

Dec. 2, 1941.

D. R. HULL

2,264,978

ARTICLE OF MANUFACTURE

Filed April 6, 1940

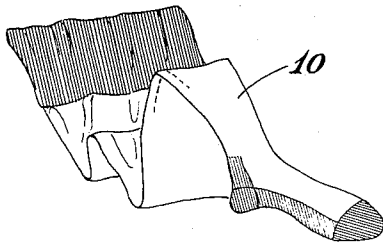


Fig. 1

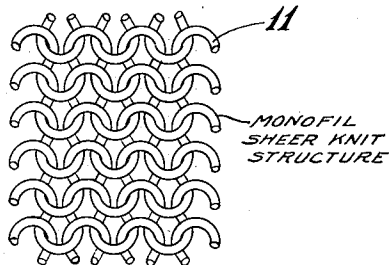


Fig. 2

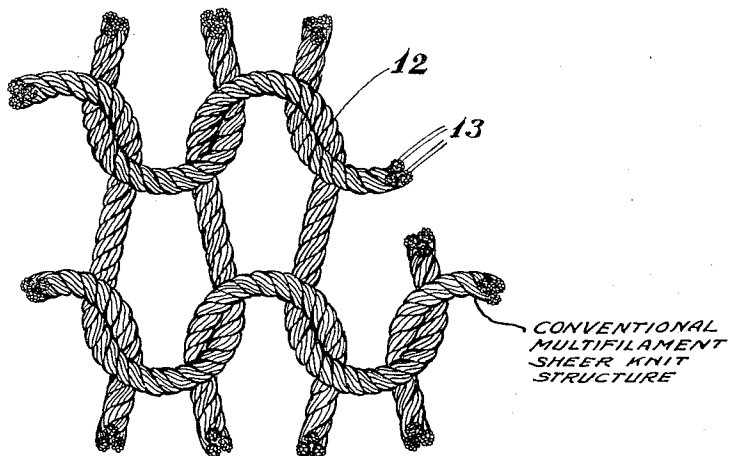


Fig. 3

Donald R. Hull INVENTOR

BY *Louis A. Wick*
ATTORNEY

UNITED STATES PATENT OFFICE

2,264,978

ARTICLE OF MANUFACTURE

Donald R. Hull, Newport, Del., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

Application April 6, 1940, Serial No. 328,221

1 Claim. (Cl. 66—178)

This invention relates to sheer, knit fabrics, such as ladies' sheer, knit hose which have been knit from single, artificial filaments, or so-called "mono-fils." More particularly, the invention relates to such sheer, knit articles and fabrics which have been knit from mono-fils composed of organic acid cellulose derivatives.

Heretofore, ladies' sheer, knit hosiery has been manufactured almost exclusively from natural silk. Very recently, such hosiery has been made from synthetic linear polyamide yarn, see U. S. Patent No. 2,157,116 to Wallace H. Carothers. Still more recently, it has been proposed to make sheer, knit hosiery, and similar sheer, knit goods from mono-fils having a denier of between 5 and 30, a tenacity of at least 2 grams per denier, a modulus of elasticity, not to exceed 0.6, and a

Tenacity

Modulus of elasticity

factor of at least 6. See U. S. Patent application of R. A. Clawson, Serial No. 328,179, filed of even date herewith. For many years the public has expressed a desire for ladies' full-fashioned hosiery which will exhibit great sheerness and durability, and which may be purchased at a low cost.

It has now been discovered that sheer, knit hose of surprisingly good sheerness, durability, softness and flexibility can be made of mono-fils of cellulose acetate, and similar organic acid derivatives of cellulose, under certain conditions as hereinafter set forth.

It is, therefore, an object of the present invention to produce ladies' full-fashioned hosiery of great sheerness and durability and having a satisfactory softness, flexibility and elasticity, which hosiery can be made at a low cost.

It is a further object of the invention to make such hosiery of mono-fils of cellulose acetate and similar organic acid derivatives of cellulose.

Other objects of the invention will appear hereinafter.

The present invention will be described with particular reference to mono-fils of cellulose acetate, it being understood that mono-fils of similar organic acid cellulose derivatives can be used equally as well in the production of sheer, knit hosiery.

Mono-fils suitable for use in accordance with the present invention must have a denier of between 10 and 50, and the product of the denier and the tenacity (in grams per denier) of the mono-fils must be at least 40. Furthermore, it is essential that the mono-fils be spun as a single, unitary filament from a filament-forming solu-

tion. Unitary filaments other than true mono-fils, that is, unitary filaments produced, for example, by cohering, merging or coalescing a plurality of fine filaments, are unsuitable for use in the production of sheer, knit hosiery.

The details of construction of the sheer, knit structure of the present invention will be more clearly apparent by reference to the following description taken in connection with the accompanying illustrations in which:

Figure 1 is a side elevational view showing generally the construction of ladies' sheer knit hosiery.

Figure 2 is a magnified view of a small section of a sheer knit structure knitted from single filaments or mono-fils.

Figure 3 is a very highly magnified view of a small section of a sheer knit structure knitted in the conventional construction from a multifilament yarn.

Referring to the drawing, reference numeral 10 designates a sheer knit ladies' stocking. Numeral 11 designates a mono-fil, i. e., a single filament, knitted to form a sheer knit structure. Numeral 12 designates the previously known, conventional form of multifilament yarn in a sheer knit construction. The individual fine filaments 13 are twisted to form a highly twisted thread. Three of the highly twisted threads are then twisted together to form the three-thread yarn 12 as illustrated in Figure 3.

The following examples are illustrative of specific methods for the production of sheer, knit stockings from mono-fils in accordance with the present invention. The invention is of course, not to be limited by the specific details of these examples.

Example I

A 30-denier cellulose acetate mono-fil spun as a single unitary filament from a cellulose acetate filament-forming solution, and having a strength of 2.0 grams per denier, was passed through a 10% aqueous solution of diethylene glycol and dried. The mono-fil was knit into a 45-gauge full-fashioned stocking fabric, looped and seamed. The stocking was then passed through a water bath having a temperature of 25° C. for removal of the diethylene glycol. The stocking was then dyed and boarded in the conventional manner. The stocking exhibited great sheerness and durability and had a very satisfactory soft hand and flexibility.

Example II

A 100-denier cellulose acetate mono-fil, spun

as a single unitary filament from a cellulose acetate filament-forming solution, was hot drawn, with a draw ratio of 4 to 1 in accordance with the process set forth in U. S. patent to Niogret No. 1,921,426. The drawn mono-fil had a denier of 25 and a strength of approximately 3 grams per denier. The mono-fil was passed through a 10% aqueous solution of diethylene glycol and dried. The mono-fil was then knit into a 48-gauge full-fashioned stocking fabric, looped and seamed. The finished stocking was washed with water at room temperature for removal of the diethylene glycol. After dyeing the stocking was boarded in the conventional manner. The stocking exhibited very desirable sheerness, durability and flexibility.

Cellulose acetate mono-fils of the type and size hereinabove referred to can be prepared by anyone skilled in the art by the conventional dry spinning process with suitable adjustment of draw-off speed, spinning cell temperature, spinning head temperature, etc. Such mono-fils may also be produced in accordance with known processes for the wet spinning of cellulose acetate. Particularly desirable mono-fils may be obtained by spinning a high viscosity cellulose acetate from a filament-forming solution of somewhat higher concentration than that conventionally used, for example, a concentration of from 30%, 35% or even 40% cellulose acetate in acetone by the dry spinning method wherein the evaporative medium contains very high concentrations of solvent vapor around the spinning orifice or orifices, for example, 1000 grams or more of acetone per cubic meter. By high viscosity cellulose acetate is meant that a solution of cellulose acetate in acetone having a concentration of 24% cellulose acetate, when measured at room temperature, will have a viscosity of 1000 poises or more. The cellulose acetate will preferably be acetone-soluble and have a combined acetic acid content of about 54%. The high concentration of acetone vapor about the spinneret may be secured by spinning in a closed cell such as that shown in U. S. Patent No. 1,782,581 (Niogret). The draw-off or windup speed of mono-fils so spun will, of course, be relatively low depending on the denier and length of travel in the spinning cell, the temperature of the spinning cell, the amount and kind of solvent used, etc. If 100-denier filaments are being spun, the windup may be no more than about 10, 20 or 30 yards per minute, although with filament deniers of the order of 20 to 30, the windup speed may be 50 to 100 or more yards per minute.

Under certain circumstances it may be desirable to spin a filament of 70, 80 or 100 or more denier per filament, and then draw the filament 2, 3, 5 or more times its original length by suitably softening the yarn, for instance, by means of heat and then stretching the same. The stretching process may be carried out in accordance with U. S. Patent No. 1,921,426 (Niogret). By so drawing the high denier filament, the tenacity of the spun mono-fil may be increased to 2, 3, 4 or more grams per denier.

As above indicated, the denier of mono-fils for use in knitting sheer, knit stockings in accordance with the present invention must be between 10 and 50. Preferably, however, such filaments should have a denier of between 20 and 30. Furthermore, although the product of the denier and the tenacity (in grams per denier) of the mono-fils must be at least 40 grams, it is preferred that the product of the denier and tenacity of the mono-fils be at least 60 grams.

Cellulose acetate mono-fils often exhibit an inherent wiriness which makes the mono-fil difficult to knit. Nevertheless, mono-fils which exhibit considerable wiriness, when in the filament deniers above set forth, after being knit in a stocking exhibit satisfactory softness and flexibility. Sufficient softness and pliability to enable inherently wiry mono-fils to be knit may be secured by incorporating in the mono-fils a plasticizer, or by treating the mono-fil with a suitable finish and, preferably, a finish that has a plasticizing action on the cellulose acetate. Included among suitable plasticizing agents for use in treating mono-fils are high boiling, polyhydric alcohols, such as glycerol, ethylene glycol, diethylene glycol, propylene glycol, as well as numerous other known plasticizers for cellulose acetate and similar organic acid esters of cellulose. Finishes having such a plasticizing action greatly soften cellulose acetate mono-fils and may be easily removed after the stocking has been knitted, thereby permitting the mono-fils to regain their original physical properties such as resiliency and strength. Under certain conditions it may be desirable to incorporate a plasticizer in the spinning solution. The resulting mono-fil produced from such a spinning solution will retain the plasticizer throughout the manufacture and use of the stockings. Although this method of producing filaments may be less desirable, it could probably be accomplished at a smaller cost of manufacture.

The finish, or plasticizer, may be applied from aqueous or non-aqueous solutions or emulsions and the amount of flexibilizing agent incorporated in the filament may vary widely, for instance, from approximately 1% to 30% or 40%, based on the weight of the dry, unfinished cellulose acetate filament. Preferably the amount of flexibilizing material in or on the mono-fil should comprise about 5% to 15% by weight of the filament. If a flexibilizing agent is incorporated in the spinning solution and the mono-fils produced therefrom, the amount of plasticizer or flexibilizing agent used should preferably be about 5% to 20% by weight of the cellulose acetate. Concentrations outside these limits may, of course, be used, and the amount used will depend to a large extent on the particular plasticizer or flexibilizing agent used, the specific characteristics of the cellulose acetate in the spinning solution, and the solvent medium used in the solution, and whether or not a finish is applied to the yarn as it leaves the cell or at any time prior to its use in the knitting machine.

Stockings produced in accordance with the invention as above described have a greater sheerness than similar stockings knit from multifilament yarns of the same denier. Stockings produced in accordance with the present invention have a snag resistance as great or greater than that of stockings knit from natural silk yarn having a like denier. Furthermore, it has been found that when a mono-fil of the present invention does break, it is more difficult for a run to start.

Stockings produced in accordance with the present invention present a good appearance; they have good clinging quality and satisfactory elastic properties, especially in view of the fact that the mono-fils are not twisted. These stockings have a remarkably soft hand and flexibility even though the mono-fils in some instances exhibit a certain wiriness. It would be expected that a stocking made from cellulose acetate

mono-fils would be very stiff, for mono-fils have been used heretofore for purposes requiring stiffness, that is, in the manufacture of tooth brush bristles, paint brush bristles, carpets, etc. Despite the generally recognized inherent characteristics of cellulose acetate mono-fils, the sheer stocking fabrics of the above-described example have a surprisingly desirable soft hand, great snag resistance, and highly desirable sheerness.

Sheer, knit stockings or similar sheer, knit goods need not be knit entirely from cellulose acetate mono-fils. It is also within the scope of the invention to use other types of fibers and yarns; e. g., silk, viscose rayon, cellulose acetate multifilament rayon, cotton, etc., in combination with the cellulose acetate mono-fils. For example, a stocking may be knitted from cellulose acetate mono-fils in the heel and toe and silk in the foot and leg. Or, a stocking may be knitted from cellulose acetate mono-fils in the foot and leg and cotton in the heel and toe. Stockings containing cellulose acetate mono-fils in any part thereof lie within the scope of this invention.

The mono-fils used in accordance with this invention may contain modifying agents, such as luster-modifying agents, plasticizers, pigments and dyes, anti-oxidants, resins, etc.

Although cellulose acetate multifilament yarns as well as cellulose acetate mono-fils have been known for a very considerable number of years prior to the present invention, the discovery, at this late date, that cellulose acetate mono-fils may be advantageously used for the production of ladies' sheer, knit hosiery and similar sheer, knit fabrics comes with a great deal of surprise.

In view of the surprisingly good elasticity, strength, durability, snag resistance, run resistance, flexibility, softness of hand, and good appearance, a cellulose acetate mono-fil sheer, knit stocking and similar sheer, knit goods of this invention, it is quite apparent that an important advance in the art has been made. There is less wastage of yarn caused by the breakage of small filaments, for a fairly large mono-fil does not snag so easily as do the numerous small filaments of a multifilament yarn. Sheer, knit stockings of cellulose acetate multifilament yarn have been of substantially little value in the art. Sheer, knit stockings made of cellulose acetate mono-fils show surprising promise both in stocking characteristics and in the fact that they are produced at comparatively low cost in comparison with other sheer, knit stockings on the market.

Since it is evident that many changes and modifications can be made in the above-described details without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited to the details as above set forth, except as set forth in the appended claim.

I claim:

A sheer, soft, durable, knit structure consisting of mono-fils of cellulose acetate having a denier of between 10 and 50, and a product of denier times tenacity (in grams per denier) of at least 40, the mono-fils being directly spun in the form of a single unitary filament from a filament-forming solution.

DONALD R. HULL.