United States Patent [19]

Werner et al.

[11] **3,723,238**

[45] **Mar. 27, 1973**

[54] **NON-WOVEN FLEECE OF CONTINUOUS FILAMENTS**

[75] Inventors: **Helmut Werner**, Elsenfeld; **Hans Stapp**, Momlingen, both of Germany

[73] Assignee: **Enka Glanzstoff AG**, Wuppertal, Germany

[22] Filed: **Sept. 25, 1970**

[21] Appl. No.: **75,348**

Related U.S. Application Data

[62] Division of Ser. No. 787,013, Dec. 26, 1968, Pat. No. 3,574,908.

[52] **U.S. Cl.** **161/169**, 161/178, 28/72

[51] **Int. Cl.** **B32b 3/20**

[58] **Field of Search**.....161/69, 178, 55, 59; 28/72 R, 28/721 VW

[56] **References Cited**

UNITED STATES PATENTS

665,979	1/1901	Restein	161/178
2,880,056	3/1959	Carr et al.	161/178
2,999,296	9/1961	Breen et al.	161/169
3,304,220	2/1967	McIntyre	161/55

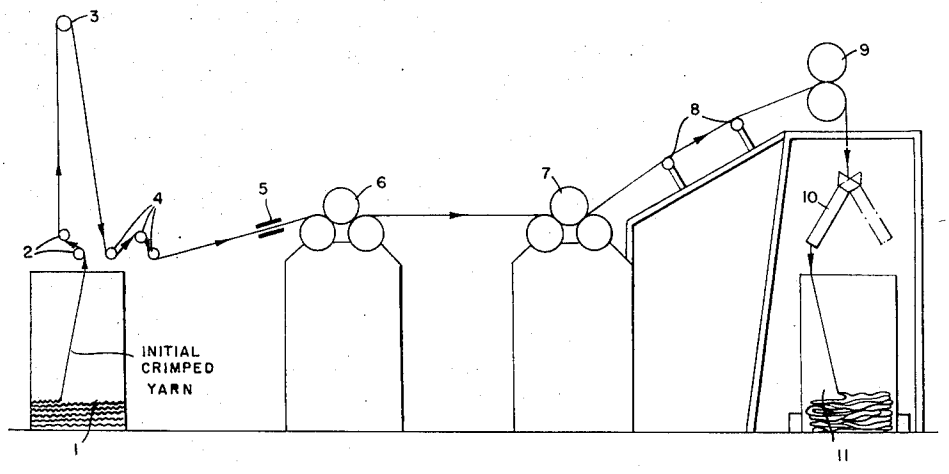
Primary Examiner—Morris Sussman

Attorney—Johnston, Root, O'Keeffe, Keil, Thompson and Shurtleff

[57] **ABSTRACT**

A non-woven fleece article composed of continuous tubular filaments of a spun and stretched synthetic fiber-forming polymer, especially a yarn composed of continuous hollow tubular polyethylene terephthalate filaments, wherein individual permanently crimped filaments have a yarn size of about 0.5 to 20 denier, a crimping arc number of 50 to 120 arcs per 10 cm. and a hollow volume of its tubular structure of 10 to 30 percent. The final desired article is one in which a fleece has been formed by coiling or layering a yarn consisting essentially of these filaments after the yarn has been subjected to a temporary elongation within the range or region of the stress-strain curve which produces an elastic strain but under a load of at least 0.1 grams/denier, the permanent extension or set of the filaments being less than 4 percent, and then releasing the tension on the yarn whereby the crimped structure of the filaments is reformed and the yarn spreads out laterally. The resulting coiled or layered yarn product is useful as a fleece-like filler material in pillows, quilts, jackets and the like.

6 Claims, 3 Drawing Figures



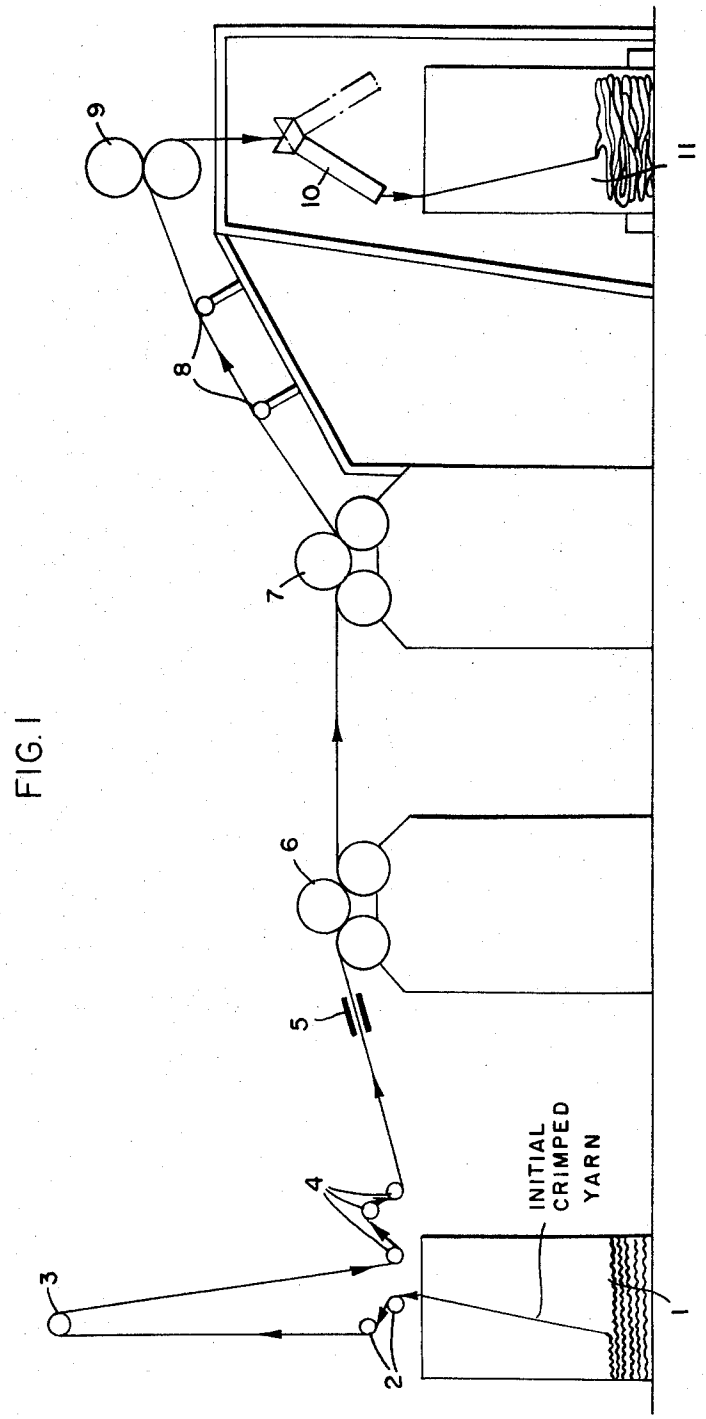


FIG. 1

INVENTORS:
HELMUT WERNER
HANS STAPP

BY: Johnston, Root, O'Keeffe, Keil, Thompson & Shurtleff
ATT'YS

FIG. 2

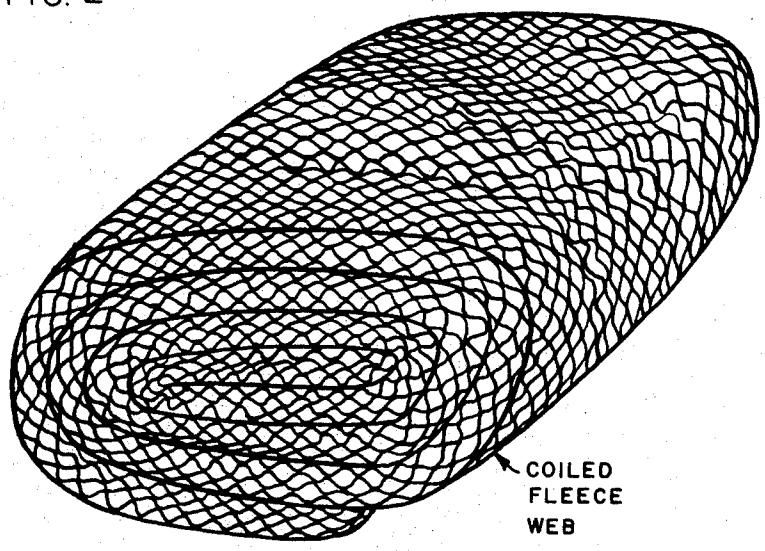
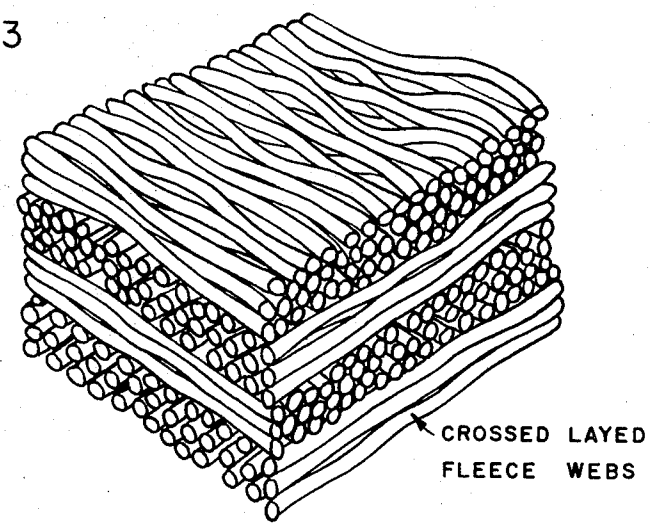


FIG. 3



INVENTORS:
HELMUT WERNER
HANS STAPP

BY: Johnston, Root, O'Keeffe, Keil, Thompson & Shurtleff
ATT'YS

NON-WOVEN FLEECE OF CONTINUOUS FILAMENTS

This application is a division of our copending application, Ser. No. 787,013, filed Dec. 26, 1968, now issued as U. S. Pat. No. 3,574,908.

Cushions, pillows and quilted articles, such as quilted blankets, anoraks and the like have been filled with non-woven synthetic fibrous fleeces consisting of staple fibers and also with non-woven fleeces which consist of endless or continuous filaments. Such fleeces of continuous filaments are preferably manufactured by spinning a synthetic fiber-forming polymer from multi-apertured spinning heads so that the filaments, preferably after being drawn or stretched, are accumulated on a suitable base or support means. Texturizing or bulking of the filaments is usually carried out either by subjecting the filaments to a turbulent blowing or by applying an electrical field before collecting the filaments into a fleece-like web.

One object of the present invention is to provide a voluminous fleece or filler which can be used for filling cushions, pillows, or the like and which are non-woven fibrous webs or planar structures, preferably made up in layers or in the form of a coil or roll. In particular, it is an object of the invention to provide a non-woven fleece composed of continuous fiber-forming thermoplastic tubular filaments by using an initially spun and stretched yarn in which the tubular filaments have already been given a permanent crimp, preferably by mechanical means such as a conventional stuffing box. Yet another object of the invention is to provide a novel fleece which is easily obtained and which has been bulked by laterally spreading out the crimped tubular filaments into a more useful non-woven sheet or web as compared to the initial yarn of the continuous filaments. Other objects and advantages of the invention will become more apparent upon consideration of the following detailed description.

It has now been found in accordance with the invention, that a valuable non-woven fleece can be obtained from continuous tubular filaments of a synthetic fiber-forming polymer if the initially spun and stretched yarn made of permanently crimped individual tubular filaments having an individual titer of 0.5 to 20 and preferably about 3 to 8 denier and a crimping arc number of from 50 to 150 and preferably about 65 to 120 arcs per 10 cm. is subjected to a temporary elongation sufficient to bring the individual filaments within the range of elastic strain under a load of at least about 0.1 grams/denier, and the tension on the yarn is then partially or completely released but to an extent sufficient to reform the crimped structure of the individual filaments and to permit the yarn to spread out laterally. In general, the load producing the required elongation should amount to about 0.1 to 1 g./den., depending upon the particular synthetic filaments being used. Also, the permanent extension or set of the filaments, i.e., after relaxation of the tension, should be less than 4 percent and preferably less than 3 percent. The voluminous spatial configuration of the continuous tubular filaments in the non-woven yarn web or fleece of the invention thus corresponds to or is determined by the application and release of tension within the above specified limitations, including a small but definite permanent extension of filaments which is a residual property imparted by the temporary application of tension.

When it is desired to produce very bulky and voluminous non-woven yarn webs or fleeces, an extremely advantageous initial yarn is one composed of hollow tubular filaments which have a hollow volume of 10–30 percent, preferably 12–25 percent, with reference to the total volume of each individual filament, i.e., each filament preferably has a uniform annular cross-section with the hollow central portion being not more than about 30 percent of the total cross-sectional area of the filament. Polyethylene terephthalate filaments are especially suitable as the hollow tubular filaments.

The expression "range of elastic strain" should be understood throughout this specification and claims to mean that region of the stress-strain curve which extends up to a specific load value of the individual crimped filaments, this load value being that at which an identical but uncrimped yarn exhibits a permanent extension below 4 percent. This "elastic strain" is also sometimes referred to as the "elastic elongation," i.e., that increment or region of elongation where the filament remains almost completely elastic except for a small amount of permanent extension. The optimum loading and with it the degree of elongation, varies for different types of polymer filaments, but may be readily determined by a few preliminary tests. This optimum effect is achieved for purposes of the present invention when the yarn or tow of crimped continuous filaments, after a temporary elongation, spreads apart to form a non-woven fibrous web or fleece of maximum width. The maximum specific loading may be considered to be the load value at which the crimp of the yarn, after removal of load, still just reforms or springs back along the yarn. However, it is generally advisable to keep the load below this maximum loading value.

When using polyethylene terephthalate filaments, the temporary elongation is preferably carried out using such a load that the permanent extension or set produced in the yarn is less than 3 percent and most preferably less than 1.5 percent. However, the load must be at least 0.1 g./den.

With polyethylene terephthalate tubular filaments which have an individual filament titer of 0.5 to 20 den., preferably 3 to 8 den. and a crimping arc number of 60 to 150 per 10 cm., preferably 80 to 150 per 10 cm., a load of 0.1 to 1 g/den. has been found satisfactory and produces adequate results; however, by using a load of about 0.5 to 0.8 g./den., extremely good results can be obtained. Continuous linear polyester filaments and particularly polyethylene terephthalate filaments which have been spun in a conventional manner to provide a hollow tubular structure, e.g., with a hollow volume of 10–30 percent, preferably 12–25 percent, as defined above, may have a relatively wide range of crimping arc number, depending on the end use of the fleece. For example, as a fleece for filling cushions or pillows in the form of a coiled or layered yarn web or the like, it is sufficient to provide a permanent crimping of these hollow tubular filaments of about 50 to 120 arcs per 10 cm., preferably about 65–100 arcs per 10 cm. When used as a voluminous fleece for filling quilted articles, e.g., in the form of a single sheet or web of fleece, these same arc numbers are also quite suitable. Such crimping can be readily produced by condition the initially spun and stretched hollow tubular filaments through a conventional stuffing box.

The products of the invention are not limited, however, to these initial polyester materials. If the non-woven fibrous webs or fleeces are to be further processed in order to produce a lining material or insert of minimum thickness or a non-woven textile fabric where the bulk or voluminosity of the web is less important, then yarns or tows made from polyamides, polypropylene or other synthetic fiber-forming polymer may also be used to great advantage. The chemical structure of the polymers being used, including stereoregulation, and any pretreatments to which the filaments have been subjected during their manufacture naturally have an effect on the process. Thus, for example, the spinning conditions, the nature and degree of the drawing for molecule orientation and the crimping to which the filaments have been subjected affect the final product. These factors must be considered when selecting the process conditions and when trying to produce certain properties in the final product.

However, the broad ranges recited herein are generally applicable to all such fiber-forming polymers, and by following the specific elongation and relaxation steps defined herein while carefully controlling the amount of load during elongation to avoid exceeding the elastic limit, one can easily determine the optimum affect in terms of producing a maximum width or spreading apart of the fleece web or band.

One important influence on the process according to the invention is the degree of crimping, i.e., the number of crimping arcs per unit of length. It does not matter what kind of crimping is used or how the crimping has been obtained. For example, yarns crimped in a stuffing box, which exhibit a so-called two-dimensional crimp, are especially useful, but the process may also be applied very successfully to filaments which have a three-dimensional crimp. Such filaments or yarns are obtained, for example, by spinning two chemically or physically different polymers using special nozzles, to produce so-called composite threads or filaments.

The individual filament titer or denier may vary within relatively wide limits and must ordinarily be chosen to suit the intended application or area of utility of the fleece. Likewise, the choice of initial filament materials depends on the end use of the fleece. Very good results are obtained using threads or filaments of all types which have an individual filament titer of 3 to 8 denier.

The spreading out or lateral separating effect is most strongly influenced by the degree of elongation which, according to the process of the invention, must take place in the region of elastic strain but under a load of at least 0.1 g./den. At the lower and upper limits of the region of elastic strain or the amount of loading, the spreading apart of the crimped filaments is usually only slight but a temporary elongation within such limits is still reasonably within the scope of the invention in terms of a distinguishing effect.

When the loading force tension of the elongation acts on a yarn of crimped filaments, the crimp first "disappears" by becoming latent and the yarn as well as the individual filaments appear to be almost smooth before the filaments are subjected to the elongation or elastic strain. It is desirable, prior to the device which elongates the yarn within the region of elastic strain, to arrange an apparatus in which elongation may take place predominantly within the region of crimping elongation, i.e., simply to "straighten out" the crimp. For example, conventional braking devices are suitable for this purpose.

The width of the non-woven yarn web or fleece which is produced depends, naturally, on the number of individual filaments of the yarn or tow being used. This number of individual filaments, depending on the purpose for which the product is intended, may be for example between 3,000 and 30,000 or more.

The method of producing the non-woven yarn web or fleece is not limited to the use of any specific apparatus, although devices in which the elongation of the yarn is accomplished between triple or quadruple rollers, i.e., a series of draw rolls, have been found to be particularly suitable. Such devices must allow for the accurate adjustment and maintenance of the low degrees of tension which are necessary to provide a relatively low load. After the drawing step, the yarn may be completely released of tension and taken off or accumulated in a tensionless condition. However, as a rule it is usually more convenient to guide the treated yarn, after the second set of draw rolls, over an additional take-off device behind which a traversing device can be arranged.

The handling of the yarn between the second set of draw rolls and the take-off device may be varied within wide limits. Thus, for example, it is possible to release the tension in the treated yarn completely or only partially, so that the elastic strain and, where appropriate, the crimp, is able to relax or reform entirely or partially. In this situation, the spreading out effect is produced in the yarn in this relaxing zone, the extent of this effect depending on the lessening of the tension. The elongation of the yarn according to the invention may also be accomplished in two stages, e.g., if the peripheral velocities of three roller units are in sequence $v_1 v_2$ and v_3, then one maintains relative speeds in which $v_1 < v_2 < v_3$ applies. In such a case, it is desirable to effect the major proportion of the elongation in the first drawing zone. As soon as the yarn has left the last guide means, the complete spreading apart to form the non-woven yarn structure of greater width takes place as already mentioned. At the same time, the crimping arcs again "jump" back into position, i.e., the crimped structure simultaneously reappears.

In the accompanying drawings:

FIG. 1 is a partially schematic side elevational view of apparatus which is suitable for carrying out the process of the invention;

FIG. 2 is a perspective view of a coiled fleece web as one preferred type of non-woven product obtained by the process of the invention; and

FIG. 3 is an enlarged perspective view of a small section of another type of non-woven product obtained by the process of the invention.

The invention is further illustrated in detail by an example taken with reference to FIG. 1 of the accompanying drawing.

EXAMPLE

Polyethylene terephthalate having a solution viscosity (η_{rel}) of 1.60, measured as a 1 percent solution of the polymer in m-cresol at 25°C., is spun through a

180-aperture nozzle or spinning head to produce a hollow tubular filament yarn. The yarn is drawn, i.e., stretched, in a conventional manner under an atmosphere of steam maintained at 160°C. (draw ratio = 1:4.1), and the stretched filaments are subsequently crimped in a stuffing box. The resulting yarn exhibits the following properties:

Strength = 47.7 Rkm. (5.3 g./den.)
Elongation = 45 percent
Hollow volume = approximately 12 percent
Individual titer = 5.5 denier
Crimping arc number = 100 arcs per 10 cm.
(The crimping arc number is counted on a large number of filament lengths which have been loaded with a weight of 3 mg., the observed arcs being those variations considered to be any mark change in direction; i.e., a sine curve would correspond to two crimping arcs).

Referring now to FIG. 1, this initial polyester crimped yarn is fed from a supply container 1, via a torsion bar brake 2 and the deflecting rods 3 and 4 to a set of three rollers 6. Arranged just before the latter is a yarn guide 5 which is particularly advantageous for the purpose of initially spreading out or positioning a large number of individual filaments into a web or band of minimum width. The peripheral velocity of the rollers of the set of three rollers 6 is 60m/min. The yarn is elongated between the triple roller arrangement 6 and a second more rapidly rotating triple roller arrangement 7, by between 8 percent and 10 percent. The tension applied by this drawing operation corresponds to a loading of 0.75 g./den. After leaving the triple rollers 7, the yarn is then guided over two rods 8 to a pair of rollers 9, the peripheral velocity of which corresponds to that of the triple roller arrangement 7. Behind or after the pair of rollers 9, the yarn quickly spreads out with a complete release of tension to form a non-woven yarn web or fleece having a width of approximately 55 cm. and is deposited, by means of a simple traversing device 10 in a collecting carton or box 11.

Instead of the receiving container 11 shown in FIG. 1, it is also possible of course to use other collecting or take-up devices. Thus, for the manufacture of a filler for cushions, pillows or pads, the non-woven yarn web is wound loosely, e.g., on a reel or spindle either from the supply container shown or directly after leaving the take-off rolls 9 as described. The non-woven web or fleece may also be deposited in a number of relatively flat layers one above the other. The filling elements for cushions or the like, which are manufactured in this way and illustrated by way of example in FIG. 2 of the drawing, are very soft and bulky and also are much more stable in shape than are fillings consisting of staple fibers. Both when the non-woven yarn webs or fleeces are used in coiled form or as a number of layers, it is possible by inwardly folding the front or end portions of the non-woven yarn web to prevent any of the free filament ends from being disposed on the surface of the filler so that they cannot project through the covering or outer fabric of the filled article. However, even if such steps are not taken, any danger that the yarn or filament ends might project through the covering of a cushion or similar article is much less than when the filling material consists of staple fibers. FIG. 2 merely shows a cushion filling in the form of a single layer of a wound or coiled yarn web or fleece.

When manufacturing quilted articles, it is possible, depending on the desired result, to use thicker or thinner non-woven yarn webs. For quilts or sleeping bags, for example, a number of non-woven yarn webs or flat structures according to the invention can be disposed in layers one above the other, whereas for protective and lightweight garments, thinner non-woven yarn webs are generally preferred. The individual layers may all extend substantially in the same direction or they may form any desired angles with each other by cross-laying. FIG. 3 shows a section or small cut-out portion of a filler for a quilted article, in a highly enlarged perspective view, which has been formed by cross-laying of individual layers of the yarn webs or fleece bands.

Further tests have shown that the articles of the invention include a wide variety of non-woven yarn webs or fleeces produced from other fiber-forming polymers or from mixtures of continuous thermoplastic crimped filaments of hollow tubular form. The non-woven voluminous webs or fleeces of the invention are especially distinguished by a substantially complete absence of broken or otherwise severely distorted filaments aside from the intentional permanent crimping which retains practically its original capacity for crimp contraction. At the same time, one achieves a much more voluminous fleece or web than could have been expected from the relatively mild processing conditions applied to the initial spun, stretched and crimped yarn.

On the other hand, the yarn webs or fleeces of the invention are also distinguished by a good coherence, and if desired they can be further impregnated with a bonding agent or otherwise bonded together to form a more rigid but highly flexible and porous fibrous structure.

The invention is hereby claimed as follows:

1. A non-woven fleece article consisting essentially of a layered yarn web of continuous tubular filaments of a synthetic fiber-forming polymer, each of said filaments having an individual titer of about 0.5 to 20 denier, a two-dimensional crimping with a crimping arc number of from 50 to 120 arcs per 10 cm. and a hollow volume of its tubular structure of 10 to 30 percent, the individual filaments of each yarn layer being laterally spread out in a spatial configuration determined by the application and release of tension on the initial spun, stretched and crimped filaments collected as a continuous yarn, with a load for said tension of at least 0.1 grams/denier sufficient to place the filaments within the range of elastic tension but not exceeding a permanent extension of about 4 percent.

2. A non-woven fleece article as claimed in claim 1 wherein said fiber-forming polymer is polyethylene terephthalate.

3. A non-woven fleece article as claimed in claim 1 wherein each of said filaments has an individual titer of about 3 to 8 denier and a crimping arc number of about 65 to 100 arcs per 10 cm.

4. A non-woven fleece article as claimed in claim 3 wherein said fiber-forming polymer is polyethylene terephthalate.

5. A non-woven fleece article as claimed in claim 4 wherein the permanent extension of said filaments is not more than about 3 percent.

6. A non-woven fleece article as claimed in claim 4 wherein the yarn web contains about 3,000 up to approximately 30,000 individual filaments.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,723,238 Dated March 27, 1973

Inventor(s) Helmut Werner and Hans Stapp

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

First page, left-hand column, tenth line, insert

-- [30] Foreign Application Priority Data

Jan. 2, 1968	Germany	G 38682/34f Gbm
Jan. 4, 1968	Germany	G 38686/8h Gbm
May 22, 1968	Germany	P 17 60 471.6

--.

Column 4, line 40, "v_1v_2" should read -- v_1, v_2 --.

Signed and sealed this 27th day of November 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents