

- [54] **METHOD OF KNITTING ON A DOUBLE CYLINDER MACHINE AND STOCKING FORMED THEREBY**
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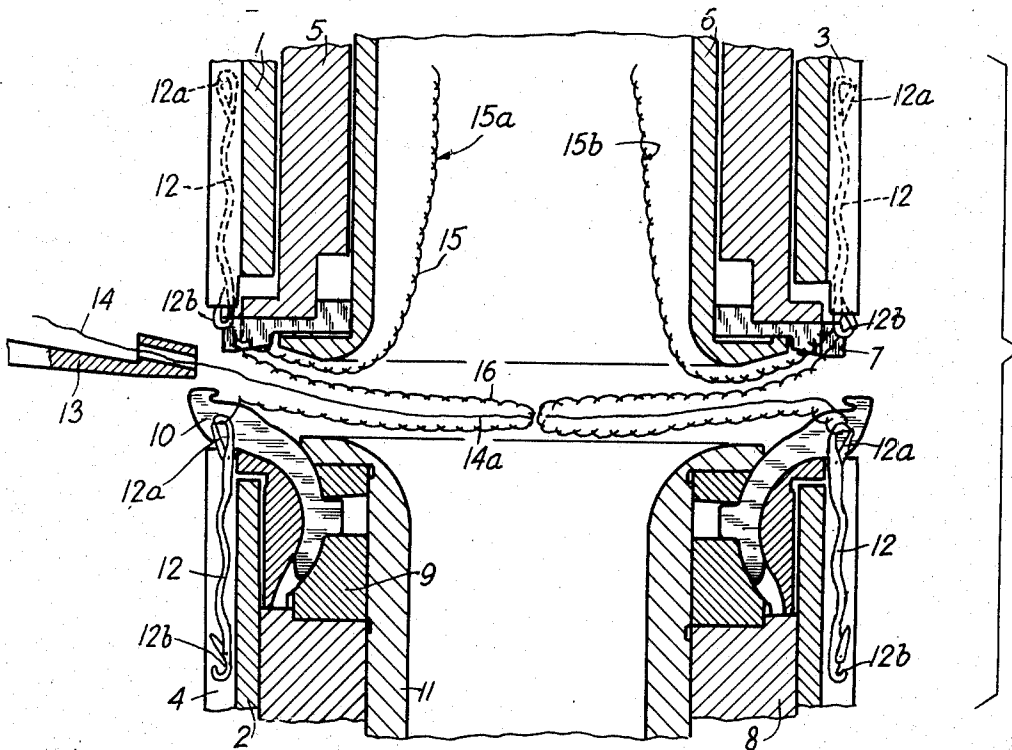
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[51] Int. Cl. **D04b 9/10, D04b 9/56**
[58] Field of Search..... 66/14, 187, 26, 9 R, 66/173

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- [57] **ABSTRACT**
A method of forming a stocking on a double cylinder circular knitting machine, comprising knitting the stocking from the welt through the sole and instep on the needles in one of the cylinders, continuing the formation of the toe portion by knitting a predetermined number of circular courses on both of the cylinders so as to provide a toe portion having a combination of stitches, contracting the toe portion at about its center and stitching the last course thereof to the instep and sole.

5 Claims, 7 Drawing Figures



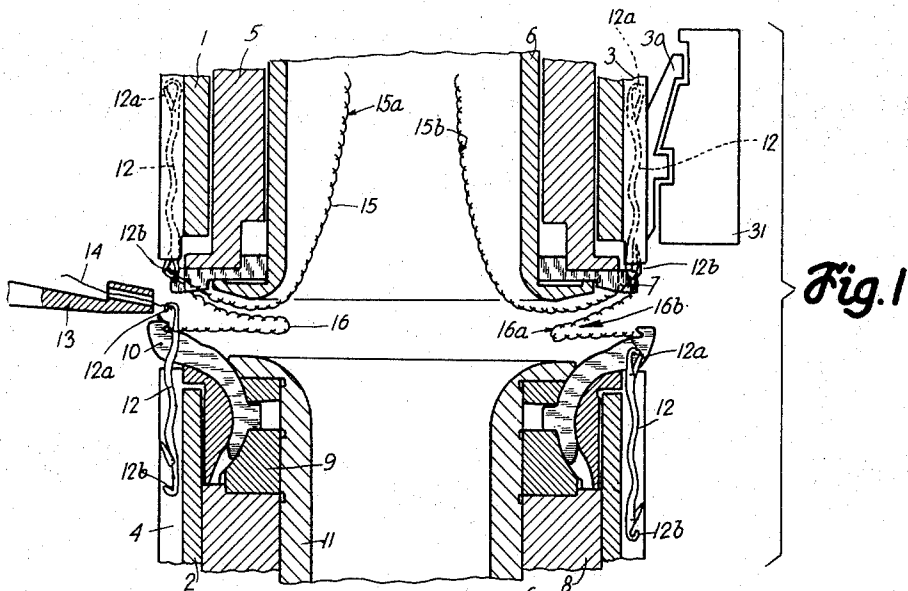


Fig. 1

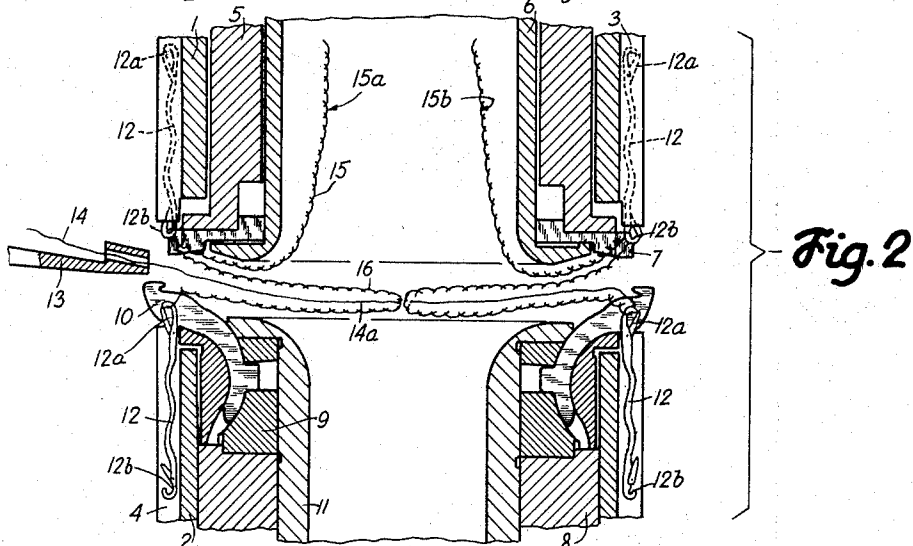


Fig. 2

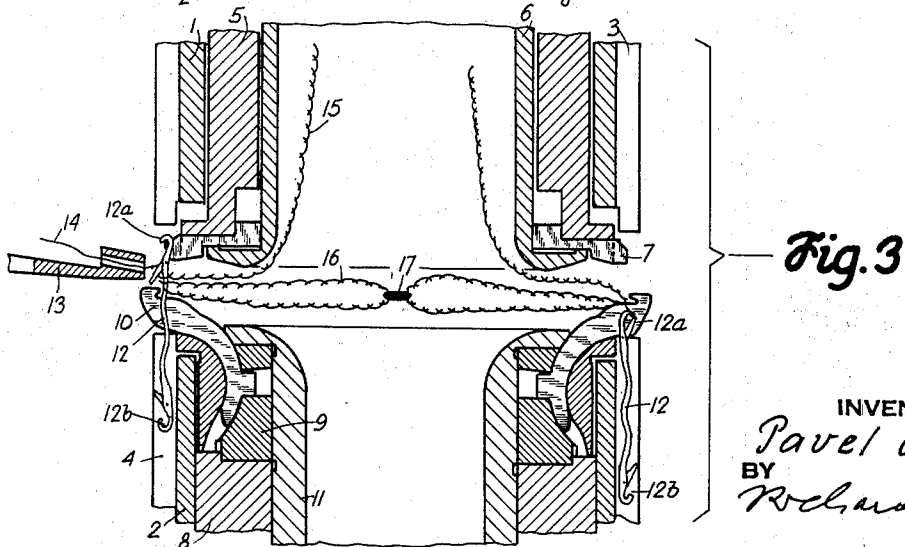


Fig. 3

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Fig. 4

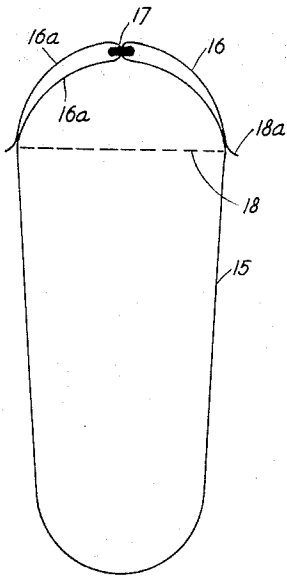


Fig. 5

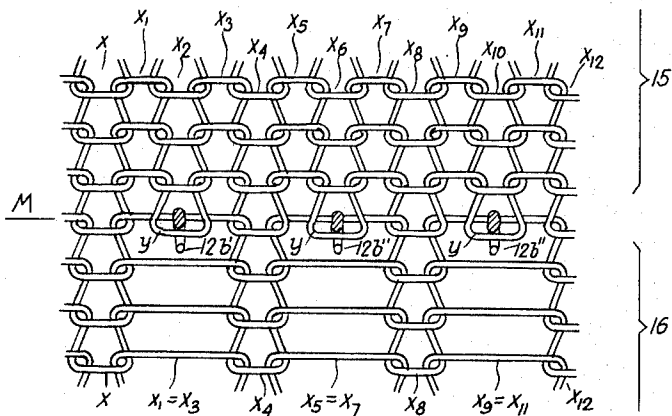
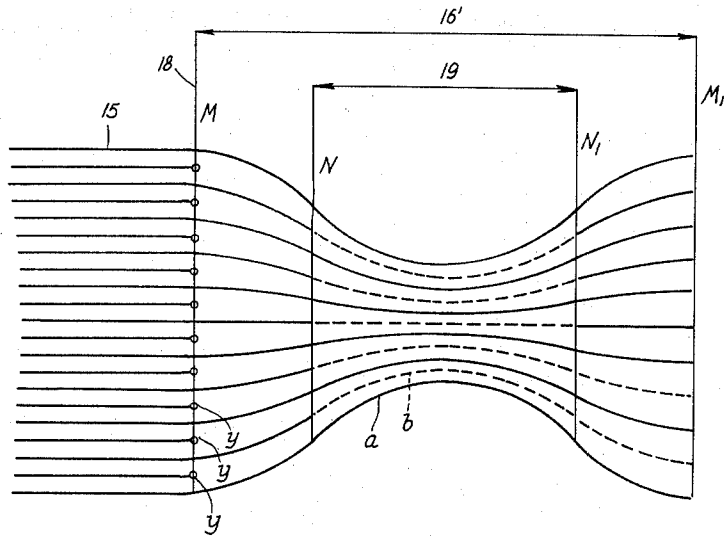


Fig. 6

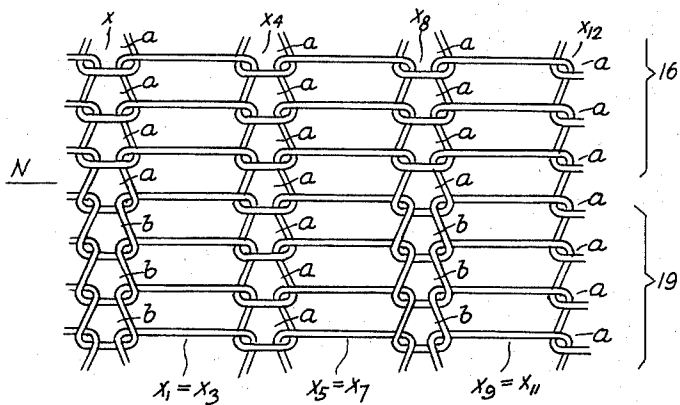


Fig. 7

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METHOD OF KNITTING ON A DOUBLE CYLINDER MACHINE AND STOCKING FORMED THEREBY

The present invention relates to the knitting of seamless hosiery and, in particular, to the method of closing the toe portion of stockings on double cylinder circular knitting machines.

Methods of forming closed toe portions of seamless hosiery are well known in one cylinder knitting machines. In such machines, it is conventional to begin the knitting of the stocking from the toe portion proceeding subsequently to the welt. In such manner, the toe portion may be started as if it were the welt itself and after the initial course of loops is knitted, the sinker loops thereof are transferred to the hooks of the patterning mechanism arranged above the cylinder. After such transfer, the patterning disc and the cylinder are rotated to knit the further loop course necessary for the toe portion. After the necessary number of loop courses are knit the patterning disc is stopped and the cylinder rotated at least a further 180° twisting the knitted fabric. After such twisting, which can be more than 360° if desired, the loops from the transfer disc are returned to the needles on the cylinder and knitting of the toe portion resumed. It will be obvious that the characteristic of the toe portion thus produced, while seamless, is a twisting over of a part of the knitting.

Another method of closing the toe portion of a seamless stocking on a single cylinder machine is similar to the first, in that, the initial course of loops is transferred to the patterning disc and a length of toe material knitted. However, here, instead of twisting the yarn, it is inserted within the needle cylinder wherein it winds about the knitting contracting and closing it off. Subsequently, the material is removed from the patterning disc and knitting resumed.

The common disadvantage of these two methods is that the stocking is knit from toe to welt. Since the welt is the focus of mechanical stress, it is that portion of the stocking requiring the greatest strength. However, the final courses of any knitting are the weakest and most easily unraveled. A further disadvantage of these methods is that the toe is formed only of plain stitches which, when very thin gauge yarn is employed, results in unnecessary tears and runs.

Opposed double cylinder circular knitting machines have also been used in making "seamless" stockings. That is, leg inseam and sole portions have been made as tubular portions. The heel and toe have, by and large, generally been made by holding the tubular portion and knitting the heel and toe by oscillating, rather than rotating the cylinders. This produces a substantially flat portion which is then seamed and stitched to the remainder of the stocking. This method, as is readily apparent, does not produce a truly seamless stocking.

It is the principle object of the present invention to provide a method for closing the toe portion of seamless hosiery without any of the known disadvantages.

It is another object of the present invention to form stockings on a circular knitting machine from welt to toe.

It is another object of this invention to knit seamless hosiery on a double cylinder knitting machine, permitting the use of different and various yarns.

It is another object of this invention to provide a method of closing the toe portion of seamless hosiery

at a point wherein the fabric is provided with a combination of knit and purl stitches reinforcing the same.

These and other objects and advantages, as well as a full disclosure of this invention, will be seen from the following description and the accompanying drawings in which:

FIG. 1 is an enlarged fragmentary view of a longitudinal section through the opposed cylinders of a double cylinder knitting machine showing the first stages in the knitting of the toe portion;

FIG. 2 is a view similar to that of FIG. 1 showing an advanced stage in the knitting of the toe portion;

FIG. 3 is a view similar to FIGS. 1 and 2 showing the final stage of closing the toe portion;

FIG. 4 is a diagrammatic view of the sole and toe portion of a stocking made in accordance with the present invention;

FIG. 5 is a diagrammatic development of the toe portion of a stocking made in accordance with the present invention;

FIGS. 6 and 7 are enlarged fragmentary diagrammatic views of the stitch structure of the toe portion shown in FIG. 5.

Only a fragmentary portion of a double cylinder knitting machine is shown in FIGS. 1 to 3 which, for the purpose of illustrating the present invention, is all that is required to be shown since the general construction of such machine is well known in the art.

The knitting machine illustrated comprises an upper needle cylinder 1 and a coaxially aligned lower needle cylinder 2. The cylinders 1 and 2 are spaced from each other to permit passage of knitted material between them and are rotatable about their common longitudinal axis. The cylinders are provided with a plurality of longitudinal grooves or needle slots 3 and 4, respectively arranged around the outer periphery of the cylinders in opposed paired relationship. Slidably mounted within each of the opposed pairs of slots 3 and 4 is a double ended needle 12 having a hook 12a at its upper end and a hook 12b at its lower end. As is well known, the needles 12 can be caused to transfer between the upper and lower cylinders 1 and 2 by means of the standard sliders or jacks 30 operated by one or more cam cylinders or cam blocks 31 shown only in connection with the upper cylinder in FIG. 1 arranged about the exterior of the needle cylinders.

The upper needle cylinder 1 is also mounted on a bearing sleeve 5 inside of which is located a smooth contoured inlet throat 6 through which the knitted material may also be drawn. The lower edge of bearing sleeve 5 is provided with a plurality of fixed bits or sinkers 7, each being associated and cooperating with successive needles 12 to effect looping of yarn into a stitch that is herein defined as a back loop or purl stitch.

The lower cylinder 2 is also mounted on a bearing sleeve 8 which is provided at its upper end with a sinker cam 9 into which is slidably secured a plurality of curved, movable sinkers 10. The sinkers 10 are adapted to move in a predetermined manner guided by the sinker cam 9 into association and cooperation with predetermined successive needles 12 to cooperate therewith to effect the looping of yarn into a stitch herein defined as a face loop or knit stitch. Within the lower bearing sleeve 8, there is also provided with an inlet throat 11 which, in addition to permitting passage of fabric therethrough if desired, cooperates with the bearing sleeve to fix the sinker cam 9 in place.

Mounted adjacent the exterior of the cylinders 1 and 2 in proximity to the space between them is one or more yarn guides 13 through which yarn 14 may be fed into the needles 12 which, when the cylinders are rotated in known manner, produce a circular fabric of a plurality of horizontal courses having a stitch or loop configuration predetermined by the relative location of the needles and sinkers and in which cylinder they are operating. Each course comprises a succession of stitches each comprising a needle loop (a loop formed by pull of the needle on the yarn) alternating with a sinker loop (a loop formed by the pull of the sinker on the yarn). The needle and sinker loops being arranged in vertical wales conforming to the particular stitch.

The apparatus thus described is highly suitable to the production of conventionally formed stockings; the welt, leg, heel, sole and instep portions may be knit by rotating the cylinders and manipulating the needles, sinkers, jacks, etc., in the well known manner. According to the present invention, a seamless toe can be developed on the present apparatus.

Turning to FIG. 4, the stocking formed in accordance with the present invention comprises a body 15 including welt, leg, heel, instep and sole, which latter two, end in a marginal circular course of loops 18, and a toe portion 16 which, briefly, is formed of a series of circular courses of predetermined length which is then doubled back over itself and bound by a winding of yarn 17 and secured at its free end into the marginal edge 18.

In actual operation of the knitting machine shown, the needles 12 are set within cylinders 1 and 2 to provide a particular form of stitch desired. For illustrative purposes, it may be assumed that a plain knit stocking is to be made and that, therefore, all the needles 12 employed in forming leg, sole and instep portions are initially located and normally employed in the lower cylinder 2. If preferred, the knitting may be similarly started in the upper cylinder; however, if so, the stocking will require turning inside out when finished. Thusly, the cylinders 1 and 2 may be rotated in a predetermined direction to effect as seen in FIG. 1 the continuous knit of the yarn 14 from the open welt into the leg, heel, sole and instep portions of the stocking 15 which has a front side 15a and a reverse side 15b. The stocking body 15 is conveniently drawn through the upper cylinder and does not require turning. The knitting progresses in known manner until the sole and instep portions are completed and the marginal loop course 18 is reached.

Turning now also to FIG. 5 wherein the stocking is shown in diagrammatic development and FIGS. 6 and 7 wherein an enlarged view of the stitch structures are shown, the stocking body 15 comprises a series of successive knit courses having wales X, X₂, X₄ . . . made up of needle loops (a) alternating with wales X₁, X₃, X₅ . . . made up of cooperating sinker loops. As the knitting of instep and sole reaches the marginal course 18, delineated by the line M, the needles 12 employed in the lower cylinder 2 are equally divided and alternate needles with their yarn loops Y are transferred to the upper cylinder 1 by means of their associated jacks and cam. The needles 12 thus transferred to the upper cylinder 1 are held in withdrawn position by the jacks 30 and cam 31 so that they are ineffective in further knitting operations. As seen in FIG. 6, the hooks 12b', 12b'', 12b''' . . . of the withdrawn needles hold the needle loop Y in every fourth wale X₂, X₆, X₁₀ . . . inactive.

It is evident from this that continued knitting on the needles remaining in the lower cylinder 2 will produce a portion formed of successive circular knit courses made up of loops alternating with a sinker loop of twice the width as in wales X, X₄, X₈, . . . and wales X₁, X₃, X₅, X₇, X₉, respectively. Knitting in this fashion is continued from line M for a predetermined number of courses delineated by line N forming that portion of the fabric 16' (FIGS. 6 and 7) which by reference to FIG. 1 will be seen to also have a front side 16a and a reverse side 16b. The result of this skip knitting is to permit the elasticity of the yarn to constrict and taper the toe portion as shown.

After reaching the course defined by the line N, corresponding roughly to the position of the machine as shown in FIG. 1, additional needles 12 in alternate manner are again transferred from the lower cylinder 1 to the upper cylinder 2. However, these needles, representing every fourth needle of the original number in the lower cylinder and representing wales X, X₈, X₁₆, . . . (FIG. 6) are not inactivated but are maintained movable in the upper cylinder 1 by operation of jacks 30. Thus, the needles in the upper cylinder produce purl loops (b) as seen in FIG. 7, in each of wales X, X₈ and X₁₆ . . . in the courses following the line N. Knitting in this manner is continued, forming a ribbed type fabric (1 × 1), until a predetermined number of courses are obtained denoted by numeral 19 and delineated by line N₁ in FIG. 5. It will be observed that central portion 19 of the toe 16 takes on a symmetrical double taper extending conically inward from line N to a narrow point and then tapering conically outward to the line N₁. As the knitting reaches the course defined by line N₁, the active needles maintained in the upper cylinder, i.e., every fourth needle of the original number of needles is transferred back to the lower cylinder 2 and knitting resumed to effect the formation of the remainder of the toe portion 16. That is, the portion between the courses defined by N₁ and M₁ in FIG. 5 are completed. These courses are knit in exactly the same manner and stitch and conform to the courses previously knit between the lines M and N, thereby providing a toe fabric of symmetrical configuration having a free edge defined by line M₁.

At the completion of the final course M₁, the fabric is held, in part, by the alternate needles inactively fixed on the upper cylinder 1 and in part by the active needles held on lower cylinder 2, as seen in FIG. 2. At this stage, the yarn 14 is removed from the hooks 12a of the needles held in the lower cylinder and both cylinders rotate for a predetermined number of times. During this time the needles no longer pass through a knitting motion. The rotation of the cylinders 1 and 2 cause the yarn 14 to wind about the narrowest center portion of the toe 16, forming the binding 17, as seen in FIG. 3. It is preferred that during the winding of yarn 14, into the binding 17, that the yarn guide 14 be braked so that a drag is exerted on the yarn 14 causing it to tightly wind itself into as small a point as possible, thus closing the knit and avoiding unraveling of the yarn.

After formation of the tightly wound binding 17, the yarn 14 is cut and the remaining needles secured in the upper cylinder 1 are transferred back to the lower cylinder 2. Consequently, the marginal course 18 is made contiguous with the finally knit course M₁ and the toe portions M to N and N₁ to M₁ are doubled one to the other as seen in FIGS. 3 and 4, placing the front face

16a on both the inside and outside of the toe. The stocking is given its final finishing touches by knitting a few unraveling courses 18a which join together the marginal course 18 and the final course M₁ and prevent the stocking from unraveling.

Finally, the stocking is released from the needle and withdrawn through the upper cylinder 1 into a collecting vessel. By closing the knitted fabric in the manner shown, the fabric may be thus withdrawn from the machine through the upper cylinder without damage to the fabric or inconvenience.

It will also be appreciated that the method described herein may be employed to close the toe of the stocking no matter what its stitch structure, since the stitch structure depends solely on the original position in which the needles are placed. Ribbed stockings of 1:2, 2:1 or greater may also be closed by providing for the withdrawal of predetermined needles in the formation of the toe and binding the same as described.

Having thus described the present invention, it will appear obvious that what has been disclosed is a successful method of employing a highly versatile and economical knitting machine in a novel manner to provide an improved hose and that the objects set forth, namely the formation of a closed toe without overtwisting and/or weakened structure, is obtained. It is also clear that the novel method provides an improved hose having a reinforced toe as well as a strengthened welt.

I claim:

1. The method of forming a stocking on a double cylinder circular knitting machine comprising the steps of knitting leg, heel and instep-sole portions of the stocking on the needles in only one cylinder, completing the

instep-sole portion by knitting a marginal edge of the instep-sole portion, thereafter inactivating a predetermined number of loops by transferring a predetermined number of needles to said second cylinder, forming a toe portion of said stocking by continuing the knitting for a first set of predetermined courses, transferring a second predetermined number of needles to said second of the cylinders for operation therein and knitting a second predetermined set of courses employing needles of both said cylinders to produce a combination of knit and purl stitches, returning said second predetermined number of needles to said one cylinder and further knitting a third predetermined set of courses thereon corresponding to the first set of predetermined courses, thereby forming a symmetrical toe portion having a free edge, contracting said toe portion at its longitudinal center by winding a yarn thereabout to bind said toe portion at its center and knitting said free edge to said marginal edge.

2. The method according to claim 1 including the step of knitting at least one anti-ravel course after securing the free edge of the toe portion to the marginal edge of the instep-sole portion.

3. The method according to claim 1 wherein the toe portion is contracted and bound by winding a yarn about the center thereof while a portion of the needles remains in each cylinder.

4. The method according to claim 1 including the step of withdrawing said stocking from said cylinders through the said second cylinder.

5. A stocking made in accordance with the method of claim 1.

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