolactam), polyester (e.g. polyethylene terephthalate) polycarbonate, or any other rigid fibers. Mixtures of two or more of such rigid fibers of course can be employed with the lactone copolymer spandex threads in preparing the garment.

The invention will be understood best in connection with the drawings wherein:

FIGURE 1 is a view in elevation of one girdle made according to the invention; and

FIGURE 2 is an elevational view of another form of the invention.

Referring to FIGURE 1 there is provided a girdle designated generally at 2 having a front central panel 4; a back panel 6, hip encircling panels 8 and 10. In this form of the invention the entire girdle is made of a blend of 70% Dacron (polyethylene terephthalate) fibers and 30% of Glospan spandex stretch fibers. The Glospan spandex fibers employed were made by reacting toluene diisocyanate (2.25 NCO groups per available hydroxyl group) with hydroxyl terminated copolymer of 40%

epsilon methyl epsilon caprolactone-60% epsilon caprolactone copolymer having an equivalent weight of 1,500 and a functionality of 2.3. The hydroxyl groups were provided by employing 2% of a 70:30 mixture of diethylene glycol and glycerine based on the total of the caprolactones in the mixture which were copolymerized. The spandex fibers employed had been cured by using 2% ethylene diamine in toluene as the spinning bath followed by curing at 175° C. for 1 minute.

Referring to FIGURE 2, the girdle designated generally at 12 has a front panel 14 and a back panel 16 as well as top panels 18 made of Dacron fibers. In addition the girdle has front and rear hip panels 20 and 22 and waist band 24 made of the same 70% Dacron-30% Glospan spandex stretch fibers as set forth in connection with FIGURE 1.

In the drawings, in all of the areas in which the fibers are indicated by vertical lines there is employed the 70% Dacron 30% Glospan spandex stretch fibers while the fibers in the areas indicated by horizontal lines are 100% Dacron fibers.

As indicated supra, the Dacron fibers can be replaced in whole or in part by nylon or cellulose acetate fibers.

The following example illustrates the preparation of a cured Glospan spandex thread used in the invention.

EXAMPLE

A hydroxyl terminated copolymer polyester of 60% epsilon caprolactone and 40% epsilon methyl epsilon caprolactone having a molecular weight of 1,500 and a functionality of 2.3 was prepared using the technique of Hostettler Patent 3,186,971. The hydroxyl end groups were obtained by employing 2% of a 70:30 mixture of diethylene glycol and glycerine in the reaction mixture of the epsilon methyl epsilon caprolactone and the epsilon caprolactone.

100 parts of the hydroxyl terminated lactone copolymer polyester was heated with 12.5 parts of 2,4-toluene diisocyanate at 90° C. for 1 hour and then at 120° C. for 1 hour to give an isocyanate terminated lactone copolymer polyester polyurethane prepolymer.

The viscous polyurethane prepolymer thus prepared was extruded through a spinnerette into a bath containing 4% of ethylene diamine in toluene. The extruded liquid was converted almost immediately to a thread. The thread was removed from the bath, cured at 175° C. for 1 minute. The thread thus obtained was employed in conventional fashion to form the girdles illustrated in FIGURES 1 and 2.

What is claimed is:

1. A stretch garment wherein a substantial portion of the fibers making up the garment are spandex fibers made from a hydroxyl terminated polyester copolymer of epsilon caprolactone and a methyl epsilon caprolactone, said garment being characterized by requiring a relatively low force to pull the fabric thereof out into a stretched condition while at the same time the pulled out fabric exerts a relatively high force to return to its original unstretched condition.

2. A stretch garment according to claim 1 which is a girdle and in which the copolymer is made from 75% to 30% of epsilon caprolactone and 25% to 70% of methyl epsilon caprolactone and the copolymer has a functionality of 2.1 to 2.5.

3. A girdle according to claim 2 wherein the methyl epsilon caprolactone is epsilon methyl epsilon caprolactone.

4. A girdle according to claim 3 wherein the methyl epsilon caprolactone is 35% to 45% of the copolymer.

5. A girdle according to claim 4 wherein the polyisocyanate of the spandex is toluene diisocyanate.

6. A girdle according to claim 2 wherein the polyisocyanate of the spandex is toluene diisocyanate.

7. A girdle according to claim 2 wherein the hydroxyl terminated polyester has a molecular weight of 750 to 3,000.

5

8. A girdle according to claim 2 wherein 10 to 50% of the fibers in the stretch portions of the girdle are the spandex fibers, the balance of the fibers being relatively rigid fibers.

9. A girdle according to claim 8 wherein the methyl epsilon caprolactone is epsilon methyl epsilon caprolactone.

10. A girdle according to claim 9 wherein the copolymer contains 35 to 45% of the methyl epsilon caprolactone and the polyisocyanate of the spandex is toluene diisocyanate.

6

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U.S. Cl. X.R.

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