

Dec. 14, 1971

G. WOOD ET AL

3,626,727

TUBULAR KNITTED FABRIC

Filed Dec. 1, 1969

4 Sheets-Sheet 1

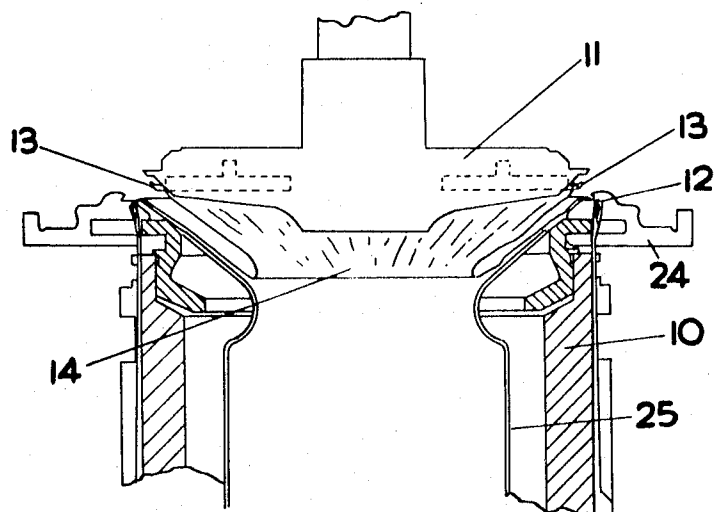


FIG. 1

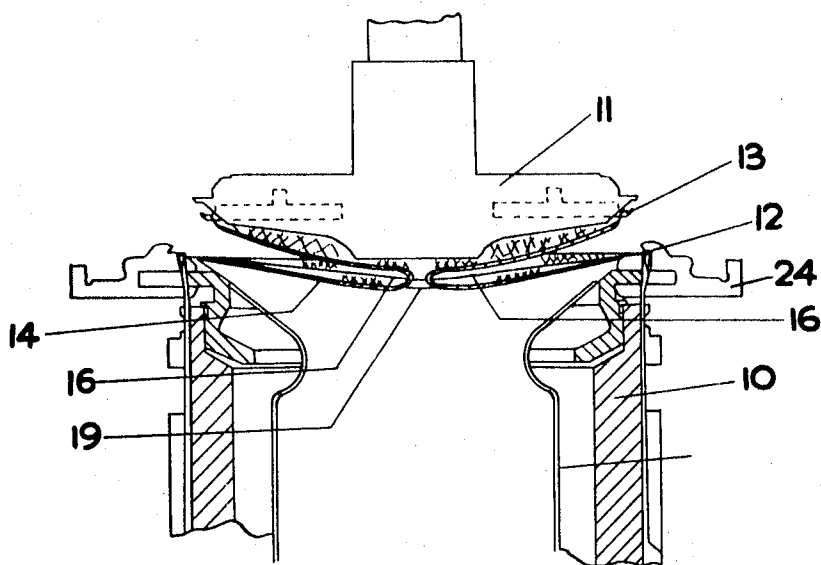


FIG. 2

Dec. 14, 1971

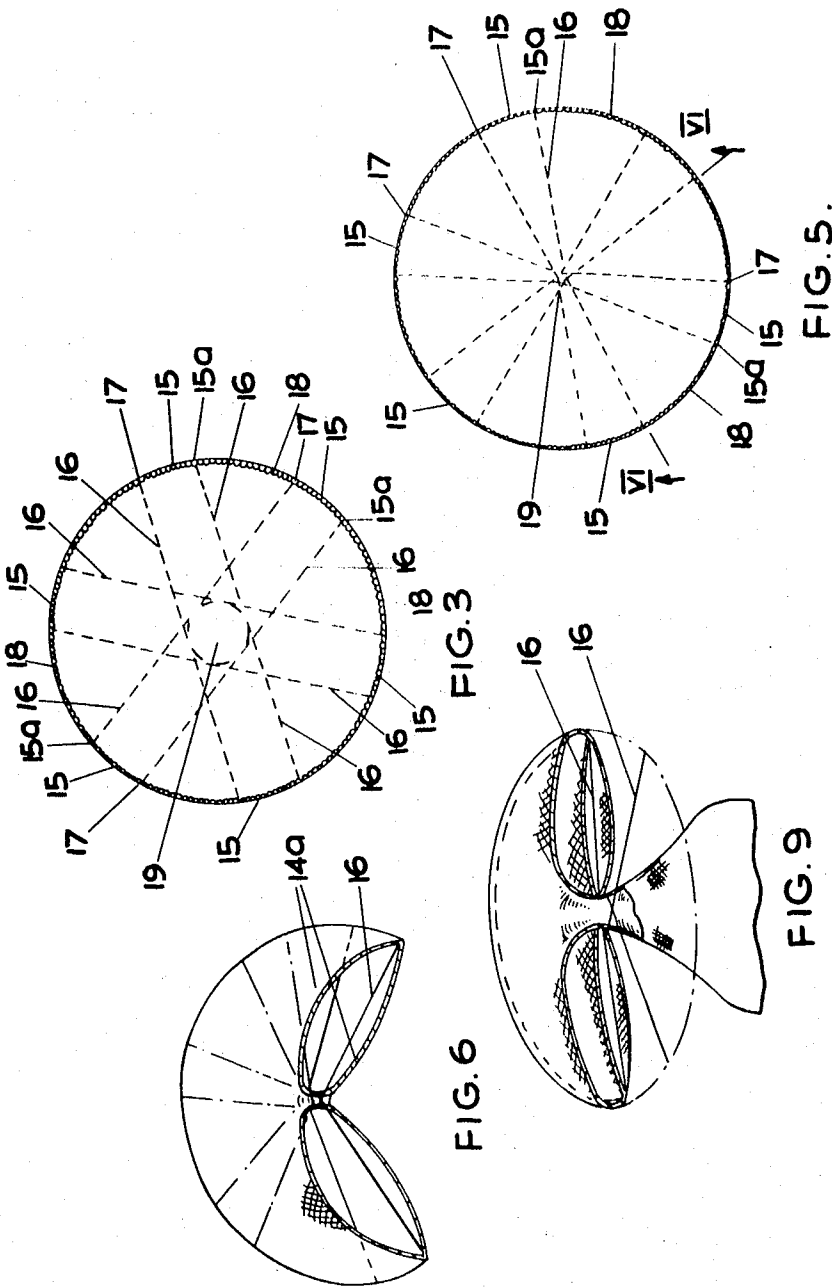
G. WOOD ET AL

3,626,727

TUBULAR KNITTED FABRIC

Filed Dec. 1, 1969

4 Sheets-Sheet 2



Dec. 14, 1971

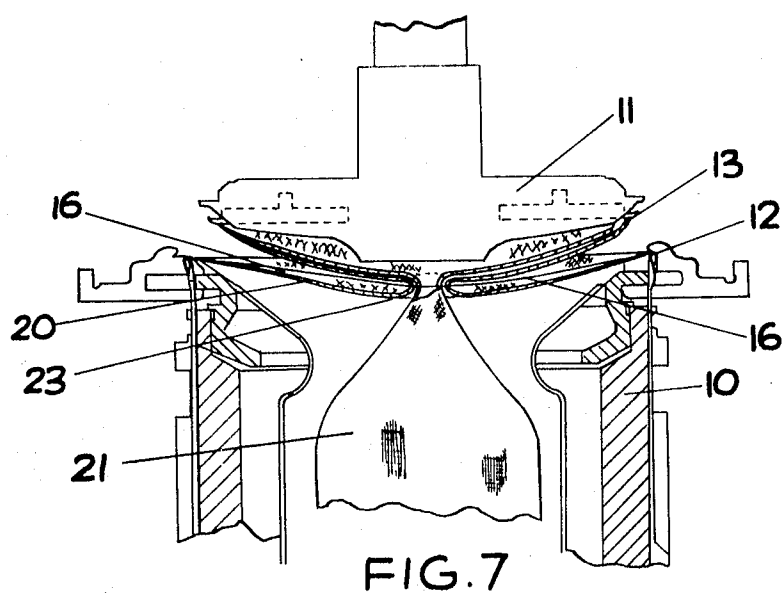
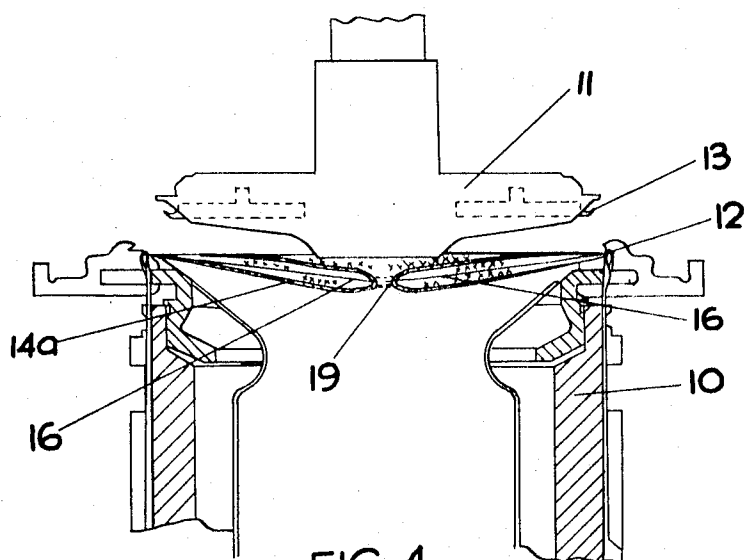
G. WOOD ET AL

3,626,727

TUBULAR KNITTED FABRIC

Filed Dec. 1, 1969

4 Sheets-Sheet 3



Dec. 14, 1971

G. WOOD ET AL

3,626,727

TUBULAR KNITTED FABRIC

Filed Dec. 1, 1969

4 Sheets-Sheet 4

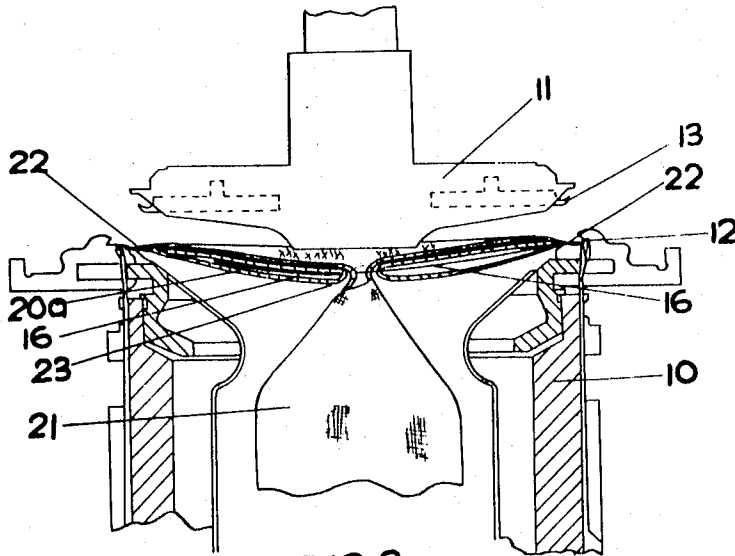


FIG. 8

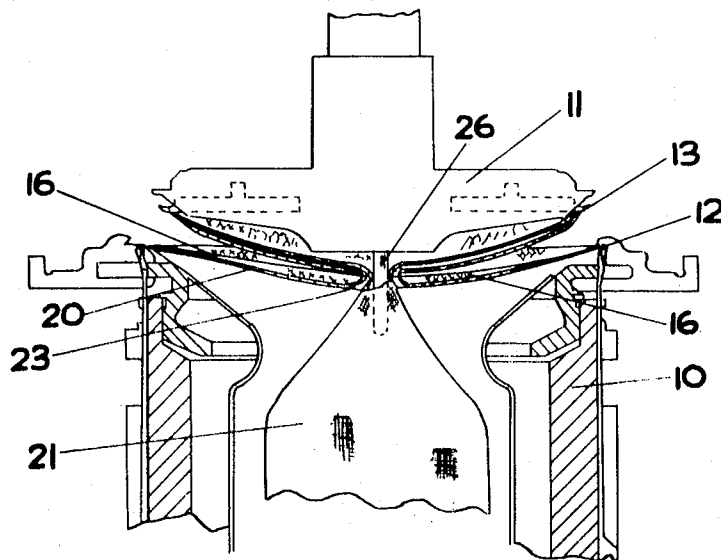


FIG. 10

1

3,626,727

TUBULAR KNITTED FABRIC

Gillies Wood, Evington, England, assignor to The Bentley Engineering Company Limited, Leicester, England

Filed Dec. 1, 1969, Ser. No. 881,227

Claims priority, application Great Britain, Dec. 6, 1968, 57,963/68

Int. Cl. D04b 9/56

U.S. Cl. 66—95

5 Claims

ABSTRACT OF THE DISCLOSURE

A closed fabric tube and more especially a foot part of a stocking or other article of hosiery footwear, and a method of forming it in which a double ply welt-like portion of closure fabric is constricted by means of U-shaped loops of yarn spaced around the fabric and each partly encircling the fold line of the welt-like portion and anchored at each end in a knitted course at the junction of the plies thereof. Each U-shaped loop may be formed of yarn used in knitting the welt-like portion and may be of a length such that full constriction to close the fabric is obtained when the closure fabric is extended to a required shape.

This invention is for improvements relating to tubular knitted fabric and is concerned more particularly with the closure of a fabric tube in a manner which does not require linking or seaming operations to be performed after knitting of the tube. One object of the invention is to provide an improved manner of closing a fabric tube which can be effected in a simple manner economically on a machine in which the fabric tube is knitted.

The invention is more particularly concerned with a fabric tube which is closed by means of a double ply fabric produced in similar fashion to a turned welt having the fold of the double ply portion drawn inwards to close the end of the tube. In accordance with the invention such a closed fabric has the closure effected by a plurality of U-shaped loops of yarn spaced circumferentially of the tube and together forming a constricted closure or neck by pulling said fold of the double ply portion towards the centre of the tube. The loops of yarn conveniently extend from the periphery of the double ply portion with U bends partly encircling the constricted central portion of the double ply fabric. The sequence of such loops of yarn is such that the central part of the fabric is constricted completely, partly by one loop and partly by at least one other. Two diametrically positioned loops may be employed but generally it will be preferred to employ at least three or four such loops and a larger number than this, say six or eight loops, is found to be convenient and particularly effective.

The invention includes a procedure for forming a closed tubular fabric article in which a portion of fabric produced in similar fashion to a turned welt is knitted and, prior to the joining together of the beginning and end parts of the welt like portion, U-shaped loops are formed by a yarn being withdrawn from the needles and fed partly around the knitted fabric and then re-introduced to the needles and by the same procedure being repeated at a suitably spaced position or positions around the needle circle, after which the welt-like portion is turned by the joining the stitches in its initial part to stitches in its last part. The loops extending partly round the central portion of the welt-like fabric thus constrain the fold therein into a neck portion which may or may not be completely closed. Depending on whether the welt-like portion is knitted before or after the main part of the fabric tube it will be followed either by the knitting of such main

2

part or by the knitting of a small number of courses of anti-ravel fabric.

The invention is particularly useful in the manufacture of stockings, socks and similar hosiery articles for effecting the closure of the toe ends of the feet of such articles. After such an article has been knitted and closed or partly closed by the provision of the constricting loops incorporated in the welt-like portion as aforesaid, the article is shaped on a board and the double ply portion will thereby become stretched to the shape of the toe end of the board, and this will cause the U-shaped loops to become drawn taut. If such loops have not completely closed the fabric at the time of their formation the pull on the loops to draw them taut as just described will have the effect of fully closing the fabric at the fold of the welt-like construction by exerting so to speak a throttling effect on the knitted fabric. In the case where the article of hosiery is knitted in the normal direction, i.e. with the toe formed last of all, this manner of partial closure by the U-shaped loops followed by turning of the welt-like portion and subsequent knitting of courses of anti-ravel fabric will leave a sufficient central opening to enable a toeward portion of the main part of the fabric (which will have become encircled by the constriction in the welt portion) to be drawn through such opening in the welt-like portion and the latter turned inside out so that the anti-ravel courses forming the final part of the knitted article will be brought to the inside of the tubular fabric.

A convenient procedure which is applied to the manufacture of a stocking or other hosiery article is as follows. In the construction of the toe fabric a short length of tubular fabric is produced by knitting over loop holding elements so that one end of the tube is held on the elements and the other in held on the needles. Knitting is continued until a sufficient length of fabric has been knitted to enable it to be closed as double fabric to the center of the tube. Thereupon U-shaped loops of yarn are caused to extend inwards of the needles in such manner that the bend of each U partly encircles the short fabric tube. By providing a number of such loops, around the tube, the ends of the loops being knitted or joined to the tube at the periphery thereof, the tube is constrained into a neck which is not necessarily closed. The knitting of the double ply portion constituting the toe fabric is now completed by transferring the held loops from the elements back to the needles.

The toe fabric produced by this method has two particular features, these are:

- (a) during the manufacture of the stocking or other article on the knitting machine, although closure means is provided in the toe fabric, actual closing of the tube need not take place;
- (b) absolute closure of toe fabric can be obtained at a convenient time such as during the boarding and finishing of the stocking or other article, the closure being obtained automatically by using the means provided during the manufacture of the toe fabric.

Actual closure of a stocking or sock which incorporates this novel closure fabric is obtained simply by drawing the stocking onto a former which fits the foot portion. As soon as the "toe" of the former presses into the constricted zone of the double ply fabric it causes the U-shaped loops of yarn to draw in contrasting directions and tighten their loops within the fold of toe fabric thus drawing the periphery of the tubular fold inwards until it is completely closed. By regulating the length of the short fabric tube which is to provide the double ply toe fabric and regulating the length of the loops providing the closure means, suitable proportions for the final toe "cap" shape may be arrived at. Heat setting of the stocking whilst on the former will cause the closure to become permanent.

The invention includes tubular knitted fabric having an end part formed of double thickness welt like construction having incorporated between the plies of said end part constricting threads in the form of U-shaped loops spaced apart around the fabric and arranged so as to constrict the fold of the welt like portion to a substantially closed state when said portion is drawn out lengthwise of the fabric. The constricting threads in the form of U-shaped loops conveniently run from and to the line at which the plies of the welt-like portion are joined together.

Advantageously the invention can be applied to an article of knitted hosiery footwear, e.g. a ladies stocking, with the double welt-like part aforementioned forming the toe end part of the foot and being closed by the combined constricting action of the U-shaped loops of the constricting threads.

In practising the invention the welt-like end part of tubular knitted fabric may incorporate two U-shaped loops as aforesaid positioned diametrically opposite one another, or a greater plurality of such loops spaced around the tubular fabric.

In the case of a tubular knitted fabric or hosiery article in which the welt-like end part has been knitted after the remainder of the fabric it is necessary for a band of anti-ravel fabric to be knitted as a terminal part to prevent unravelling. The invention includes the provision of a portion of tubular fabric or a hosiery article having an end part closed by constricting threads in the form of U-shaped loops and also having a terminal band of anti-ravel fabric positioned on the inside of the fabric portion or article.

Certain specific procedures and structures in accordance with the invention will now be described with reference to the accompanying drawings, in which:

FIGS. 1, 2 and 4 show in central vertical cross-section the dial and upper part of a needle cylinder of a circular knitting machine and illustrate various stages in one procedure for forming fabric at the closed end of a fabric tube,

FIG. 3 is a plan view showing the end closing fabric,

FIG. 5 corresponds to FIG. 3 but shows the fabric substantially fully closed,

FIG. 6 is a side perspective view, partially broken away, of part of the fabric when in the stage of FIG. 5,

FIGS. 7 and 8 correspond to FIGS. 2 and 4 but illustrate a modified procedure,

FIG. 9 corresponds to FIG. 6 but shows a fabric formation resulting from the procedure illustrated by FIGS. 7 and 8, and

FIG. 10 corresponds to FIG. 7 but shows a further modification.

In FIGS. 1, 2, 4, 7 and 8 of the drawings parts of a cylinder and dial type circular knitting machine are shown including a needle cylinder 10, a welt dial 11, needles 12, welt hooks 13, sinkers 24 and a central throat tube 25.

A particular manufacturing sequence illustrated by FIGS. 1 and 6 of the drawings is as follows. To knit a stocking commencing at the toe end, "make up" courses are started using both the needles 12 and the welt hooks 13, in similar manner to that used in commencing a conventional returned welt. The short length of fabric which is then knitted depends as shown at 14 in FIG. 1 from the hooks 13 to the needles 12 and may be knit on all of the needles or only a fraction of the needles (uniformly spaced around the needle circle) as desired. When sufficient fabric to form a closure has been knitted, the needles 12 are then directed to a low inactive track where they hold their loops and at this stage the aforementioned U-shaped loops of yarn are generated to constrict the tube of fabric approximately midway between the hooks 13 and the needles 12. The U-shaped loops may be obtained by raising to knitting activity, at succeeding courses, different small groups of needles 12 extending along small arcs 15 (FIG. 3) of the needle circle, which causes the yarn to be knit over arc 15, and then causes a looping yarn 16 to extend (as shown somewhat diagrammatically in FIG. 3) from

the trailing needle 15a of the active group 15, part way around the fabric tube and then to rejoin active needles at 17, and be knitted by the first mentioned and the next following group of needles at 15, and be laid in or knitted along the intermediate arc of needles at 18. The yarn is then again caused to extend part way around the fabric tube and back to the beginning of the second group of needles at 15 and the procedure repeated until all six of the loops 16 have been formed. FIG. 2 illustrates the condition of the fabric 14 and machine parts while the loops 16 are being formed.

Having produced the desired number of fabric constraining loops, the held fabric loops on the hooks 13 are transferred back to the needles 12 all of which are then caused to knit to complete the double ply toe portion indicated at 14a (FIG. 4) having a central opening 19 surrounded by loops 16 contained within the double ply fabric and constituting means by which automatic closure can be obtained. Knitting can now proceed to make the foot, leg and if desired a welt portion which may be terminated by means such as anti-ravel stitches to prevent unravelling. Final closure of the stocking to the stage illustrated in FIGS. 5 and 6 is automatically obtained as previously described by drawing the stocking on to a board and may be part of the finishing operations.

It will be understood that there is thus produced a stocking (or other article of hosiery footwear) having a double ply toe portion 14a of welt-like structure having incorporated between the plies constricting yarns or threads in U-shaped loops which together form constricting means for closing the toe portion 14a. Any convenient number of such U-shaped loops may be employed from two upwards and spread out substantially uniformly around the toe fabric.

In an alternative procedure, the sequence of knitting may be reversed and the stocking commenced at the top or welt end. In this case, any desired welt may be made followed by the leg and foot fabric. Having completed the final course of the foot anti-ravel stitches may be knitted to enable certain needles to release their loops while other needles draw stitches in conjunction with advanced welt or dial hooks 13, so that the stocking may be held on the hooks 13. Knitting is then continued to form a welt like fold of fabric indicated at 20 in FIG. 7, which hangs in tubular form between the welt dial hooks 13 and the needles 12 and surrounds the toe end part of the stocking indicated at 21 suspended from the welt dial hooks. When as shown in FIG. 7 a short length of fabric sufficient to comprise a double ply toe portion has been knitted, U-shaped constraining loops 16 are generated in the manner described previously to draw inwards the fold of fabrics. In this case however the stocking foot portion 21 depending from the hooks 13 will also be contained within the constrained circular fold 20 of toe fabric. At this stage the stitches being held by the hooks 13 are returned to the needles thus completing the double ply toe portion as indicated at 20a in FIG. 8 and also joining the final course of the foot of the stocking to the terminal loops of the toe fabric.

After knitting a few courses of anti-ravel fabric shown at 22, FIG. 8, the stocking may be pressed off the needles 12 and, because of the nature of the closure means contained in the double ply toe fabric and the central opening shown at 23 therein, the foot portion, which is encircled by the double ply fabric 20a may be drawn through the opening 23 in the toe fabric thus causing the anti-ravel courses 22 to be positioned on the inside of the stocking toe. Final closure of the stocking is obtained during the boarding, as already stated.

The product of the alternative procedure just described is a stocking (or other article of hosiery footwear) having its toe end portion of double ply welt-like structure having incorporated between the plies a plurality of U-shaped loops of yarn which together form constricting

means serving to close the toe at the fold of the welt-like doubled fabric, and having a band of anti-ravel fabric positioned on the inside of the toe end portion at the join line of the two plies of the welt-like portion. Similarly, there could be produced any tubular knitted fabric having an end closed in the same manner.

For best results it is advisable to have the U-shaped loops 16 of yarn forming the constricting means all of substantially the same length so that substantially the same pull is exerted by each of them to draw the welt-like portion of doubled fabric together along its fold line at a central position. This can be at least partially attained by controlling the tension in the yarn during the formation of the U-shaped loops, but can be more positively achieved by employing the modification shown in FIG. 10. In this modification the welt dial 11 of the knitting machine is provided with a central depending rod or peg 26 of circular cross-section which is arranged to project within the double ply welt-like fabric 20 and provides a sizing device around which the yarn forming the U-shaped loops is passed in a suitably tensioned condition. In the same way all loops 16 are measured to cause them to have the same length. It will be understood that the dial 11 will subsequently be raised, as by the means disclosed in the Wignall et al. application, Ser. No. 769,840, after the two plies of the welt-like portion have been joined together.

The use of the rod or peg 26 is illustrated in FIG. 10 in connection with the alternative procedure described with reference to FIGS. 7 to 9 and shows the stage of procedure corresponding to FIG. 7. The rod or peg 26 can equally well be used in practising the first procedure described at the stage of procedure corresponding to FIG. 2.

The invention may be regarded as constituting a modification of the invention described in Wignall et al. co-pending U.S. patent application Ser. No. 769,840, filed Oct. 23, 1968 and it may furthermore be practised in conjunction with the invention described in Findlay et al. co-pending U.S. patent application Ser. No. 776,943, filed Nov. 19, 1968. In accordance with the invention of the last mentioned application a separate piece of fabric is knitted between welt dial hooks 13 and the needles such as 12 while the stocking itself is still retained on the needles by loops remaining at an inactive low level thereon. The separate piece of fabric is constricted midway between the welt dial hooks and the needles by winding a yarn around the fabric or employing other means of closure. Instead of constricting the separate piece of fabric in this way it may be constricted to a partly or fully closed state by means of a plurality of U-loops such as 16 formed as described herein. Afterwards, as explained in application Ser. No. 776,943, the held loops on the dial are returned to the needles to complete the toe cap of double ply fabric and knitting takes place to join the toe cap onto the stocking to complete the sequence. By virtue of the fact that the foot of the stocking may be finally drawn through a semi-constricted and partly closed zone, the stocking could be held on the welt hooks (after knitting anti-ravel courses if necessary) whilst the closure fabric is knitted thus enabling any anti-ravel courses required for termination of the knitting to be caused to be positioned on the inside of the stocking.

Although the improved procedure in the formation of a closure part for tubular fabric has been described as if carried out by use of a single yarn feeder only, it will be evident that the procedure may be practised using a plurality of feeders at different feeding stations for simultaneous formations of different U-loops. As already indicated, it is generally desirable to have a reduced number of wales in the double ply closure fabric by knitting

such fabric on alternate needles or more widely spaced needles only, whilst the main part of the fabric is knitted on all of the needles, in order to avoid undue bulk at the closure part. Furthermore it may be advantageous to knit the central portions of the welt-like closure fabric of less bulk than the remainder of such welt-like part, for example by knitting such central portion of thinner yarn than used for the remainder of the fabric.

It will be readily appreciated that the procedure described herein may be performed equally well by the use of loop holding elements other than welt hooks. Such other loop holding elements may be needles of an upper needle bed, for example the dial needles of a cylinder and dial rib knitting machine, or needles in the upper cylinder of an opposed co-axial needle cylinder machine.

The invention may be employed for producing on a knitting machine closed foot parts of ladies stockings, stocking tights, panti-hose and like garments as well as other forms of hosiery footwear.

What I claim is:

1. A method of producing an end part of a closed tubular fabric article comprising the steps of knitting on a circular knitting machine a welt-like portion of fabric whilst one end of the fabric is held on loop holding instruments, forming a plurality of circumferentially spaced U-shaped loops each by withdrawing a yarn from the needles, feeding it partly around the knitted fabric and reintroducing it to the needles so that the U-shaped loops together constrict the central part of the welt-like portion of fabric, and turning the welt-like part by joining the stitches in its initial part to the stitches in its last formed part.

2. A method according to claim 1 including the step of knitting tubular fabric as a continuation from the welt-like part after turning the latter.

3. A method according to claim 1 including knitting tubular fabric preceding the welt-like portion and knitting a band of anti-ravel fabric as a continuation from the welt-like portion of fabric after turning the latter.

4. A method according to claim 3 including the step of reversing the welt-like portion by drawing the end part of the first knitted tubular fabric through the constricted central part of the welt-like portion to bring the band of anti-ravel fabric to the inside.

5. A method of producing a toe end part of an article of hosiery footwear comprises forming a constricting and turning a welt-like portion of fabric at a toe end thereof by the steps as claimed in claim 1 with the U-shaped loops of yarn partly constricting the welt-like portion, and shaping and setting the toe end part in such manner as to draw the U-shaped loops to a taut condition to constrict the fabric to a substantially fully closed state.

References Cited

UNITED STATES PATENTS

2,069,021	1/1937	Schuessler	66—171
2,506,745	5/1950	Schuessler	66—174
2,522,842	9/1950	Scholl.	
3,184,236	5/1965	Zens	66—170 XR
3,236,070	2/1966	Clayton, Jr.	66—170

FOREIGN PATENTS

20,540	1901	Great Britain	66—9 R
814,164	6/1968	Italy	66—187

WILLIAM C. REYNOLDS, Primary Examiner

U.S. Cl. X.R.

66—170, 187