Aug. 9, 1955 R. HILL 2,714,813

KNITTED ARTICLE AND METHOD OF MAKING SAME

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Fig. 2.

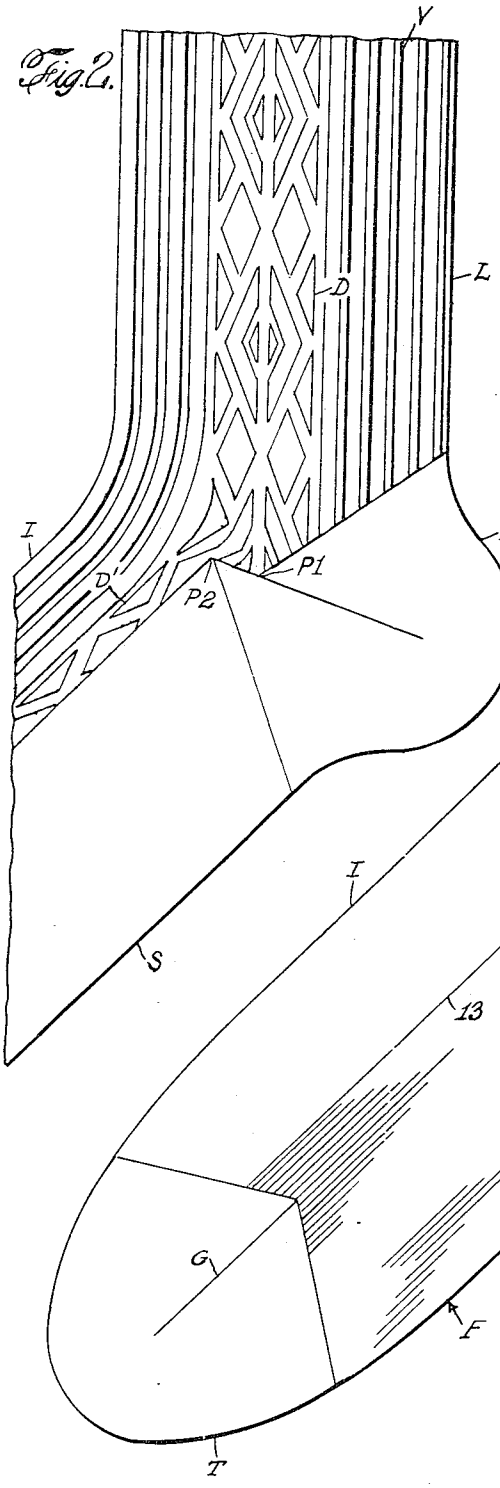


Fig. 1.

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FIG. 3.

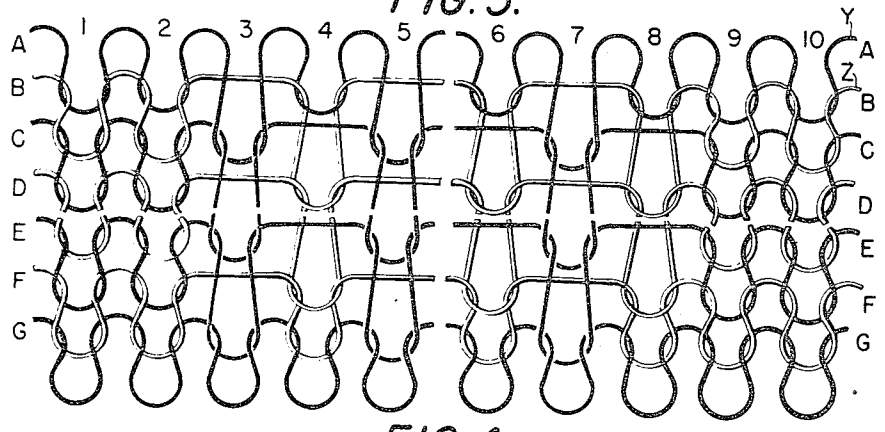


FIG. 4.

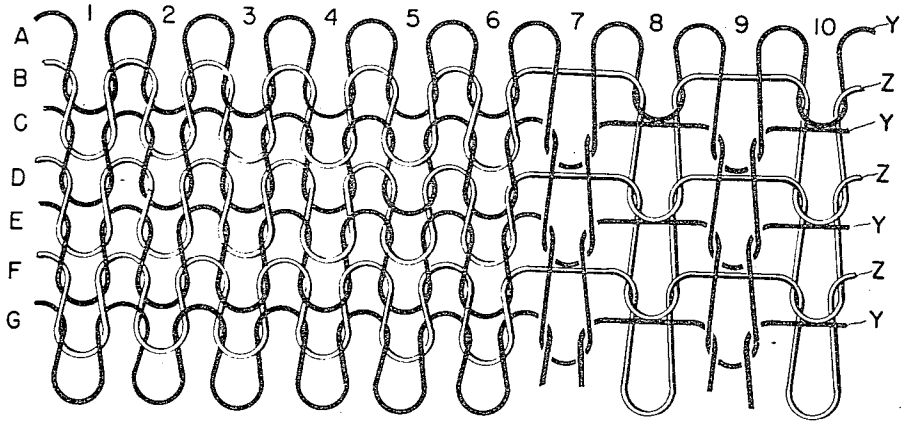
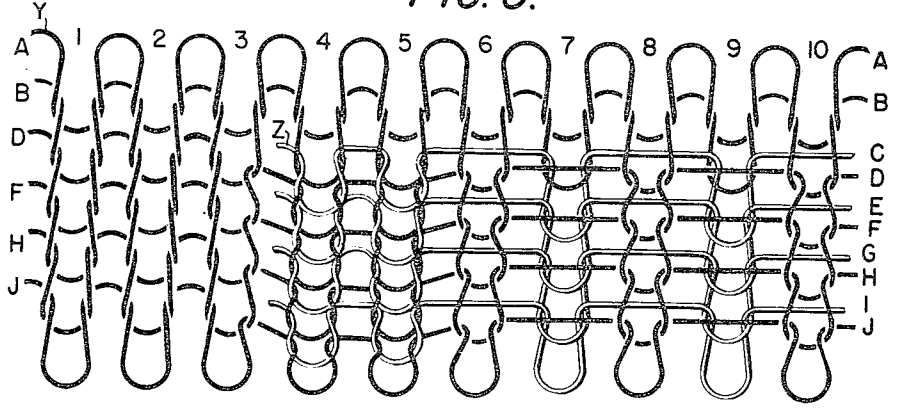


FIG. 5.



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Fig. 6.

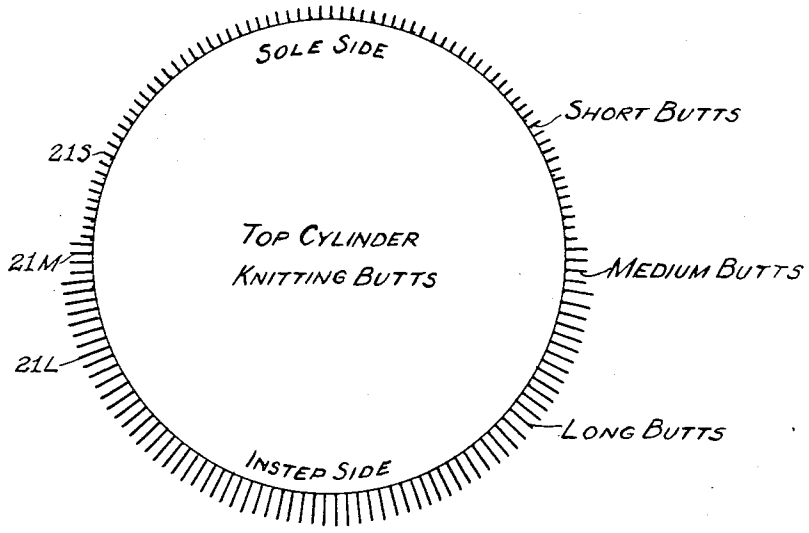
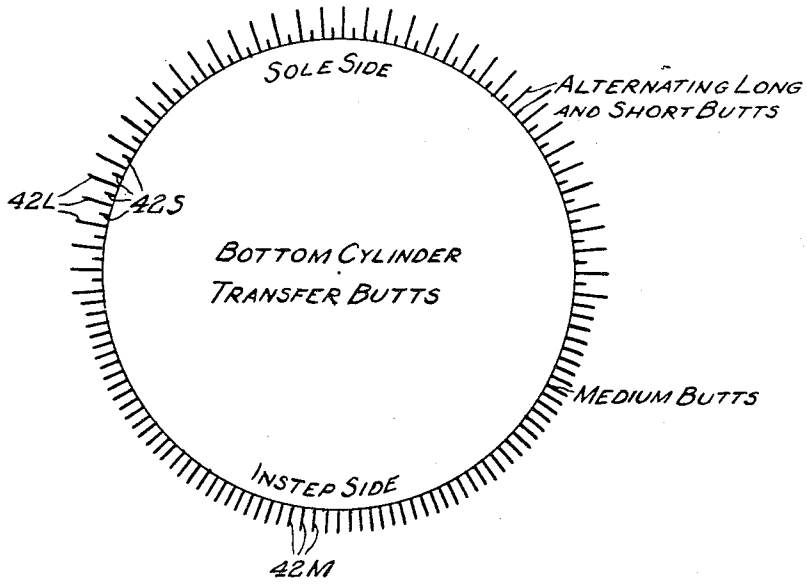


Fig. 7.



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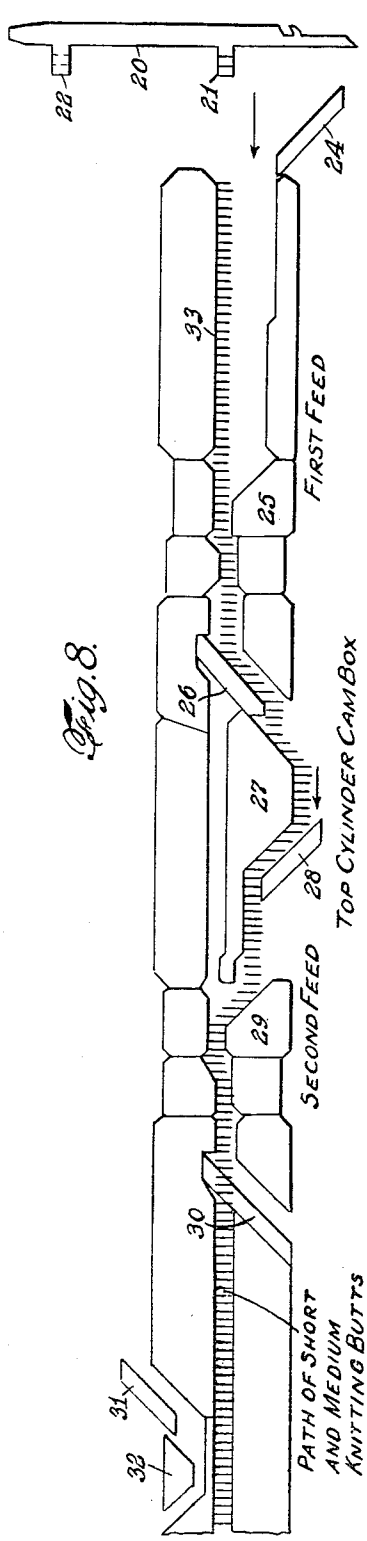


Fig. 8.

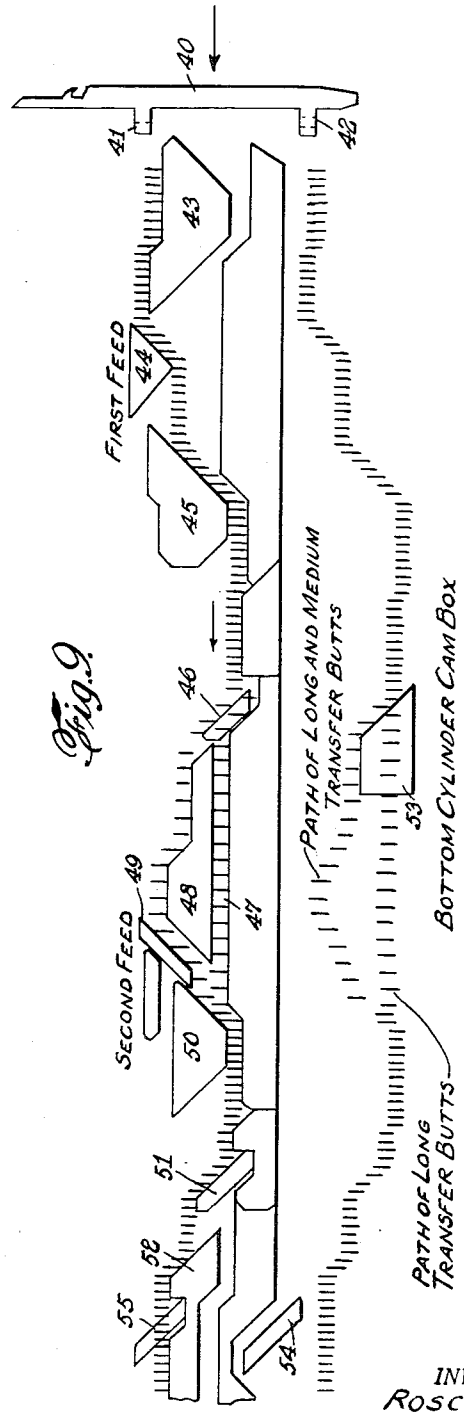


Fig. 9.

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Fig. 10.

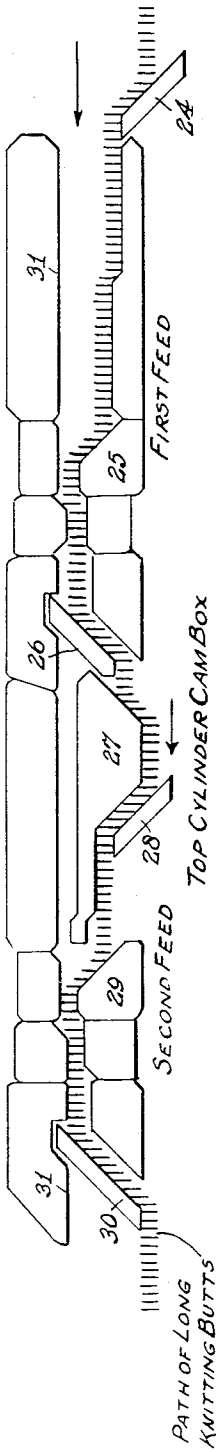
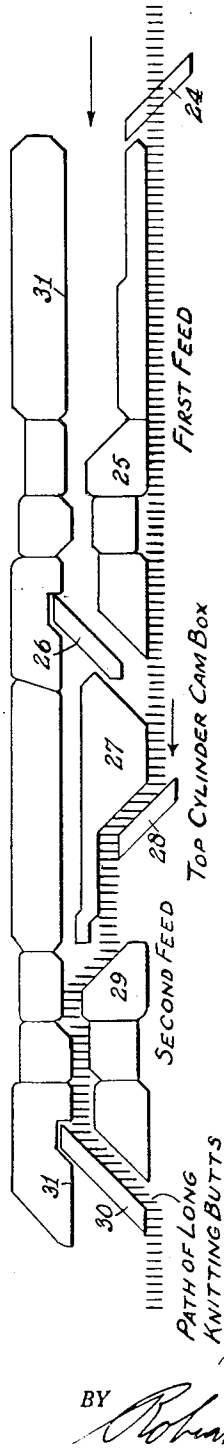


Fig. 11.



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United States Patent Office 2,714,813
Patented Aug. 9, 1955

2,714,813

KNITTED ARTICLE AND METHOD OF MAKING SAME

Roscoe Hill, Aldershot, Ontario, Canada, assignor, by mesne assignments, to The Bentley Engineering Company Limited, Leicester, England, a corporation of Great Britain

Application April 5, 1952, Serial No. 280,801

22 Claims. (Cl. 66—178)

The present invention relates to knitted articles having portions formed of double fabric and integral portions formed of single fabric and to a method of producing such articles.

The invention is particularly applicable to knitting circular seamless articles of hosiery, such as socks, slack socks, hose and stockings. In accordance with the invention, there is provided a circular seamless article of hosiery having a sole portion formed of double fabric, i. e. two separate layers, while the leg and instep are formed of single fabric which may be plain or rib knit, as desired. If the leg and instep are rib knit, they may have straight vertical ribs, including so-called broad ribs, or may have a Links-Links pattern.

The double fabric of the sole portion provides a soft cushioned sole which makes the hosiery especially comfortable to wear and also increases their warmth and wearing qualities. A further feature of the invention is that the outer fabric of the sole portion is formed of consecutive outwardly facing stitches, to provide plain knit fabric, while the inner fabric is formed of consecutive inwardly facing stitches which provide a fabric that is likewise plain knit but is reversed relative to the outer fabric. The two fabrics are thus arranged back to back. The outer fabric faces outwardly to provide a smooth finished appearance while the inner fabric faces inwardly to provide a smooth surface in contact with the sole of the wearer's foot. This increases the comfortable characteristics of the hosiery. In a preferred embodiment of the invention, comfort is still further increased by the fact that the fabric of the sole is a more loosely knit, softer fabric than the rest of the article.

At the ends of the sole, the two layers of fabric are united with one another by interknitting the yarns forming the inner and outer fabrics respectively. The fabrics are likewise joined along both sides of the sole, i. e. at the junctions between the sole and the instep. The construction is such that there is no seam or ridge where the fabrics are joined. The yarn forming one of the fabric layers of the sole, for example the outer fabric, is knit also in the instep portion so that the sole and instep together form an integral circular knit seamless fabric. The yarn forming the other fabric layer, e. g. the inner fabric of the sole, may also be knit across the instep, the instep fabric in this case being a two feed fabric. Alternatively, the yarn forming the inner sole fabric may be floated across the instep, the floats being trimmed out in finishing the article.

In producing a knitted article in accordance with the invention, the single fabric portion and the double fabric portion are knit concurrently, single fabric being knit in a portion of each course and double fabric being knit in another portion of each course. The two fabrics of the double fabric portion are knit simultaneously. At the beginning and at the end of the double fabric portion, the two yarns forming the inner and outer fabrics, respectively, are interknit with one another to provide an integral union between the two fabrics. They may also

be interknit, if desired, at one or more intermediate points.

The method in accordance with the invention can be carried out on coaxial cylinder circular knitting machines, for example those made by the Bentley Engineering Company, Ltd. of Leicester, England, and sold under the name "Komet." Other machines of this type may also be used.

As the invention is especially applicable to articles of hosiery, it is herein particularly described with reference to such articles. However, the method in accordance with the invention is applicable to knitting other articles where it is desired to have a portion formed of double fabric and an integral portion formed of single fabric. As herein used, "double fabric" and "double layer fabric" refer to two separate and distinct fabrics superposed one on the other to provide two separate layers of material, while "single fabric" and "single layer" designate a construction in which there are not two separable layers, although the terms may include fabrics such as rib knit fabric or plated fabric that are sometimes referred to as double fabrics.

The nature and advantages of the invention will be more fully understood from the following description and claims in conjunction with the accompanying drawings, in which:

Fig. 1 is a side view of a sock in accordance with the present invention.

Fig. 2 is a partial view of a sock illustrating another embodiment.

Fig. 3 is a stitch diagram from the outer face of the fabric showing the fabric structure at the beginning and end of the double fabric sole portion of the article of Fig. 1 and also the sides of the sole portion, together with adjacent portions of the instep, the central portions of the sole and instep being broken away to avoid unnecessary repetition of stitches.

Fig. 4 is a similar stitch diagram showing adjacent portions of the single fabric instep and double fabric sole portion of a sock having a rib knit instep portion, such as that of Fig. 2.

Fig. 5 is a similar stitch diagram showing adjacent portions of the instep and sole fabric of an article of hosiery in which the yarn forming one of the sole fabrics is floated across the instep portion.

Fig. 6 is a diagrammatic illustration of the arrangement of short, medium and long knitting butts of top cylinder sliders of a "Komet"-type knitting machine for carrying out the invention.

Fig. 7 is a similar showing of the arrangement of transfer butts on bottom cylinder sliders.

Fig. 8 is a schematic layout of the top cylinder cam box of the machine, showing the path of short and medium knitting butt sliders.

Fig. 9 is a schematic layout of the bottom cylinder cam box of the machine, showing the path followed by long and medium transfer butt sliders and short transfer butt sliders, respectively.

Fig. 10 is a schematic illustration of the upper cam box showing the path of long knitting butt sliders.

Fig. 11 is a schematic illustration of the top cam box showing the path of long butt sliders when making an article in which one yarn is floated across the single fabric portion, as illustrated in Fig. 5.

In Fig. 1, there is shown an article of hosiery in accordance with the invention in the form of a sock having a top or rib portion R, a leg portion L and a foot portion F. The top portion R is formed of tubular seamless fabric having good expansibility and recoverability, such, for example, as 1 x 1 or 2 x 2 rib knit fabric or rib or plain knit fabric containing elastic thread. The leg portion L is formed of tubular seamless plain knit

fabric. It may be either single or multiple feed fabric, a particular embodiment herein shown and described being two feed fabric with alternate courses knit of one yarn and intervening courses of another yarn. The foot F comprises a heel portion H, a toe portion T and an intermediate tubular seamless portion of which the lower side constitutes a sole portion S and the upper side an instep portion I. The heel portion H and toe portion T are knit by reciprocation, with progressive narrowing and widening to form gores G. The instep portion I forms a continuation of the leg and is preferably the same kind of fabric. In the embodiment herein shown and described, it is two feed plain knit fabric, alternate courses being knit of one yarn and intervening courses knit of another yarn.

The sole portion S is formed of double fabric comprising an outer fabric **11** and an inner fabric **12**. In Fig. 1, a small portion of the outer fabric is broken away to show the inner fabric. The outer sole fabric **11** is formed of outwardly facing stitches of one of the yarns forming the instep while the inner sole fabric **12** is formed of inwardly facing stitches knit of the other yarn forming the instep. The stitch structure is illustrated in Fig. 3. In this figure, the needle wales are numbered **1** to **10** and the courses are lettered from A to G. It will be understood, however, that wales **5** and **6** are not consecutive since the middle portion of the sole has been broken out and, likewise, courses D and E are not consecutive, as the figure represents only the beginning and the end of the double sole portion. The course A represents the last course of the heel or, preferably, a continuous circular course following the heel. In either event, it comprises consecutive stitches of a yarn Y which is knit at each wale. For clarity of illustration, the stitches at wales **3**, **5** and **7** are shown longer, but in the actual fabric all of the stitches of this course are approximately the same length. The next course B is knit of a second yarn Z. In the instep portion of the fabric, represented in Fig. 3 by wales **1**, **2**, **9** and **10**, the yarn Z is knit at each wale, outwardly facing stitches of the yarn Z being drawn through outwardly facing stitches of the preceding course which is formed of yarn Y. In the sole portion of the fabric, the second yarn Z is knit at alternate wales only, i. e. at wales **4**, **6** and **8** in Fig. 3, inwardly facing stitches of the yarn Z being drawn through alternate stitches of the preceding course formed of the yarn Y. If the course A is the last course of the heel, all of its stitches are outwardly facing stitches. If it is an additional course following the heel, it may be composed solely of outwardly facing stitches or, alternatively, alternate stitches in the sole portion, e. g. the stitches in wales **4**, **6** and **8**, may be inwardly facing stitches. The next course C is knit of the first yarn Y. In the instep portion of the fabric, as represented by wales **1**, **2**, **9** and **10**, the yarn of course C is knit to form outwardly facing stitches which are drawn through the outwardly facing stitches on the preceding course B formed of yarn Z. In the sole side of the fabric, the yarn of course C is knit only at the intervening wales, **3**, **5** and **7**, outwardly facing stitches being drawn through outwardly facing stitches of course A. The next course D is knit of the second yarn Z. In the instep portion of the fabric, as represented by wales **1**, **2**, **9** and **10**, outwardly facing stitches of the yarn Z in course D are drawn through outwardly facing stitches of the yarn Y forming course C. The two yarns are thus interknit. In the sole portion of the fabric, the yarn Z of course D is knit only at alternate wales, **4**, **6** and **8**, inwardly facing loops being drawn through the inwardly facing stitches of course B which is likewise formed of yarn Z. This knitting sequence is continued throughout the length of the sole, the two yarns Y and Z being knit alternately. In the instep portion of the fabric, courses formed of outwardly facing stitches of the yarn Y alternate with courses formed of outwardly facing stitches of the yarn Z. In the sole portion of the fabric, the yarn Z is knit only at alternate wales, inwardly facing stitches being drawn through inwardly facing stitches of the last preceding course that is formed of the same yarn Z. The other yarn Y is knit only at the intervening wales, outwardly facing stitches being drawn through outwardly facing stitches of the last preceding course that is formed of the same yarn Y. Thus, in the sole portion, there are two separate fabrics, one formed of consecutive outwardly facing stitches of one yarn Y and the other formed of consecutive inwardly facing stitches of the other yarn Z. In each of these fabrics, the stitches are approximately twice as long as those in the instep portion of the fabric. Selective control is provided for slackening stitches on top and bottom needles on the sole side of the cylinders to get proper length and balance. At the beginning of the sole, the inner and outer fabrics are united with one another by reason of the fact that stitches of course B formed of yarn Z, and also stitches of course C formed of yarn Y, are interlooped with stitches of course A. Likewise, at the end of the sole, the inner and outer fabrics are joined by reason of the fact that stitches of course E, which is the last course of the outer fabric of the double sole, and also stitches of course F, which is the last course of the inner fabric, are both interlooped with stitches of course G, which is either the first course of the toe portion T or a circular course preceding the toe portion. In the latter case, the stitches of course G that interloop with the inwardly facing stitches of course F may be inwardly facing stitches or may be outwardly facing stitches, as shown. The inner and outer fabrics of the double sole are also joined along the side edges **13** (Fig. 1) of the sole by reason of the fact that, in the instep wales **2** and **9**, the yarns Y and Z are interknit with one another. The two fabrics are thus joined smoothly without a seam and without any objectionable ridge or thickening.

The courses forming the instep I and the double sole S are continuous circular courses which, in the instep portion, provide a two feed plain knit single fabric and, in the sole portion, a double fabric comprising an outer fabric formed of consecutive courses of outwardly facing stitches of one of the yarns and an inner fabric formed of consecutive courses of inwardly facing stitches of the other yarn. Hence, the two fabrics are both plain knit fabrics but they are reversed relative to one another so as to be back to back. The smooth surface of the outer fabric faces outwardly while the smooth surface of the inner fabric faces to the inside of the sock.

The sock shown in Fig. 2 is similar to that of Fig. 1, except that the leg portion L and instep portion I are formed of rib knit fabric which may either have straight vertical ribs, as, for example, broad rib fabric such as 3 x 6 or 4 x 7 rib knit fabric, or may have fancy ribs, such as those referred to as Links-Links fabric. In the particular embodiment illustrated in Fig. 2, there are vertical ribs V and a Links-Links pattern D in the leg portion of the sock with ribs and a portion D' of the pattern extending down into the instep. The double sole and fabric structure are essentially the same as that of Figs. 1 and 3, except that, in the leg and instep portions, certain of the stitches are inwardly facing stitches while others are outwardly facing stitches, to form the rib pattern. Thus, instead of being two feed plain knit fabric, as in Figs. 1 and 3, the fabric of the leg and instep portions in Fig. 2 is two feed rib knit fabric. If desired, the yarns of the two feed rib knit fabric are selectively floated at selected stitches or groups of stitches in known manner to produce two color designs. A further feature of the construction shown in Fig. 2 is that, in knitting the heel by reciprocation, the fabric is first narrowed, starting at the point P1, and is then widened, the widening being continued beyond the point P1 to a point P2 by picking down additional needles. The last course of the heel thus widened is preferably of the same

extent as the desired width of the double-sole. The additional widening of the last part of the heel avoids the hole that sometimes appears at the point of the heel.

Fig. 4 illustrates the stitch structure of a portion of a sock with a rib knit leg and instep and a double sole such as that shown in Fig. 2. In Fig. 4, as in Fig. 3, the course A represents the last course of the heel or a circular course following the heel. The instep portion of the fabric is illustrated by wales 1 to 6 while wales 7 to 10 illustrate the structure of the double sole. In the particular rib pattern shown in the instep portion, there are inwardly facing stitches in wales 2 and 3 of course A, wales 3 and 4 of course B, wales 4 and 5 of course C, wale 5 of course D, wales 4 and 5 of course E, wales 3 and 4 of course F and wales 2 and 3 of course G, the remaining stitches in wales 1 to 6 of courses A to G being outwardly facing stitches. Alternate courses A, C, E and G are knit of one yarn Y while courses B, D, F are knit of a second yarn Z. In the sole portion, there is an outer fabric formed by outwardly facing stitches of the yarn Y and a separate inner fabric formed by inwardly facing stitches of the yarn Z. While, for the sake of clarity, the yarn Y is shown as being knit only at alternate wales, 7, 9, etc., there are no intervening wales in the outer fabric and, hence, the stitches of wales 7, 9, etc. are consecutive to one another in the finished fabric. The same is true of the inwardly facing stitches formed of the second yarn Z. Likewise, since the stitches of course E are interlooped with the stitches of course C in the outer sole portion of the fabric, these courses are consecutive in the finished fabric. The inner and outer sole fabrics of Fig. 4 are united with one another at the ends of the sole and also at the sides of the sole, in the same manner as described above in connection with Fig. 3.

The two yarns Y and Z may be of the same color, or different colors, as desired. When different colors are used, the two feed leg and instep portions have a two-tone or two-color effect. The outer fabric of the sole portion is of one color while the inner fabric of the sole portion is of a different color. Heel and toe yarns can be used to match the color of the outer sole so that the heel, sole and toe are solid color.

Fig. 5 illustrates another embodiment in which the leg and instep portions are formed of single feed fabric. Fig. 5 illustrates the beginning of the double sole. Wales 1, 2 and 3 represent instep wales while wales 6 to 10 represent sole wales. Wales 4 and 5 represent a junction between the sole and instep corresponding to the line 13 in Fig. 1. Courses A and B formed of yarn Y illustrate continuous circular courses immediately following the heel. These courses are knit of the same yarn which is knit at consecutive wales. Following the course B, there is an intermediate course C which starts at wale 4. This course is formed of a second yarn Z. In wales 4 and 5, outwardly facing stitches of the yarn Z are drawn through preceding outwardly facing stitches of the yarn Y in course B. In the wales forming the sole portion of the fabric, the yarn Z of course C is knit at alternate wales, 6, 8, 10, etc., only, inwardly facing stitches being drawn through alternate outwardly facing stitches of course B. At the other side of the sole, the yarn Z is knit in one or more junction wales like wales 4 and 5, the construction being symmetrical. In the next course D, the first yarn Y is interknit with consecutive stitches of course B—likewise formed of yarn Y—at the instep wales 1, 2 and 3. In the junction wales 4 and 5, outwardly facing stitches of the yarn Y of course D are drawn through outwardly facing stitches of the yarn Z of course C. In the sole portion of the fabric, the yarn Y of course D is knit only at intervening wales 6, 8, 10, etc., outwardly facing stitches being drawn through the intermediate outwardly facing stitches of course B. Course D is followed by another intermediate course E formed of the second yarn Z. In the junction wales 4 and 5, the outwardly facing stitches of the yarn Z of course E are drawn through outwardly facing stitches of the yarn Y in course D. In the wales forming the sole portion of the fabric, the yarn Z of course E is knit only at alternate wales, inwardly facing stitches being drawn through the inwardly facing stitches of the preceding course C formed of the same yarn Z. This knitting sequence is continued throughout the length of the sole. In the instep portion, the yarn Y of courses F, H, J, etc. is knit at consecutive wales, the stitches of each course being drawn through stitches of a preceding course formed of the same yarn. In the junction wales, such as 4 and 5, stitches of yarn Y alternate with stitches of the yarn Z. In the sole portion, outwardly facing stitches of the yarn Y in courses F, H, J, etc. interloop with outwardly facing stitches of the same yarn in preceding and succeeding courses. Inwardly facing stitches of the second yarn Z forming intermediate courses E, G, I, etc. interloop with inwardly facing stitches of the preceding and succeeding courses of the same yarn to form the inner fabric of the sole. Thus, the outer sole fabric and the instep fabric are formed by consecutive outwardly facing stitches of the yarn Y while the inner sole fabric is formed by inwardly facing stitches of the yarn Z. The inner and outer fabrics are joined at the beginning and end of the sole, in the same manner as described above in connection with Fig. 3. The fabrics are joined at the side edges of the sole by interknitting the two yarns, as illustrated in wales 4 and 5. One or more junction wales are provided at the opposite sides of the sole and, if desired, in one or more intermediate wales, for example down the center of the sole. The courses of the yarn Y are continuous circular courses. The yarn Z is not knit in the instep portion—other than the junction wales. It is either cut in each course or, alternatively, is floated across the instep, the floats being subsequently trimmed out in a finishing operation. In the embodiment of Fig. 5, the stitches in the double sole fabrics are of substantially the same length as those in the instep portion.

The width of the double sole can be varied as desired. It may be equal to, less than, or greater than, the coursewise extent of the heel portion which is normally half the circumferential extent of the tubular fabric. In Fig. 1, the double sole is shown wider than the coursewise extent of the heel so that it extends on each side beyond the point P of the heel. If desired, a double fabric portion may be provided in like manner above the heel, in the so-called "high splice" area. While the double fabric portion has been shown substantially rectangular in shape, it may be widened or narrowed as desired, for example to provide a tapered double fabric portion above the heel. The invention is likewise applicable to other knitted articles where it is desired to have a portion of the article formed of double fabric and another portion formed of single fabric. In some cases, it is desirable to use yarns of different character for the inner and outer fabrics of the double portion. For example, in a sock, the insole may be knit of cotton yarn and the outsole of wool.

The invention is preferably carried out on a two feed coaxial cylinder circular knitting machine having double ended needles which are operable in either cylinder and are transferable from one cylinder to the other. When in the bottom cylinder, the needles are operated by bottom cylinder sliders having knitting butts and transfer butts engaging cams in a bottom cylinder cam box to raise and lower the sliders, and hence the needles, as the needle cylinders revolve. When in the top cylinder, the needles are operated by similar, but reversed, top cylinder sliders having knitting butts and transfer butts engaging cams in the top cylinder cam box. In order to produce a Links-Links leg and instep portion, such as that illustrated in Fig. 2, the machine is provided with Links-Links mechanism comprising, for example, jacks or selectors having butts at different levels, selector levers arranged at corresponding levels and adapted to engage the selector butts and a Links-Links pattern drum selectively

operating the selector levers. As such mechanism is well known, it will not be further described.

The top cylinder cam box is shown schematically in Fig. 8. An upper cylinder slider **20** is illustrated at the right hand side of Fig. 8 and has knitting butts **21** and transfer butts **22**. The cams for the top cylinder comprise a heel bolt cam **24**, first feed stitch cam **25**, bolt cam **26**, clearing cam **27**, second feed bolt cam **28**, second feed stitch cam **29** and welt bolt cam **30**, all acting on the knitting butts **21**, and transfer cams **31** and **32** acting on the transfer butts **22**.

The bottom cylinder cam box is shown in Fig. 9. At the right hand side of Fig. 9, there is illustrated a bottom cylinder slider **40** having a knitting butt **41** and transfer butt **42**. The bottom cylinder cam box has a heel stitch cam **43**, center cam **44**, first feed stitch cam **45**, a bolt cam **46** blocking a raceway **47**, a clearing cam **48**, bolt cam **49**, second feed stitch cam **50**, bolt cam **51** and clearing cam **52**, all working on the knitting butts **41**. There are also a selecting cam **53** working on the transfer butts **42** and transfer cams **54** and **55** working respectively on the transfer and knitting butts.

The knitting butts **21** of the top cylinder sliders **20** are of three lengths, namely long, medium and short. The arrangement of top cylinder knitting butts is shown schematically in Fig. 6. The sliders on the sole side of the cylinder have short knitting butts **21S**. The sliders on the instep side of the cylinder have long knitting butts **21L** except that, between the long butts and the short butts, there are several sliders at each side having medium butts **21M**. The transfer butts **22** of the upper cylinder sliders are also preferably of three different lengths and are arranged to provide for transfer of the needles to produce vertical ribs of the desired width, for example in the top portion or leg portion of a sock.

The transfer butts **42** of the bottom cylinder sliders **40** are of three different lengths. The arrangement of bottom cylinder transfer butts is shown schematically in Fig. 7. On the sole side of the cylinder, long butts **42L** alternate with short butts **42S**. The alternating long and short butts extend over somewhat more than half the needle cylinder corresponding to the portion having short and medium knitting butts in the top cylinder (Fig. 6). On the instep side of the bottom cylinder, the sliders have medium transfer butts which extend over an arc corresponding to the long knitting butts of the top cylinder. The knitting butts of the bottom cylinder sliders are of two lengths, with the customary arrangement of long butts on the instep side of the cylinder and short butts on the sole or heel side. The circumferential extent of the short butts corresponds to the maximum coursewise extent of the heel and is usually 180°.

In making a sock such as that shown in Fig. 1, the machine operates in customary manner to knit the top R, leg L and heel H, the top and leg being knit by continuous circular knitting and the heel H by reciprocating knitting with appropriate narrowing and widening to form a heel pocket. Following completion of the heel, the machine again goes into circular knitting and the lower transfer cams **54** and **55** come into operation, acting on the sliders having long transfer butts **42L** to transfer alternate needles on the sole side to the upper cylinder. The number of needles transferred depends on the desired width of the double sole. To produce a wider sole, as shown in Fig. 1, the needles transferred to the top cylinder include several needles at each side of those used to produce the heel. Following the transfer of the desired needles to the top cylinder, the welt bolt cam **30** (Fig. 8) is partly withdrawn to miss short and medium knitting butt sliders in the top cylinder. In the bottom cylinder cam box, the reverse welt bolt cam **46** (Fig. 9) is withdrawn to miss all of the knitting butts of the bottom cylinder sliders. The selecting cam **53**, which is preferably movable, is positioned so as to raise long and medium transfer butt sliders in the lower cylinder but miss short transfer butt sliders.

The path of short and medium knitting butt sliders in the top cylinder is shown in Fig. 8. The path of long knitting butt sliders in the upper cylinder is shown in Fig. 10. The alternate needles that have been transferred to the upper cylinder on the sole side are actuated by sliders having either short or medium butts (Fig. 6). These needles knit at the second feed. As the welt bolt cam **30** is withdrawn so as to miss all but the long knitting butts, the short and medium butts continue in the welt track **33** and hence bypass the first feed. Any upper cylinder needles on the instep side of the cylinder are actuated by upper cylinder sliders having long knitting butts. As shown in Fig. 10, these needles knit at the second feed, are cleared by the welt bolt cam **30** and are actuated by the heel bolt cam **24** and stitch cam **25**, to knit also at the first feed. Thus, any upper cylinder needles on the instep side of the cylinder knit at both feeds while the alternate needles on the sole side knit only at the second feed to form the inwardly facing stitches of the inner sole fabric. With a plain knit instep portion, all of the instep needles are in the lower cylinder. However, to produce a rib knit instep, selected needles are in the upper cylinder on the instep side.

In the lower cylinder, needles on the instep side are actuated by sliders with medium transfer butts. These needles are drawn by center cam **44** and stitch cam **45**, to knit at the first feed. They are then raised by the selecting cam **53** engaging the transfer butts and further raised to clearing height by cam **48** engaging the knitting butts so that they are in position to receive yarn at the second feed where they are drawn down by bolt cam **49** and stitch cam **50**. If the double sole is the same width as the heel, the instep needles can be raised for the second feed by putting in the bolt cam **46** far enough to engage the long knitting butts. The cam **53** would not then be needed. On the sole side of the bottom cylinder, the alternate sliders having long transfer butts are empty, having transferred their needles to the upper cylinder, as described above. The intervening sliders have short transfer butts which miss the selecting cam **53** (Fig. 9) so that the knitting butts of these sliders pass through the track **47** since the bolt cam **46** is withdrawn. Hence, these sliders, which are the only sliders on the sole side of the bottom cylinder containing needles, bypass the yarn at the second feed. All of the sliders are raised by the cam **51** and their needles take and knit yarn fed at the first feed. Thus, the needles on the instep side of the lower cylinder knit at both feeds while the needles on the sole side knit only at the first feed to form the outwardly facing stitches of the outer sole fabric. The stitch lengths of the top and bottom needles on the sole side are controlled so that the sole fabrics balance the instep fabric and one another.

When the desired length of foot fabric has been made, the bolt cams are returned to their normal operating positions, the needles in the upper cylinder are transferred to the lower cylinder and the second feed is taken out of action. The machine is thereupon operated in the normal manner to make the toe.

While the foregoing description has been directed primarily to making a sock such as that shown in Fig. 1, it will be understood that the operations are the same in producing a sock with a rib knit leg and instep portion, such as that shown in Fig. 2, except that, in knitting the leg and instep, certain needles are positioned in the upper cylinder to produce the inwardly facing stitches of the rib knit portion and in knitting the heel additional needles are picked down to widen the last portion of the heel, as described.

To produce a sock having a double sole and a single feed instep, as illustrated in Fig. 5, the machine is essentially the same, except that the medium transfer butt lower cylinder sliders on the instep side of the cylinder,

as shown in Fig. 7, are replaced by short transfer butt sliders. However, between the short butt sliders of the instep side and the alternating long and short butt sliders of the sole side, there is provided at least one, and preferably two or three, sliders at each side, having medium transfer butts. With this butt arrangement, all of the lower cylinder needles knit at the first feed. The only ones knitting at the second feed are those having medium butts and which form the junction wales 4 and 5 in Fig. 5. If it is desired to tie the inner and outer sole fabrics together at one of more wales intermediate the sides of the sole, corresponding needles are provided with medium transfer butts on the bottom cylinder sliders so that these needles knit at both feeds. In the top cylinder, the heel bolt cam 24 is withdrawn so as to miss all of the sliders. Hence, upper cylinder needles knit only at the second feed. This comprises alternate needles on the sole side of the cylinder which form the inner sole fabric and any needles on the instep side, in the event a rib knit instep is desired.

The cam movements described above are preferably controlled from a suitable pattern drum and/or pattern chain, so as to be automatic. While the method and the machine operations have been described with particular reference to the articles of hosiery shown by way of example in the drawings, it will be understood that the method in accordance with the invention may be used in producing other articles. Moreover, the method may be varied to produce desired variation in the articles being knit. For example, to produce double fabric in the area above the heel of a sock, alternate needles on the heel side are transferred to the upper cylinder and the machine is operated in the manner described above to produce the double fabric of the sole. Upon reaching the heel, these needles are retransferred to the lower cylinder.

It will be understood that, insofar as they are not mutually exclusive, the various features and characteristics of the several embodiments of the invention are interchangeable with one another and that other modifications may be made within the scope of the appended claims.

What I claim and desire to secure by Letters Patent is:

1. In an article of hosiery, a seamless circular knit leg portion and a foot comprising integral reciprocatorily knit heel and toe pockets and an intervening seamless circular section the upper portion of which constitutes an instep portion and the under portion of which constitutes a sole portion, said sole portion comprising an outer fabric formed of successive courses of outwardly facing stitches of a first yarn and a separate inner fabric formed of successive courses of inwardly facing stitches of a second yarn, said first and second yarns being interknit with one another at the opposite ends of said sole portion and also along the opposite sides of the sole portion to join the said two fabrics together and the instep portion being formed of a single layer fabric.

2. In an article of hosiery, a seamless circular knit leg portion and a foot comprising integral reciprocatorily knit heel and toe pockets and an intervening seamless circular section of which the upper portion constitutes an instep portion and the under portion constitutes a sole portion, said sole portion comprising an outer fabric formed of successive wales of outwardly facing stitches of a first yarn joined to alternate wales of the fabric preceding and succeeding said sole portion and an inner fabric formed of successive wales of inwardly facing stitches of a second yarn joined to intervening wales of the fabric preceding and succeeding said sole portion, said first and second yarns being interknit with one another in wales extending along the lateral side edges of the sole to join the two fabrics together and the instep portion being formed of a single layer fabric.

3. In an article of hosiery, a seamless circular knit leg portion and a foot comprising integral reciprocatorily knit heel and toe pockets and an intervening seamless circular section comprising an instep portion and a sole portion, said sole portion comprising an outer fabric formed of successive courses of outwardly facing stitches of a first yarn and a separate inner fabric formed of successive courses of inwardly facing stitches of a second yarn and the instep portion being formed of a single layer fabric comprising alternate courses of said first yarn interlooped with intervening courses of said second yarn.

4. In an article of hosiery, a seamless circular knit leg portion and a foot comprising integral reciprocatorily knit heel and toe portions and an intervening seamless circular section comprising an instep portion and a sole portion, said sole portion comprising an outer fabric formed of successive courses of outwardly facing stitches of a first yarn and a separate inner fabric formed of successive courses of inwardly facing stitches of a second yarn, said first and second yarns being interknit with one another around the sole portion to join said two fabrics together, and the instep portion being formed of a single layer plain knit fabric comprising outwardly facing stitches of at least one of said yarns.

5. In an article of hosiery, a seamless circular rib knit leg portion and a foot comprising integral reciprocatorily knit heel and toe portions and an intervening seamless circular section comprising an instep portion and a sole portion, said sole portion comprising an outer fabric formed of successive courses of outwardly facing stitches of a first yarn and a separate inner fabric formed of successive courses of inwardly facing stitches of a second yarn, said first and second yarns being interknit with one another around the sole portion to join said two fabrics together, and the instep portion being formed of a single layer rib knit fabric comprising outwardly facing stitches and inwardly facing stitches of at least one of said yarns.

6. In an article of hosiery, a seamless circular rib knit leg portion composed of outwardly facing stitches and inwardly facing stitches arranged to form a Links-Links pattern and a foot comprising integral reciprocatorily knit heel and toe portions and an intervening seamless circular section comprising an instep portion and a sole portion, said sole portion comprising an outer fabric formed of successive courses of outwardly facing stitches of a first yarn and a separate inner fabric formed of successive courses of inwardly facing stitches of a second yarn, said first and second yarns being interknit with one another around the sole portion to join said two fabrics together, and the instep portion being formed of a single layer fabric consisting of outwardly facing stitches and inwardly facing stitches of at least one of said yarns, said inwardly facing stitches and outwardly facing stitches of the instep portion being arranged to provide a continuation of a portion of the Links-Links pattern of the leg.

7. In an article of hosiery, a seamless circular knit leg portion and an integral foot portion comprising reciprocatorily knit heel and toe portions and an intervening seamless circular section comprising an instep portion and a sole portion which has a greater coursewise extent than said heel portion, said sole portion comprising an outer fabric formed of successive courses of outwardly facing stitches of a first yarn and a separate inner fabric formed of successive courses of inwardly facing stitches of a second yarn, said first and second yarns being interknit with one another around the sole portion to join said two fabrics together, and the instep portion being formed of a single layer fabric knit of at least one of said yarns.

8. In an article of hosiery, a circular seamless knit leg portion and a foot comprising integral reciprocatorily knit heel and toe portions and an intervening integral circular seamless section comprising an instep portion and a sole portion, said sole portion and an area above the heel portion each comprising an outer fabric formed of successive wales of outwardly facing stitches of a first yarn forming continuations of alternate wales only of the heel

portion and a separate inner fabric formed of successive wales of inwardly facing stitches of a second yarn forming continuations of the intervening wales of the heel portion, and the instep portion and the leg portion other than said area above the heel being formed of a single layer fabric.

9. In an article of hosiery, a seamless circular knit leg portion and an integral foot portion comprising reciprocatorily knit heel and toe portions and an intermediate seamless circular knit section comprising an instep portion and a sole portion, said sole portion comprising an outer fabric formed of successive courses of outwardly facing stitches of a first yarn and a separate inner fabric formed of successive courses of inwardly facing stitches of a second yarn, said first and second yarns being interknit with one another in at least one wale along each side of the sole portion to unite said fabrics together and the instep portion consisting of a single layer fabric formed of successive courses of one only of said yarns.

10. In an article of hosiery, a foot portion comprising reciprocatorily knit heel and toe portions and an integral intervening circular seamless section constituting an instep portion and a sole portion, said sole portion comprising an outer fabric formed of successive courses of outwardly facing stitches of a first yarn and an inner fabric formed of successive courses of inwardly facing stitches of a second yarn, said yarns being interknit with one another in at least one wale on each side of said sole portion and the instep portion consisting of a single layer fabric knit of at least one of said yarns.

11. Seamless circular knit fabric comprising spaced circular courses of stitches, an integral intervening section of said fabric comprising a double layer portion for part of its coursewise extent and a single layer portion for another part of its coursewise extent, said double layer portion comprising an outer layer formed of successive wales of outwardly facing stitches of one yarn joined to alternate stitches of said circular courses and an inner layer formed of successive wales of inwardly facing stitches of another yarn joined to the intervening stitches of said circular courses, said yarns being interknit with one another in at least one wale on each side of said double layer portion to join said layers together, said single layer portion being knit of at least one of said yarns.

12. Seamless circular knit fabric comprising a double layer portion for part of its coursewise extent and a single layer portion for another part of its coursewise extent, said double layer portion comprising an outer layer formed of successive courses of outwardly facing stitches of a first yarn and an inner layer formed of successive courses of inwardly facing stitches of a second yarn, said yarns being interknit with one another in at least one side along each side of said double layer portion and said single layer portion comprising successive courses of one only of said yarns.

13. Seamless circular knit fabric comprising a double layer portion for part of its coursewise extent and a single layer portion for another part of its coursewise extent, said double layer portion comprising an outer layer formed of successive courses of outwardly facing stitches of a first yarn and an inner layer formed of successive courses of inwardly facing stitches of a second yarn, said yarns being interknit with one another in at least one wale along each side of said double layer portion and in at least one wale between said sides to tie said layers together at spaced points, and said single layer portion being knit of at least one of said yarns.

14. A method of knitting an article of hosiery which comprises knitting a plurality of circular courses to form a leg portion, knitting a plurality of part courses of varying length by reciprocation to form a heel pocket, knitting a plurality of yarns concurrently to form a plurality of circular courses forming instep and sole portions, consecutive wales of inwardly facing stitches of one of said yarns forming continuations of alternate wales only of said heel portion to form an inner sole fabric while consecutive wales of outwardly facing stitches of another of said yarns form continuations of intervening wales of said heel portion to provide a separate outer side fabric, and interknitting said yarns with one another in at least one wale at the sides of said sole portion to tie said two fabrics together, at least one of said yarns being knit in the remainder of its course to form a single layer instep fabric, and knitting a plurality of part courses of varying length by reciprocation to form a toe portion.

15. A method of knitting seamless circular fabric which comprises knitting a circular course, knitting a succeeding course of a first yarn by drawing stitches of said yarn through consecutive stitches of said circular course in a first portion only of said circular course and drawing stitches of said yarn through alternate stitches only of said circular course in a second portion of said course, knitting a succeeding course of a second yarn by drawing stitches of said second yarn through consecutive stitches of said first yarn in said first portion of the course and drawing stitches of said second yarn through the intervening stitches of the second portion of said circular course, knitting a further course of said first yarn by drawing stitches of said first yarn through stitches of said second yarn in the first portion of the course and drawing stitches of said second yarn through stitches of the preceding course of said second yarn in the second portion of the course and continuing the alternate knitting of said first and second yarns in like manner.

16. A method of knitting seamless circular fabric which comprises knitting a circular course, knitting a succeeding course of a first yarn by drawing stitches of said yarn through consecutive stitches of said circular course in a first portion only of said course and drawing stitches of said yarn through alternate stitches only of said circular course in a second portion of said course, knitting a succeeding course of a second yarn by drawing stitches of said second yarn through the intervening stitches of the second portion of said circular course and drawing said second yarn through at least one stitch of said first yarn at the junction of said first and second portions of the course, knitting a further course of said first yarn by drawing stitches through stitches of the preceding course of said first yarn except at the junction of said first and second portions of the course where at least one stitch of said first yarn is drawn through at least one stitch of said second yarn, knitting a further course of said second yarn by drawing stitches of said second yarn through stitches of the preceding course of said second yarn in the second portion of the course and drawing at least one stitch of said second yarn through at least one stitch of said first yarn at the junction of the first and second portions and continuing the alternate knitting of said first and second yarns in like manner.

17. A method of knitting a circular seamless article of hosiery on a circular knitting machine having coaxial needle cylinders and needles operable alternatively in either cylinder and transferable from one cylinder to the other which comprises knitting a plurality of circular courses by continuous rotation to form a leg portion, knitting a plurality of part courses of varying length by reciprocation to form a heel portion, positioning alternate needles on the sole side of the needle cylinder in the upper cylinder and positioning intervening needles on the sole side of the needle cylinder in the lower cylinder, feeding a first yarn at a first feeding station to the needles on the instep side of the cylinder and to the lower cylinder needles only on the sole side of the cylinder, manipulating the needles to draw stitches of said yarn, feeding a second yarn at a second feeding station to the upper cylinder needles on the sole side of the cylinder and, at each side of the sole, to at least one needle that took said first yarn, manipulating the needles to draw stitches of said second yarn, continuing the feeding and knitting of said yarns in like manner to form instep and sole portions and there-

after positioning all the needles on the sole side of the cylinder in the lower cylinder and knitting a plurality of said courses of varying length by reciprocation to form a toe portion.

18. A method of knitting a circular seamless article on a circular knitting machine having coaxial needle cylinders and needles operable alternatively in either cylinder and transferable from one cylinder to the other, which comprises knitting a circular course, positioning alternate needles in a first portion of the circumference of the needle cylinder in the upper cylinder and intervening needles in the lower cylinder, feeding a first yarn at a first feeding station to the lower cylinder needles only in said first portion of the circumference of the cylinder and to needles in a second portion of the circumference of the cylinder, manipulating the needles to draw stitches of said yarn, feeding a second yarn to upper cylinder needles only in said first portion of the circumference of the cylinder and to needles in the second portion of the circumference of the cylinder, manipulating the needles to draw stitches of said second yarn, and continuing the feeding and knitting of said yarns in like manner.

19. A method of knitting a circular seamless article on a circular knitting machine having coaxial needle cylinders and needles operable alternatively in either cylinder and transferable from one cylinder to the other, which comprises knitting a circular course, positioning alternate needles in a first portion of the circumference of the needle cylinder in the upper cylinder and intervening needles in the lower cylinder, feeding a first yarn at a first feeding station to the lower cylinder needles only in said first portion of the circumference of the cylinder and to needles in a second portion of the circumference of the cylinder, manipulating the needles to draw stitches of said yarn, feeding a second yarn to upper cylinder needles only in said first portion of the circumference of the cylinder and, at each end of said first portion of the circumference of the cylinder, to at least one needle that has taken said first yarn, manipulating the needles to draw stitches of said second yarn and continuing the feeding and knitting of said yarns in like manner.

20. In an article of hosiery, a seamless circular knit leg portion formed of single layer fabric, an integral reciprocatorily knit heel portion, an integral circular seamless portion forming an instep portion and a sole portion, said sole portion comprising an outer fabric formed of consecutive wales of outwardly facing stitches of a first yarn forming continuations of alternate wales only of said heel portion and a separate inner fabric formed of consecutive wales of inwarly facing stitches of a second yarn forming continuations of the intervening wales of said heel portion, and said instep portion being formed of single layer fabric comprising alternate courses of said first yarn and intervening courses of said second yarn, and an integral reciprocatorily knit toe portion having alternate wales forming continuations of consecutive wales of said outer fabric of the sole portion and intervening wales forming continuations of consecutive wales of said inner fabric of the sole portion.

21. In an article of hosiery, a seamless circular knit leg portion formed of single layer Links-Links fabric, an integral reciprocatorily knit heel portion having consecutive wales forming continuations of consecutive wales of approximately the rear half of said leg portion, an integral circular seamless portion forming an instep portion and a sole portion, said sole portion comprising an outer fabric formed of consecutive wales of outwardly facing stitches of a first yarn forming continuations of alternate wales only of said heel portion and a separate inner fabric formed of consecutive wales of inwardly facing stitches of a second yarn forming continuations of the intervening wales of said heel portion, and said instep portion being formed of single layer Links-Links fabric comprising alternate courses of said first yarn and intervening courses of said second yarn, consecutive wales of said instep portion forming continuations of consecutive wales of approximately the front half of said leg portion, and an integral reciprocatorily knit toe potrion having alternate wales forming continuations of consecutive wales of said outer fabric of the sole portion and intervening wales forming continuations of consecutive wales of said inner fabric of the sole portion.

22. In an article of hosiery, a seamless circular narrow rib top portion, a seamless circular knit leg portion formed of single layer broad rib fabric, an intergral reciprocatorily knit heel portion having consecutive wales forming continuations of consecutive wales of approximately the rear half of said leg portion, an integral circular seamless portion forming an instep portion and a sole portion, said sole portion comprising an outer fabric formed of consecutive wales of outwardly facing stitches of a first yarn forming continuations of alternate wales only of said heel portion and a separate inner fabric formed of consecutive wales of inwardly facing stitches of a second yarn forming continuations of the intervening wales of said heel portion, and said instep portion being formed of single layer broad rib fabric comprising alternate courses of said first yarn and intervening courses of said second yarn, consecutive wales of said instep portion forming continuations of consecutive wales of approximately the front half of said leg portion, and an integral reciprocatorily knit toe portion having alternate wales forming continuations of consecutive wales of said outer fabric of the sole portion and intervening wales forming continuations of consecutive wales of said inner fabric of the sole portion.

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