METHOD OF MAKING A RUN RESISTANT STOCKING TAB

Inventor: John J. Millar, Laconia, N.H.
Assignee: Scott & Williams, Inc., Laconia, N.H.

Filed: June 3, 1971
Appl. No.: 149,451

Related U.S. Application Data

U.S. Cl. 66/95, 66/136, 66/173, 28/73, 260/78 A, 260/78 L
Int. Cl. D04b 9/54, D04b 9/56

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Primary Examiner—Wm. Carter Reynolds
Attorney, Agent, or Firm—McNenny, Farrington, Pearne & Gordon

ABSTRACT
Fine-gauge, circularly knit seamless stocking has a tab portion of fabric formed after a transfer operation and which represents a terminal portion of knitting. Raveling or runs in the tab portion are prevented by having courses in the tab including a polyamide yarn having a much lower melting point than the yarn used in the remainder of the stocking and which fuses or becomes tacky at boarding temperature so that the fusing takes place during this stage of processing.

2 Claims, 4 Drawing Figures
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RELATED CASE

This application is a divisional application of application Ser. No. 13,700, filed Feb. 24, 1970, now U.S. Pat. No. 3,611,755, which is a continuation-in-part of my copending application, Ser. No. 765,821, filed Oct. 8, 1968, now abandoned.

This invention relates generally to seamless circularly knit hosiery and more particularly to hosiery which is knit in such a manner that a transfer operation of loops from the dial to the needles is performed at the end of the knitting operation and a tab formed of a number of courses knit after the transfer operation and before it is pressed off.

Stockings are formed with a tab portion knit after a transfer operation either when the stocking has been knit in the reverse direction and an in-turned welt is formed after knitting the body of the stocking or when the stocking is knit in the usual direction so that the toe is formed last, then a tab is formed after a transfer operation when the toe is closed on the knitting machine by constricting a double layer of fabric at the toe.

A particular problem in such a tab is that since it is formed immediately before press-off, the loops tend to be free to run and the yarn ends are subject to raveling even though the tab may be knit with a run-resistant stitch pattern and may naturally tend to curl up so that the terminal courses are protected.

One method of preventing raveling or running in the tab was disclosed in the prior patent applications of John J. Millar, Ser. No. 680,226, filed Nov. 2, 1967, now abandoned, and Ser. No. 703,949, filed Feb. 8, 1968, now U.S. Pat. No. 3,488,981, granted Jan. 13, 1970. According to the disclosure in these applications, the tab was sealed on the knitting machine by means of an electrically heated element which was brought into close contact with the tab during the knitting of the final courses. This allowed the heat to fuse the thermoplastic yarns from which the stocking was knit and after the stocking was pressed off and prior to finishing, the last knit courses were separated from the first knit courses of the tab at the fused zone so that after removal of this ring of material, the exposed yarn ends were fused together in such a manner that raveling or running was substantially eliminated.

The foregoing method of sealing the tab, while providing a substantially run-proof tab, has been found to have certain drawbacks, such as requiring the presence of a special electrically heated element, the electrical circuitry to operate the element, and additional controls on the knitting machine to bring the element into operation in the desired manner. This has been found to substantially increase the cost of the knitting machine as well as to increase the maintenance needed because of the tendency of the hot wire to pick up fused material from the stocking which tends to carbonize on the filament, which then requires periodic cleaning. Still another problem with this method has been the difficulty in obtaining consistent and proper bonding of the material. If the yarns used in the fused area are conventional nylon, there is some difficulty in restricting the fusion to the desired zone without the heat causing damage to proximate areas other than those where the bonding is desired. As mentioned in the aforesaid U.S. Pat. No. 3,488,981, efforts have been made to utilize a yarn made of a material having a lower melting point than that of the nylon used in the rest of the stocking, and using this lower melting point yarn in the structure of the tab, so that upon operation of the heated element, the temperature resulting in the fabric will be sufficient to melt the low melting point yarn but insufficient to damage the nylon yarns, so that only the low melting point yarn is melted and caused to bond to the backing nylon yarns to cause them to adhere together in such a manner as to produce a run resistant structure.

The use of a different yarn in the tab structure has another drawback because of the difference of the physical properties of the yarn from that of the nylon. The use of material such as polypropylene and various vinyl and vinyl type yarns has caused the presence in the tab of a material having a substantially lower tensile strength than that of the nylon structure. Since the tab may be in a location such as at the welt of the stocking where it is subject to continual stretching, such repeated stretching action on the bonded courses of the tab may, because of the different tensile strength of the nylon and low melting point non-nylon components, cause the latter to break and rupture, thereby destroying the bonding action which has produced the run-resistant structure. This problem is further accentuated by the fact that such low-melting point yarns are not truly compatible with nylon in that when they fuse they merely cause a surface adhesion to the nylon at the interface which may not produce a sufficiently strong bond to prevent rupture when the fabric in this area is stretched. With melt compatible yarns, the interface substantially disappears or becomes indistinct and the juxtaposed threads actually fuse or blend together at their contact points to form a solid solution of the differentially melting nylon yarns.

An important feature of the present invention is that it allows courses in the tab to be fused together after the stocking has been completely knit and removed from the knitting machine.

Another important feature of this invention is that the fusing can take place during the usual boarding, dying or other finishing operations on the stocking where the stocking is placed on a form and exposed to saturated steam at a temperature to set the stocking to the desired shape.

Another feature of this invention is that it reduces the number of courses in the tab while retaining a sufficient degree of fusion to prevent raveling and running.

Still another feature of this invention is that it is adaptable to machines having different numbers of feeds, may be used in combination with various run resist structures and requires no special modification of the knitting machine to adapt the invention to existing machines in which the tab is already formed.

Briefly, the foregoing features of this invention are realized in the preferred embodiment where the body of the stocking is knit with the conventional nylon 66 or nylon 6 yarns. When the tab portion is knit, a special yarn is introduced at at least one of the feeds of the machine and fed together in random plated relationship with a backing yarn of the same type used in the remainder of the stocking. The knitting may be done using a run resistant structure for several courses after which the stocking may be pressed off. The special yarn is a low melting point nylon yarn which fuses at normal
boarding temperatures so that when the stocking is processed in the normal manner and boarded, the heat of the boarding process will be sufficient to melt the low melting point yarn to a sufficient degree to cause it to adhere to its backing yarn and the yarns contacting it at various points in the knitted structure. After the boarding process has been completed and the stocking cooled, the low melting point yarn will thus be fused or caused to adhere to the other yarns in such a manner that no raveling or running can take place.

Thus, the fused tab is provided without special processing on the knitting machine or any separate machine and the fusing is completed during the finishing operations on the stocking. Further features and advantages of the invention will readily become apparent to those skilled in the art upon a more complete understanding of the invention as set forth in the accompanying detailed description and in the figures in which:

FIG. 1 is a diagrammatic elevation of a stocking incorporating the present invention;

FIG. 2 is an enlarged fragmentary cross-section of the welt structure including the tab of the stocking shown in FIG. 1;

FIG. 3 is an enlarged fragmentary view of the toe of a stocking in which the toe includes a tab formed after transfer; and

FIG. 4 is a fabric diagram showing a preferred stitch structure for the tab courses according to the present invention.

Referring to the figures in greater detail, FIG. 1 shows a stocking to which this invention is particularly applicable. Heretofore, ladies fine-gauge hosiery has been generally knitted starting from the welt, which was usually formed with an inturnd welt, down the leg, through the heel and into the toe which was generally finished with a reciprocated toe pocket with a number of courses of a yarn which was of a low cost variety and which was removed from the stockings during the finishing operations where the toe was closed by stitching or looping.

However, with the development of methods of closing the toe on the knitting machine, such as disclosed in the patents of John A. Currier, U.S. Pat. No. 3,327,500 issued June 27, 1967, reissued May 13, 1969 as Re. 26,581, U.S. Pat. No. 3,340,706, issued Sept. 12, 1967, reissued May 13, 1969 as Re. 26,580, and U.S. Pat. No. 3,340,707 issued Sept. 12, 1967, a problem has arisen upon termination of knitting and press-off because the terminal courses remain in the finished stocking. When the stocking is knit toe first according to the preferred method of closing the toe on the knitting machine, the inturnd welt is formed last and after knitting the welt fabric and performing the necessary transfer operation, it is necessary to terminate knitting in such a manner as to prevent the possibility of runs or raveling on the exposed edge of fabric.

Thus, as shown in FIG. 1, a stocking 10 when knit in the reverse direction is formed first with the closed toe 12 and then knit in a direction up the leg from the foot 11 and terminates in an inturnd welt indicated generally at 14. As shown in greater detail in FIG. 2, the inturnd welt consists of an outer layer of fabric 15 which is continuous with the body portion of the stocking and an inner layer of fabric 16 which is continuous with the layer 15 but has been folded over to form the double fabric layer. The layers 15 and 16 are joined together at the transfer courses indicated at 18 with interlocked courses as described in greater detail in the aforementioned Currier patents. After the transfer has taken place, additional courses are knit to form annular portion of fabric, generally called a tab, shown at 20, which represents the last fabric knit prior to press-off and which must form a barrier to prevent raveling and running into the interlocked courses 18 or further back along the fabric of the stocking.

When the stocking is knit in the opposite direction, the inturnd welt is formed first and the closed toe formed during the final portion of knitting the stocking, and a tab is also formed at the inside of the toe of the stocking as indicated in FIG. 3. In such case, the toe is formed with an outer fabric layer 22 and an inner fabric layer 23 which while constricted together at the end to form the closed toe are joined together with interlocked transfer courses at 26. Thus, after this operation has taken place there remains a tab portion 27 similar in structure to the tab 20 to prevent running and raveling in the toe area. Thus, regardless of the direction in which the stocking is knit, there remains a tab portion formed after the last transfer operation and prior to press-off which must act as a barrier to prevent runs and raveling starting and continuing into the remainder of the stocking.

It has been recognized in the aforementioned patents of Currier and the aforementioned patent applications of Millar that when the knit tab is allowed to relax it has a tendency to curl upon itself as shown in FIG. 2. While this gives some protection to the very terminal courses of the tab, it is not sufficient because of the tendency of the tab to unroll both when tension is applied by lateral stretching and under physical contact when the stocking is worn. While some protection against raveling and running is formed by knitting so-called run-resistant stitches in the tab, it has been recognized as desirable to provide additional protection, particularly when the tab appears at the welt. Because of the thermoplastic nature of the nylon or polyamide type fiber which is used today for substantially all the production of fine-gauge ladies hosiery, it has been proposed to cause some fusion of the fiber so that adjacent fibers bond together in such a manner that the yarns are locked and cannot run or ravel. In the aforementioned Millar U.S. Pat. No. 3,488,981, the area of the tab fabric was fused by the application of heat through an incandescent wire, and while this produces a fusion which is able to positively prevent runs and raveling, it increases the cycle time of the knitting machine and requires a separate operation because the additional portion of the tab must be removed outward of the fused portions because the heat cannot be applied too close to the needle circle, and also produces a longer tab than is desired to insure that the heat is kept away from the transfer courses, where any weakening of the yarn by heat would immediately cause a break which would allow runs to appear almost at once.

According to the present invention, a much smaller and yet highly run-resistant tab can be produced without requiring any special operation either on the knitting machine or during the finishing processes nor is any modification of the finishing processes required from those generally in use. Generally, this is accomplished by knitting a tab structure after the transfer courses in which is incorporated a yarn which melts or fuses to a sufficient extent during the boarding process at temperatures generally between 240° to 260° F to
bond itself to the other yarns and produce an almost runproof structure. Under these conditions, the low melting point yarn is knit with a standard nylon backing yarn in a plaited relationship to maintain the integrity of all loops in the tab structure. If a sufficient amount of the low melting point yarn is used and fusion allowed to take place for a sufficient time, then additional bonding takes place in addition to the fusion at the yarn junctions so that the folded or curled layers of fabric in the tab as shown at 20 in FIG. 2, will tend to bond themselves to each other so the tab can no longer uncurl even when stretching is relaxed and this provides additional positive sealing of the tab against raveling or runs.

The low melting point yarn used in this tab structure is necessarily a polyamide or copolyamide to insure the best possible bonding to the regular nylon (polyamide) yarns. There materials also have similar dyeing properties so that after the dyeing operation they will appear substantially the same as the conventional nylon yarns used in the remainder of the stocking.

The best yarns are copolyamides which are fiber-forming and which have a melting point within the range of from about 115° to about 140°C. Generally, such low melting point fiber-forming polyamide yarns are formed by known methods from amino acid or lactam materials, one of which contains relatively fewer carbon atoms than the other. These materials are reacted in ratios which vary from 20 to 80 parts of the low carbon atom amino acid or lactam to from 80 to 20 parts of the high carbon atom amino acid or lactam. A preferred range of ratios of such amino acid or lactam materials is from 40 to 60 parts of the low carbon atom material to from 60 to 40 parts of the high carbon atom material.

The low carbon atom amino acids or lactams generally contain six to eight carbon atoms. The high carbon atom amino acids or lactams generally contain from 10 to 15 or more carbon atoms.

Specific examples of the low carbon atom amino acids or lactams include omega-amino caproic acid or caprolactam, omega-amino caprylic acid or caprylic lactam, 6-amino-2-ethyl hexanoic acid, 4-amino-hexahydro benzoic acid. Specific examples of the higher carbon atom amino acids or lactams include omega-amino decanoic acid, omega-amino undecanoic acid, N-methylamino-undecanoic acid, omega-amino lauric acid or laurolactam, omega-amino pentadecanoic acid.

These materials may be reacted in various ratios to yield fiber-forming nylon type polyamides or copolyamides which have a melting point between about 115° and 140°C. The polymerization procedure is conventional and reference may be had, for example, to Rowland Hill, "Fibers from Synthetic Polymers," Elsevier (1953), Pages 132-133.

In general, these copolyamides have molecular weights between about 15,000 and about 20,000. Specific examples of useful copolyamides having the desired properties within the ranges aforesaid include a copolyamide of caprolactam and omega-amino deca-noic acid (50:50), a copolyamide of caprolactam and omega-amino undecanoic acid (40:60), a copolyamide of caprylolactam and omega-amino decanoic acid (50:50), a copolyamide of caprolactam and omega-amino lauric acid (55:45), a copolyamide of caprolactam and omega-amino decanoic acid (40:60), a copolyamide of omega-amino undecanoic acid and N-methylamino-undecanoic acid (55:45), and the like. Yarns formed by conventional spinning procedures are preferably used. 40 denier 9 filament strand having a tensile strength between 5 and 6 grams per denier and a melting peak between about 115° to about 140°C so that substantially complete melting and fusing of the fiber takes place at boarding temperatures between 240° and 280°F, preferably between 240° and 260°F. Of course, other yarns can be used if they have a melting or fusing temperature within this range and such yarns should be preferably of the polyamide, polyester or mixed polyamide-polyester type to provide the requisite high degree of bonding with the basic nylon fiber used in the remainder of the stocking and have a sufficiently high tensile strength that the stocking is not weakened in the areas of bonding. Since the extremes of boarding temperatures range between 220° and 270°F and all polyamide materials normally used in hosiery have a melting point above 350°F there is no fusing or bonding of the nylon yarns in the remainder of the stocking during boarding.

The tab structure which includes the low melting point yarn is preferably knit with a run resistant structure to provide a maximum amount of contact between adjacent yarns while maintaining a high degree of stretchability, both before and after fusion has taken place. A preferred structure for this purpose is shown in FIG. 4 where the numbers 1, 2, 3, and 4 indicate the position of adjacent needles on the needle cylinder while the letters D, C, B and A represent the courses formed on a two-feed machine on successive revolutions of the needle cylinder. The fabric structure is basically a stitch degenerated 2X4 run resistant fabric knit on two feeds. On one revolution as indicated at D, the first feed knits a normal nylon type 66 stretch yarn 30 of about 30 denier on all the needles, although as shown in the fabric diagram, the loops taken on alternate needles become degenerate after completion of the stitch structure and therefore show no loops in the finished fabric. However, because there were originally loops on every needle with this yarn, the considerable bulk of this yarn allows considerable stretch. Since this yarn is subsequently bonded only at its junctions with the low melting point yarn, it is free to provide a considerable amount of stretch.

On the same revolution as indicated at C, at the second feed two yarns are knit together. These yarns consist of, for example, a 15 denier nylon 66 monofilament backing yarn 31 together with the low melting point yarn 32 described above at about a weight of 40 denier. These yarns are fed together to provide a random plated arrangement without regard to which surface either yarn is exposed at. This backing yarn of a conventional type 66 nylon is used since it will not substantially soften at the boarding temperature and therefore provides loop continuity and backing support for the fusible low melting point yarn. This yarn is knit on alternate needles such as 1 and 3 on one course while the intervening needles 2 and 4 tuck and on the subsequent revolution of the needle cylinder selection is reversed so that needles 2 and 4 knit while needles 1 and 3 tuck.

This arrangement of continual knitting on all needles at the first feed station and alternate knit and tuck structures at the second feed station alternating between each revolution of the machine provide a struc-
ture that is therefore reproduced every four courses. Since the course knit at station 1 is always knit on all needles and does not include the low melting point yarn which is included only at alternate courses on a knit and tuck structure, after the fusing of the low melting point yarn considerable stretch will remain in the fabric structure while still securing all loops in the fabric to give an extremely effective run resistant arrangement.

It is recognized that other stitch structures can be used and a plain knit can be used using the low melting yarn in plaited relationship with a backing yarn either at every feed station so that it appears in every course or on spaced courses with intervening courses which are not fused by the low melting point yarn. It is recognized that if the low melting point yarn appears on all courses, a more effective anti-ravel and run resist structure is obtained at some loss in the stretchability of the fabric, and therefore by balancing the structure the proper combination of stretchability and run resistant structure can be obtained. If the low melting point yarn is introduced immediately after transfer, a minimum number of courses in the tab are required to produce a completely run resistant structure after the fusing and bonding has taken place during the boarding operation. It is desirable to have at least eight courses of this structure to provide the maximum amount of run resistance; but if it is desired to increase the stretchability and reduce the bulk of the fabric a few number of courses may be used if desired.

Regardless of the actual knitted structure used in the tab, the use of the low melting point nylon which is fused to the higher melting point nylon produces a strong run-resist structure because the nylon yarns, being compatible with each other, cause a thorough fusion rather than mere surface bonding as occurs if a non-polyamide material is used in the tab. In addition, such low melting point nylon yarns will tend to be similar in appearance, feel and dyeing properties to the nylon used in the rest of the stocking, so that they will not become readily apparent either visually or by feel. Likewise, because the low melting point nylon has similar physical characteristics of tensile strength and elongation with standard nylon yarns, it will retain the same degree of physical durability and have the same strength so that they will not tend to break or rupture during handling any more than that of the nylon yarns used in the tab and the remainder of the stocking.

What is claimed is:

1. A method of forming, on a knitting machine having a plurality of needles and transfer instrumentalities, a run resistant tab portion on a nylon stocking having the tab portion knit after a transfer operation and just prior to press-off comprising knitting said tab portion to include in at least one course two yarns in plaited relationship throughout the course, both of said yarns being nylon, one of said yarns being a nylon having a melting point above 350°F, and the other of said yarns being a nylon having a melting point between 240° and 280°F, removing the stocking from the knitting machine, and thereafter subjecting the stocking to a boarding operation at a temperature between 220° and 270°F whereby the yarn having a lower melting point is fused to the yarn having the higher melting point to provide a run resistant structure.

2. A method of forming a run-resistant section of a stocking on a knitting machine having a plurality of needles and transfer instrumentalities comprising the steps of knitting said stocking section with said needles to include in at least one course one polyamide yarn having a melting or fusing point between 240° and 280°F, said one yarn being knit in plaited relationship throughout the course with a second polyamide yarn having a melting point above 350°F, removing the stocking from the machine and thereafter subjecting the stocking to a finishing operation at a temperature between 220° and 270°F to fuse said one yarn.

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