April 1, 1941. H. E. HOUSEMAN 2,237,143

KNITTING METHOD AND MACHINE

Filed Nov. 1, 1939 6 Sheets-Sheet 1

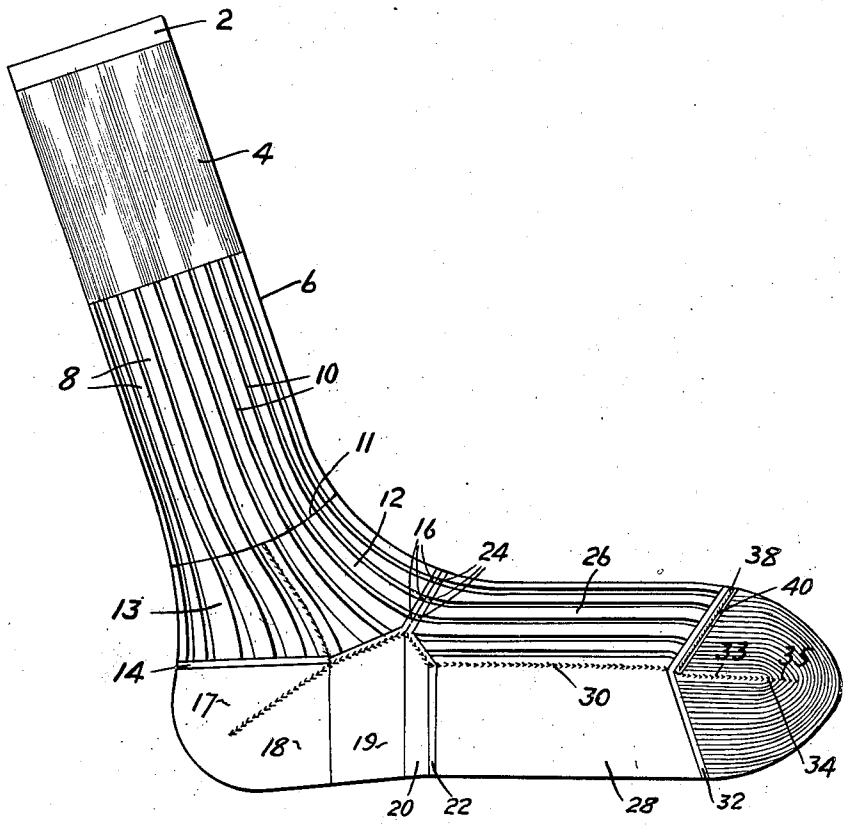


FIG. 1.

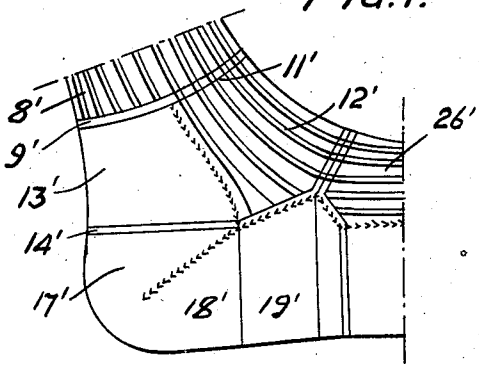


FIG. 12.

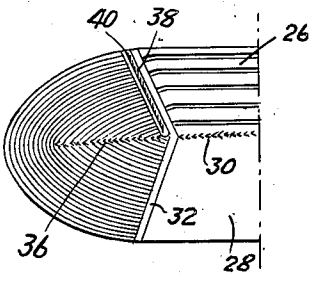


FIG. 1A.

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KNITTING METHOD AND MACHINE

Filed Nov. 1, 1939 6 Sheets-Sheet 2

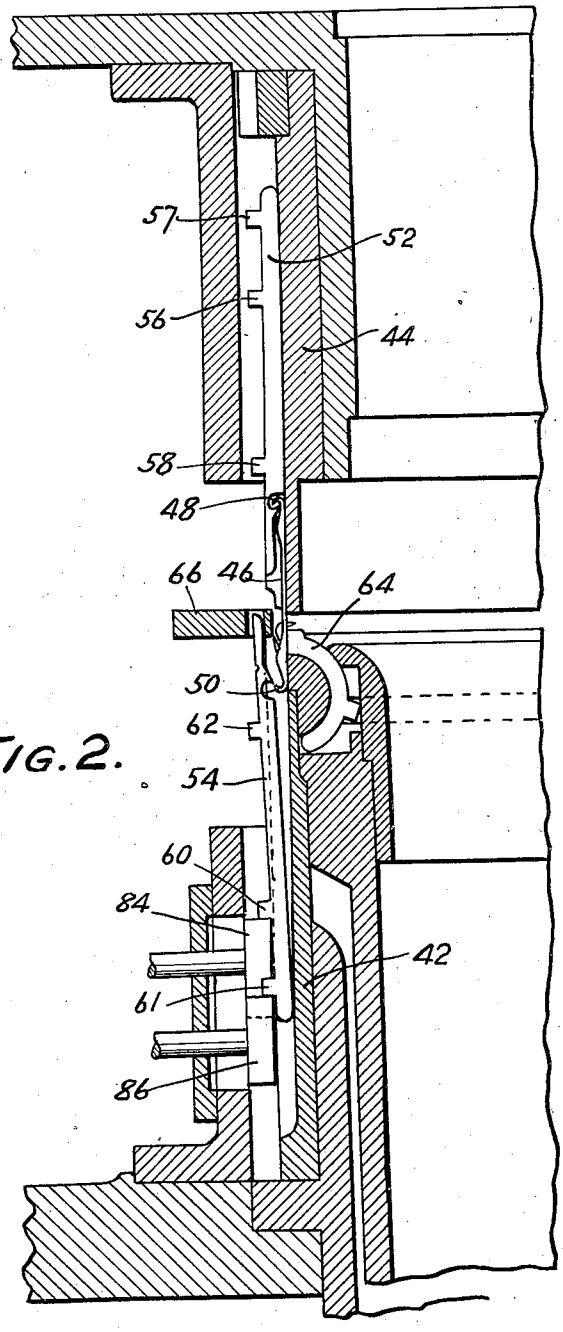


FIG. 2.

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KNITTING METHOD AND MACHINE

Filed Nov. 1, 1939 6 Sheets-Sheet 3

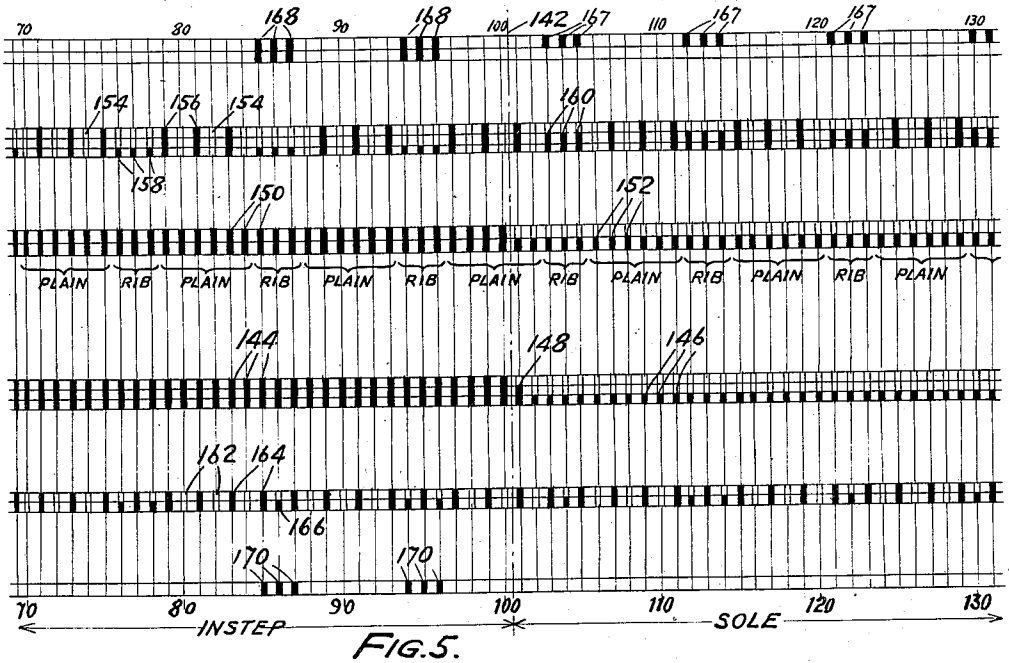


FIG. 5.

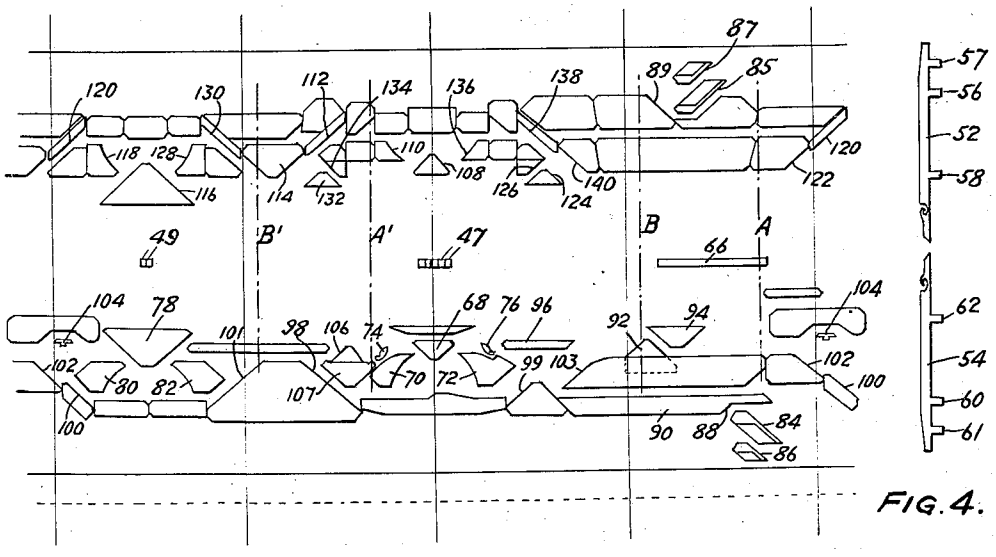


FIG. 4.

FIG. 3.

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April 1, 1941. H. E. HOUSEMAN 2,237,143

KNITTING METHOD AND MACHINE

Filed Nov. 1, 1939 6 Sheets-Sheet 4

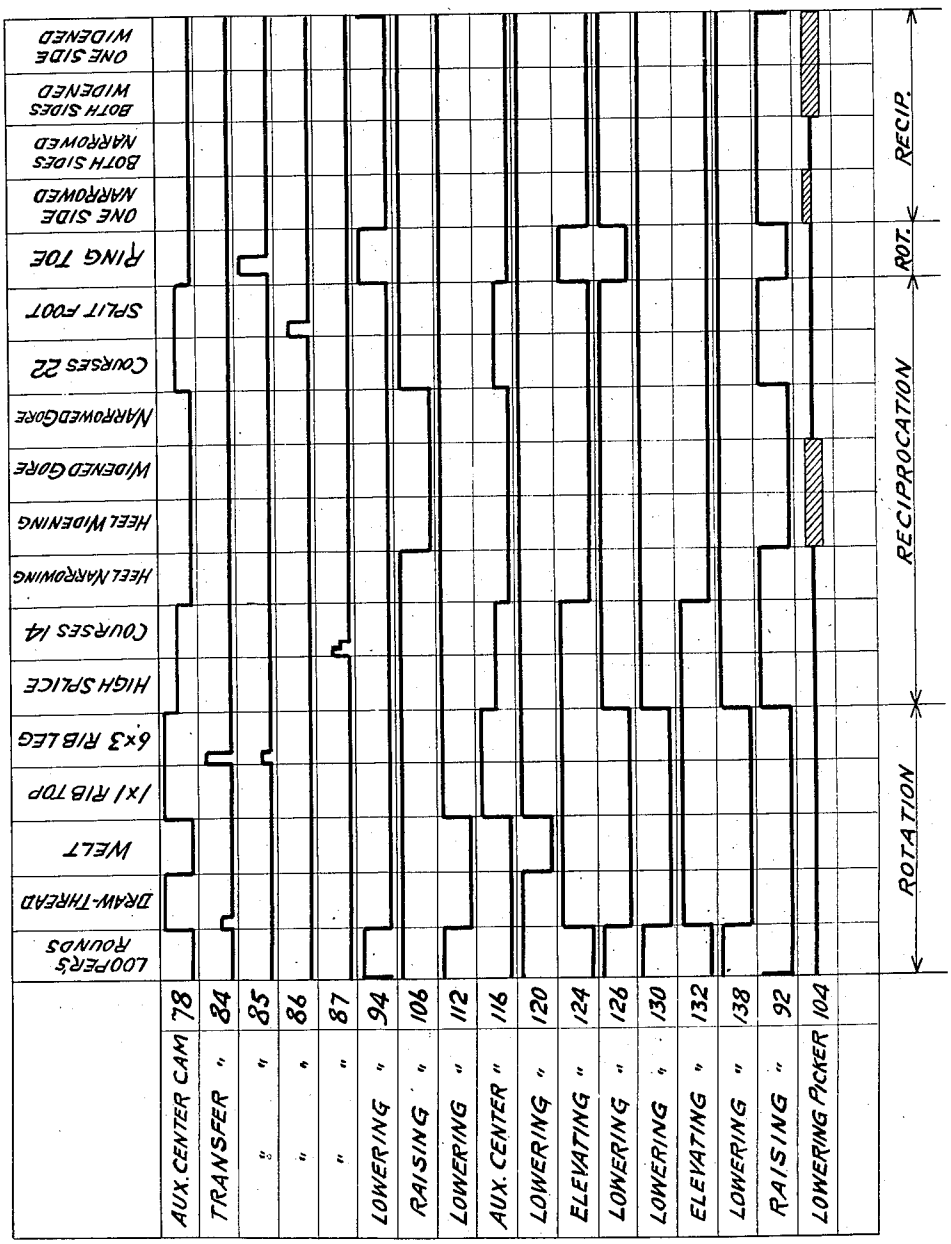


FIG. 6.

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KNITTING METHOD AND MACHINE

Filed Nov. 1, 1939 6 Sheets-Sheet 5

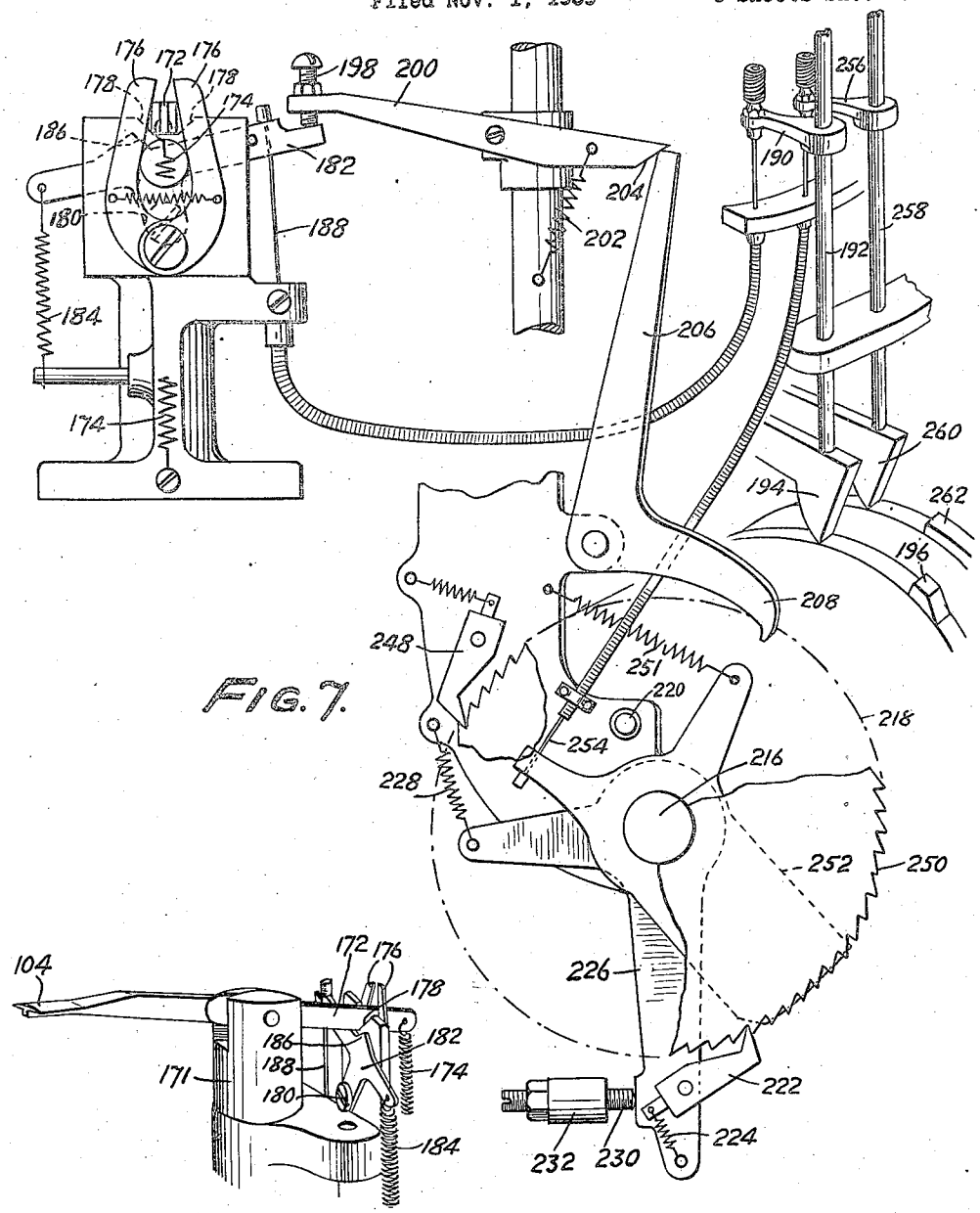


FIG. 7.

FIG. 8.

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KNITTING METHOD AND MACHINE

Filed Nov. 1, 1939 6 Sheets-Sheet 6

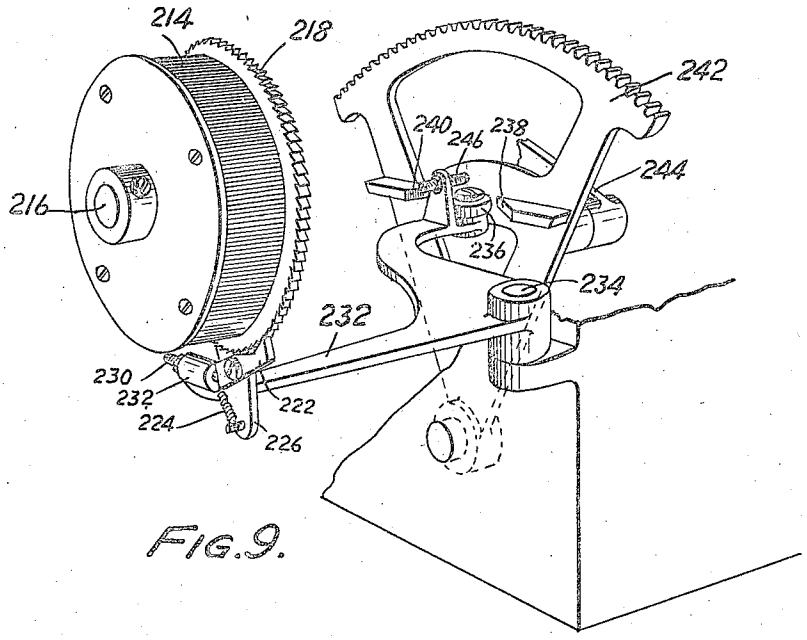


FIG. 9.

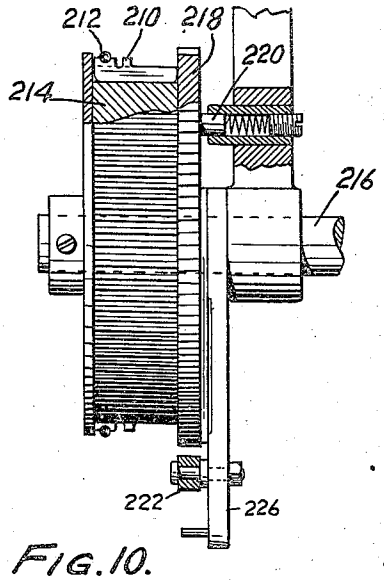


FIG. 10.

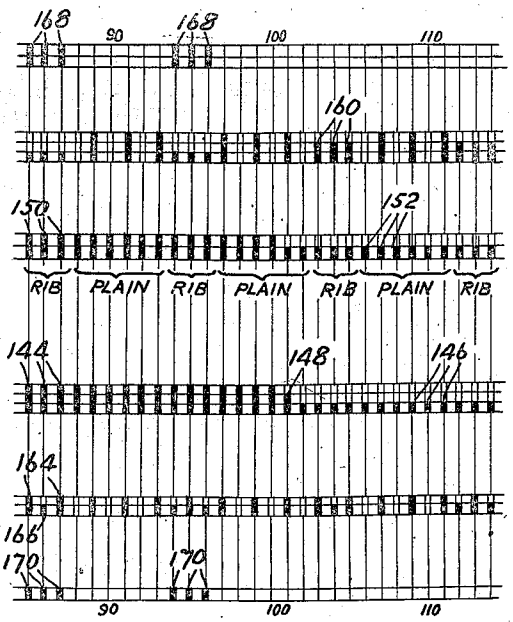


FIG. 11.

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Patented Apr. 1, 1941 2,237,143

UNITED STATES PATENT OFFICE

2,237,143

KNITTING METHOD AND MACHINE

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Application November 1, 1939, Serial No. 302,443

22 Claims. (Cl. 66—14)

This invention relates to an improved type of stocking and the method and machine for making the same, and has particular reference to a split foot type of stocking, the leg and instep of which incorporate patterning achieved by the reverse concatenation of loops and specifically involving broad ribs. The stocking in its most specific form involves knitting to cause the foot portion to approach more closely a right angle with the leg portion than in the case of stockings generally manufactured heretofore, and also involves the provision of right and left toes.

As disclosed in the patents to E. A. Hirner Nos. 1,154,116 and 1,549,307, it is possible by the inclusion of extra fabric at the bottom of the foot portion of a stocking to cause the foot portion as a whole to extend at an angle approaching a right angle with respect to the leg. This stocking provides a much better fit on the foot of the wearer than most conventional forms of stockings, this being particularly noticeable in the absence of creases over the instep, due, in ordinary stockings, to the fact that the foot tends to force the foot portion of the stocking more closely toward a right angle with the leg portion than is the case in the stocking before it is put on the foot. Additionally, with a stocking of the Hirner type a pull exerted on the top of a stocking, for example, by a garter, does not tend to tighten a stocking about the toes, but the pull is absorbed by the instep, with resulting greater comfort to the wearer when it is pulled tight. Wear at the toes is also reduced.

In my Patent No. 1,170,078, dated August 22, 1939, there is disclosed a stocking embodying the Hirner type of foot and provided with patterning in the leg and instep specifically taking the form of ribs. The entire stocking was knit as a single unit throughout.

It is frequently desirable that stockings should be provided with separate yarn in the sole and instep and also should be provided with reenforcement above the heel in what is known as a high splice. Such stockings are formed in either of two ways, namely, by rotary knitting of the portions above the heel and the sole with change of yarns or by reciprocatory knitting utilizing two feeds. The former of these methods involves so-called rotary knitting, while the latter involves reciprocatory split knitting. In accordance with the present invention, split knitting of either type may be used, reciprocatory split knitting being specifically disclosed herein. The formation of the Hirner type of foot in a split foot construction involves various complications, the solutions of which will be apparent hereafter.

If two feeds are provided for reciprocatory split knitting, the major portion of the leg of the stocking may be knit two-feed to secure rapidity of production.

To secure a better fitting stocking, and particularly in view of the closer and better fit which results from the use of the Hirner type of foot, it is desirable to provide for the formation of right and left toes. A satisfactory method of formation of right and left toes is described in the patent to Howard No. 461,183, dated October 13, 1891. It is one of the objects of the present invention to provide right and left toes of this type in a stocking of the general type mentioned above.

The various aspects of the invention, and particularly desirable features of construction of a stocking and of operation of a machine will be best understood following consideration of the detailed description herein of the practice of the invention as applied to two specific stocking formations.

This application relates particularly to the machine, the stockings forming the subject-matter of co-pending application Serial No. 302,444, filed of even date herewith.

In the accompanying drawings, Figure 1 is a diagrammatic elevation of one side of a preferred form of stocking constructed in accordance with the invention;

Figure 1A is a similar elevation of the other side of the toe thereof;

Figure 2 is a vertical sectional view through the cylinders of a double cylinder type of machine illustrating in fragmentary form the fashion in which transfer of needles is accomplished;

Figure 3 is a diagrammatic view illustrating in developed form the inner surfaces of various cams of the machine.

Figure 4 illustrates in elevation the form of upper and lower sliders used in the machine;

Figure 5 is a diagram illustrating the arrangement in the machine of various needle controlling sliders carrying knitting and transfer butts;

Figure 6 is a diagram illustrating the modifications of various cams and control of a lowering picker;

Figure 7 is a diagrammatic perspective view illustrating particularly the controlling means for the lowering picker to enable it to form right and left toes;

Figure 8 is a perspective view showing certain details of the control of the lowering picker;

Figure 9 is a perspective view showing the means for controlling the step by step movements of a trick drum;

Figure 10 is a vertical sectional view of the same;

Figure 11 is a view similar to Figure 5, but showing a modified arrangement of sliders for the formation of another type of stocking; and

Figure 12 is a view similar to Figure 1 showing an alternative high splice construction obtained by the utilization of the slider arrangement of Figure 11.

Referring first to Figures 1 and 1A, there is illustrated therein a preferred type of stocking formed in accordance with the invention and to which the disclosure of the method and apparatus described herein is made specifically applicable. This stocking comprises a welt 2 which, as pointed out later, comprises a series of courses surmounting a rib top 4 in which a conventional 1 x 1 rib arrangement may be embodied, which rib top in turn surmounts a ribbed leg portion 6 which, as specifically illustrated in Figure 1 and as described in connection with the method and machine, is of the well-known English broad rib or 6 x 3 rib type. The plain stitch portions 8 are six wales wide, while the depressed ribs 10 are three wales wide, the ribs being due, as is usual, to the reverse fashion in which the loops of the contrasting fabric portions are interlinked. The rib top 4 and the leg in the present instance are formed at two feeds with resulting rapidity of production.

While for purposes of illustration a specific rib formation is described, it will be obvious that by variations in the distribution of needles in the upper and lower cylinders and by changes of these distributions during knitting there may be provided in the stocking numerous design formations such as described, for example, in my Patent No. 2,170,078.

When the point 11 is reached split reciprocatory knitting occurs with the formation of ribs in both the instep 12 and high splice 13 as continuations of the ribs in the leg 10. The instep is knit using one of the yarns used in the formation of the leg 10, whereas a heavier yarn is preferably introduced for the formation of the high splice 13.

After the completion of the ribbed portion of the high splice, reciprocatory knitting is continued, and there are formed several courses, indicated at 14, which contain plain knitting except for the ribs at the upper portion of the instep, indicated at 16. Below these courses the heel, consisting of narrowed and widened portions 17 and 18, respectively, is formed by reciprocatory knitting. In front of this is the widened gore 19 followed by the narrowed gore 20 providing extra fabric characteristic of the foot of the Hirner type stocking. Such arrangement of the gores is specifically illustrated in Figure II of Hirner Patent 1,549,307, referred to above, and in my Patent No. 2,170,078, dated August 22, 1939.

Following the narrowed gore 20 are a series of split courses indicated at 22 and corresponding to the courses 14 in that they involve plain knitting except for the rib formation, continuing, at 24, the several ribs knit in the courses 14 at 16. (The lines shown in the drawing extending across the arch are merely to illustrate knitting zones; no visible lines are actually present in the stocking.)

Following the formation of the courses 22, the foot is knit by reciprocatory split knitting to form the instep 26 and sole 28 joined at side sutures indicated at 30. The ribs continued at 16 and 24 are continued through the instep. There is also resumed the formation of the ribs above the suture lines 30 which were interrupted by the widened and narrowed heel extensions 19 and 20 in front of the heel. As contrasted with the high splice region the lower portion of the foot is knit plain, the ribs being confined to the instep. The foot is finished with the usual rotary knit ring toe 32, following which there is formed by reciprocatory knitting the toe.

In stockings formed in accordance with the present invention, right and left toes are provided which are of the type illustrated in the Howard Patent 401,183, referred to above. The stocking shown in Figures 1 and 1A is for the left foot. On the right side of this stocking during reciprocatory knitting there is at first no narrowing, the courses extending about the bottom of the toe to the selvage edge at 33 formed on the same needle up to the point 34. From this point narrowing occurs along the line 35, needles being successively removed from action. On the left hand side of the stocking, however, narrowing occurs from the beginning of the formation of the toe along the suture 36. Following the completion of the narrowing operation, widening takes place on both sides until the full set of sole needles has been introduced on the right side of the stocking. Thereafter no further widening on that side occurs, a selvage edge being produced, but widening continues on the left side until the top of the toe is completed. Thus there is provided an asymmetrical pocket of the type illustrated in said Howard patent providing an enlarged space at the right side of this stocking. After the completion of the reciprocatory knitting there are formed by rotary knitting the loopers rounds indicated at 38 which are ultimately stitched as indicated at 40. The selvage edges at 33 are also stitched together to provide the finished stocking.

Before discussing the variations of this stocking within the scope of the invention, there will be first described the method of its formation upon the double cylinder type of machine commonly used for the production of the so-called English broad rib. This machine is of the well-known Bentley type as illustrated, for example, in Spiers Patent 1,210,866, Bentley Patents 1,713,736 and 2,045,938, and Deans Patent 2,101,494. In order to better indicate how the improved stocking is formed, so much of the Bentley machine is illustrated herein in diagrammatic fashion as to show the essential changes in the conventional machine required for carrying out the improved method to produce the stocking illustrated in Figures 1 and 1A.

Referring first to Figure 2, there are illustrated therein the lower cylinder 42 and upper cylinder 44 of a Bentley machine. These cylinders, which are driven in unison during both rotation and reciprocation, are provided with aligned slots in their exterior surfaces within which are adapted to slide double ended needles indicated at 46 having upper and lower hooks 48 and 50, respectively with cooperating latches. Usually such machines have two knitting feeds, with five fingers at the main feed and two at the second feed. One of the fingers at the second feed carries a draw thread and the other a main yarn which knits alternate courses of the leg and foot. Also slidable within the slots, but

remaining in their respective cylinders are upper sliders 52 and lower sliders 54, which are held in position by spring bands, not illustrated. The upper sliders 52 carry transfer butts indicated at 56, auxiliary transfer butts indicated at 57 and knitting butts indicated at 58, while the lower sliders carry transfer butts indicated at 60, auxiliary transfer butts indicated at 61 and knitting butts indicated at 62. The transfer butts are for the purpose of providing transfer of the needles from one cylinder to the other while the knitting butts are designed to cause the needles connected to the sliders to move through their proper knitting waves.

Sinkers of conventional type indicated at 64 serve to cooperate with the needles in the usual fashion for the formation of stitches.

In order to control the sliders for the proper transfer of the needles there is provided at the height of the separation between the cylinders a separating cam 66 which has the form indicated in my Patent No. 2,170,078, in which patent there are described in detail the construction and operation of this cam in effecting transfer. The transfer operations, with slight changes described herein, are essentially the same as described in my said patent.

In Figure 3 there is illustrated in interior development the arrangement of cams for controlling the sliders in the upper and lower cylinders. Besides the cams which are illustrated in Figure 3 there are provided the usual latch guarding cams and other conventional cams and devices which have only their conventional functions in the present machine. The sinker cams are also conventional and need not be specifically described.

Adapted to cooperate with the lower sliders there are the main feed center cam 68 adapted to engage short knitting butts and the main feed stitch cams 70 and 72. Above these are respectively located the raising pickers 74 and 76 of conventional type adapted to raise both long and short butt sliders during reciprocatory knitting.

At the auxiliary feed there is located a center cam 78 and stitch cams 80 and 82. The center cam 78 is radially movable and adapted to occupy three positions in one of which it is out of action, in the second of which it is adapted to engage long and intermediate length knitting butts of the lower sliders, missing short butts, and in the third of which it is adapted to engage knitting butts of all three lengths.

A main lower transfer cam is illustrated at 84, this transfer cam being similar to the lower transfer cam described in my said patent. Likewise, a conventional upper main transfer cam 85 is provided. Auxiliary transfer cams 86 and 87 are additionally provided in the present case to operate on the auxiliary transfer butts 61 and 57 for the purpose of securing quick transfer during reciprocation. Cam surfaces 88 and 89 serve to restore the sliders to proper positions after a transfer action takes place either through the main or auxiliary transfer cams. It will be noted that the cams 85 and 87 are slightly beyond the position of the cams 84 and 86 and the cam surface of cam 86, with the result that a double transfer may be effected as described hereafter.

A long butt slider raising cam is provided at 92. This cam is radially movable to position it so as to effect no operation on long butt sliders or to raise long butt sliders to an inoperative height so that they will not be engaged by the knitting cams at the main feed. A long butt slider lowering cam 94, which is movable radially, is provided for the purpose of bringing down long butt sliders to an active level.

A guard cam 96 insures the location of slider butts in position to either engage the picker 76 or pass properly through the cams at the main feed.

98 is the forward stitch clearing cam for the main feed, while cams 99 and 103 effect this function in reverse movements at the main feed. 101 is the reverse stitch clearing cam at the auxiliary feed and 100 and 102 together effect stitch clearing in forward movements at the auxiliary feed. The lowering picker 104 provided just beyond the auxiliary feed will be described in greater detail hereafter. It must be capable of picking down long as well as short butts.

At 106 there is illustrated the radially movable long butt raising cam operating similarly to cam 92 in reverse movements of the cylinders. This cam is adapted to engage long butts only when the cam is in its inner position. Cam 107 below it serves as a guard cam for cam 106.

The upper set of cams comprises an upper center main feed cam 108 followed by the forward stitch cam 110 and cams 112 and 114 adapted to clear the stitches. At the auxiliary feed there is the center cam 116, which is radially movable to occupy a position in which it engages no upper slider knitting butts, a position in which it engages long butts only or in a position in which it engages both long and short butts. This is followed by the forward auxiliary upper stitch cam 118 which in turn is followed by cams 120 and 122 to cause the stitches to clear the latches. At 124 there is provided a radially movable slider elevating cam which in its outer position will fail to engage any butts and in its inner position will engage all knitting butts of the upper sliders. Immediately following this is a second movable cam 126 which has a lower recessed portion adapted to engage long butts only when the cam is in its active position. When withdrawn it fails to engage any butts. Cooperating with the sliders in their reverse movements are the reverse auxiliary stitch cam 128, the latch clearing cam 130 cooperating with 114, the slider raising cam 132 corresponding to cam 124 and the recessed long butt lowering cam 134 corresponding to 126. This cam 134, however, is not radially movable, but occupies a fixed position in which it serves to lower long butt sliders only. A reverse stitch cam 136 is provided at the main feed and clearing of the latches by stitches is effected by cams 138 and 140.

Of the various cams described above, cams 84, 85, 86 and 87 are controlled in conventional fashion from the usual pattern drum cams or, if more elaborate patterns are being produced, from conventional chains. Of the lower series of cams, cams 94, 106 and 78 are radially movable as described, and as will become clear hereafter. The movements of these cams are controlled from the conventional cam drum in the usual fashion. Of the upper cams, cams 116, 124, 126 and 122 have already been described as radially movable. In addition, cams 120, 130, 112 and 138 are radially movable between outer positions in which they fail to engage any butts and inner positions in which they may engage butts of either length. These various radially movable cams are controlled in quite conventional fashion from the main cam drum of the machine through links and levers which need not be described. The

axial sliding movements of cam 92 are controlled in the same fashion.

In view of the split knitting occurring in the leg, it is essential that the stitches at the various feeds be carefully balanced. For this reason all of the stitch cams 70, 72, 80, 82, 110, 136, 118 and 128 are made axially adjustable to secure fine control of the stitches. Their radial positions, however, remain constantly the same so that they may engage knitting butts of all lengths.

To secure the proper control of needles for the formation of the stocking described herein, the upper and lower sliders have butts provided as indicated in Figure 5. The needles may be considered as divided into two series, a long butt series to form the instep, and a short butt series to form the sole of the stocking. The needles themselves are not provided with the long and short butts, but rather the sliders associated with them. Preferably, and as indicated specifically herein, equal numbers of needles are provided in the two groups on opposite sides of the center line 142. For illustrative purposes, there may be considered to be two hundred needles provided, one hundred in the instep series and one hundred in the sole series, as indicated at the top and bottom of the diagram in Figure 5.

Referring first to the knitting butts 62 of the lower sliders, all of the instep sliders are provided with long butts 144. Except for the end sliders of the sole series, all of these are provided with short butts 146. The two end sliders, however, are provided with intermediate length butts 148 which, as will be evident hereafter, provide for the formation of sutures in the split knitting.

The upper sliders of the instep series are provided with long butts 150, while the upper sliders of the sole series are provided with short butts 152.

The upper sliders are either provided with no main transfer butts, as indicated at 154, with long main transfer butts, indicated at 156, short main transfer butts 158, or intermediate length transfer butts 160. The arrangements of these butts will be apparent from Figure 5, in which it will be noted that long and short transfer butts occur in the instep series and long and intermediate transfer butts in the sole series. Both the short and intermediate transfer butts occur on groups of three sliders separated by groups of six sliders. As will appear hereafter, these short and intermediate butts are found on those sliders which knit the ribs in the leg portion of the stocking. Because of the knitting of 1 x 1 rib, every alternate upper slider must have a main transfer butt. If a short or intermediate transfer butt does not occur thereon, then a long transfer butt is provided.

The lower sliders corresponding to upper sliders which do not carry transfer butts are also lacking in transfer butts, as indicated at 162. Every alternate lower slider carries a long main transfer butt 164. Lower sliders which do not carry the butts 164, but which correspond in position to the broad rib sliders of the upper series carry short transfer butts 166. In Figure 5 the groupings of needles and sliders forming rib and plain stitches in the formation of the leg are so indicated.

The auxiliary transfer butts 57 occur in two lengths, as indicated at 167 and 168. The short butts 167 occur on all the sliders having intermediate length transfer butts 160, and, in the present instance, perform the normal functions of the butts 160, which, in the formation of the stocking of Figures 1 and 1A, are functionless but have been described to clarify the arrangement of the sliders. The longer butts 168 occur only on the two groups of leg rib forming sliders of the instep series on each side of the stocking. The auxiliary transfer butts 61 are provided as indicated at 170 on the corresponding four groups of lower sliders. The various auxiliary transfer butts control the interruption and resumption of the rib formation in the instep portion of the stocking occasioned by the presence of the Hirner heel extension.

The invention will be best understood from specific consideration of these butt set-ups. It will be evident, however, that variations in the product will require obvious changes therein.

For the production of right and left toes special control of lowering picker 104 is necessary. This special controlling means is illustrated in Figures 7, 8, 9 and 10. The picker 104 is in the form of a lever pivoted about a horizontal axis on a member 171 swiveled for movement about a vertical axis in conventional fashion. The tail portion 172 of the picker is pulled downwardly by a spring 174 into engagement with the cam surfaces 178 of a fixed plate. Normally the picker is held in central position by the action of spring controlled fingers 176.

To serve for control of the picker there is pivoted at 180 a lever 182 having a cam surface 186 adapted to engage the tail 172 of the picker to lower it to a position to be engaged by butts of sliders which have been raised out of action. In the present machine the picker 104 is inoperative when it is above such level. When it is lowered to be engaged by the butt of a raised slider and is pushed sidewise thereby it will ride up one or the other of the cam surfaces 178 to effect lowering of its butt engaging end in conventional fashion. The lever 182 is urged in a direction to remove the cam 186 from the picker by a spring 184. A flexible wire 188 is connected to the other end of the lever 182 and to an arm 190 on a rod 192 adapted to be moved upward by a follower 194 engageable by cams 196 on the main cam drum of the machine. By such action the picker 172 may be rendered operative at predetermined periods.

Additionally, the end of the lever 182 is engageable by an adjustable screw 198 carried by a lever 200 urged in a clockwise direction as viewed in Figure 7 by a spring 202. The opposite end of the lever 200 has a beveled surface 204 engageable by the upper end of a lever 206 having a follower portion 208 adapted to be engageable and raised by jacks 210 carried in slots in a drum 214 and held therein by a spring band 212. Thus a dual control may be imparted to the lever 182.

The drum 214 is conveniently journalled loosely upon the shaft 216 of the main cam drum of the machine and is secured to a ratchet disc 218 provided with normal length teeth corresponding to the number of slots in the drum 214 with the exception of diametrically opposite low teeth of which one is illustrated at 250. To prevent overrunning movements of the drum 214, a friction plunger is provided at 220 spring pressed against the surface of the ratchet 218.

The ratchet is adapted to be driven tooth by tooth by a pawl 222 pivoted to an arm 226 journalled on the shaft 216 and urged into engagement with the ratchet by a spring 224. A spring 228 normally urges the arm 226 into engagement

with an adjustable screw 238 carried by one arm of the bell crank 232 pivoted at 234, the other arm of which carries a cam following roller 236 adapted to be engaged by cams 238 and 240 carried by the segment 242 adapted to impart reciprocatory motions to the needle cylinders being driven by a link 244 driven by a crank of the usual driving arrangement. This cylinder driving arrangement is conventional and is illustrated, for example, in Figure 7 of my application Serial No. 227,452, filed August 30, 1938, now Patent No. 2,180,708. The position of the roller 238 is adjusted by means of a screw 246 which bears upon a fixed portion of the frame (not illustrated). Thus the stroke of the pawl is adjusted so that it will be greater than one tooth spacing and less than two.

A detent 248 is provided to prevent retrograde movement of the drum 214.

In order to time up the drum there is provided at 252 a guard for the low teeth 250 adapted to hold the pawl 222 outwardly so that it will not engage these teeth. This guard 252 journalled on the shaft 216 is controlled by a spring 254 and a flexible wire 256 secured on an arm 258 on a vertical rod 259 which rests upon the follower lever 260 engageable by cams 262 on the main cam drum.

As will be evident from the description of the stocking formation hereafter, the provision of right and left toes requires action of the picker as the needles move in one direction but not as they move in the other direction during reciprocatory knitting. At other times, as for example, in the formation of the heel, or in the formation of other parts of the toes, the lowering picker must be selectively active or inactive through longer periods. As will be evident from an examination of Figure 7, the two controls of the arm 102 are essentially independent, so that either of the controls may determine the activity of the lowering picker. The cam action on follower 194 is adapted to effect the long control periods of the lowering picker. The jack drum 214, on the other hand, is adapted to control the selective operations at the ends of reciprocatory movements.

This latter operation is effected by the control of the bell crank 232 by the reciprocating segment 242. At the end of each movement of this segment there is imparted to the jack drum an advancing movement. Obviously, therefore, by the location of a jack 218 only in every alternate slot in the drum the picker 104 may be rendered active at the end of a movement in one direction and inactive at the end of the movement in another direction. The particular movements during which the picker should be operative or inoperative will be different depending upon whether a right or left toe is being formed. Consequently, the jack drum is desirably made so that one-half of a revolution thereof will form a right stocking and the other half a left stocking, the two halves being defined by diametrically opposite low teeth 250. To accomplish this each half is provided with alternate jacks bearing the proper relationship to reciprocations of the segment to give the results indicated above. The number of steps of the drum required to effect this will, of course, be less than half the number of slots in the drum. Consequently, there is provided the guard 252. Throughout the formation of the portions of the stocking in advance of the half narrowing portion to form a toe, the guard 252 will be in a position to prevent engagement of the pawl 222 with a low tooth 250 despite reciprocation of the pawl during reciprocatory split knitting or heel knitting. As soon as the selective control of the picker 104 is to occur the guard 252 is moved by the action of a cam on follower 260 to uncover the tooth so that the jack drum will be advanced. After the necessary actions of the jack drum have been completed, the guard 252 will again be moved into guarding position. So long as the normal teeth are engaged by the pawl 222, the advance will continue, but when a tooth 250 is brought into position to be engaged by the pawl, the advance will cease and the drum will then be in a position to begin the formation of the other type of toe in the next stocking. During such setting up movements, no jacks, or at least no active jacks carrying butts, will engage the follower 208. Consequently, the picker may be controlled independently by the action of the cam follower 196.

The operation of the machine to form a stocking may be best appreciated from consideration of Figure 6 in conjunction with the following description. In this figure there are illustrated diagrammatically the movements of the various controlling cams, etc., to produce the various needle actions incident to the production of the stocking of Figures 1 and 1A.

In considering the operation of the machine, it is most convenient to begin with the formation of the loopers rounds finishing one stocking before proceeding to the next. In the formation of these rounds, the machine is knitting single feed with all of the needles controlled by sliders in the lower cylinder. The auxiliary lower center cam 78 is withdrawn, as indicated in Figure 6, in which figure the positions of all the other cams are also shown. Accordingly, during the formation of the loopers rounds, the knitting butts of the lower sliders controlling movements of all the needles pass down cams 68 and 70 to draw stitches and then up cam 88 passing, without engaging, the center cam 78, and then passing over the reverse stitch cam 72 for subsequent engagement with center cam 68. Plain knitting is thus effected. The knitting butts of the upper sliders move at a low level missing withdrawn cams 124, 132 and 116.

The stockings are formed on this machine in a continuous series, there being provided a draw thread joining the loopers rounds of one stocking with the welt of a succeeding stocking. The knitting and nature of this draw thread arrangement are described in Bentley Patent 2,045,938, and its formation will be briefly described herein merely to show the cam changes of the machine. The knitting of the draw thread is essentially the same as described in said Bentley et al. patent.

At the end of the formation of the loopers rounds, the transfer cam 84 is moved in to engage only the long transfer butts on the lower sliders. Cam 84 may be moved out at this time. The draw thread is introduced at the auxiliary feed, and the yarn for knitting the welt is introduced at the main feed. Center cam 78 and cams 124 and 132 are moved in and cams 112, 130 and 138 are moved out. Cam 120, which has heretofore been in its inner position, though it was not engaging knitting butts, remains in, lowering the upper sliders sufficiently to cause them to receive the transferred needles from the lower cylinder.

The knitting butts of the upper sliders now move up cams 108 and 110, past cams 112 and 130 without engaging these cams and are then depressed by cams 120 and 122 sufficiently to locate

them in position to receive the needles which are being transferred. They are then slightly raised by cam 124 to position to be reengaged by cam 108. They are thus caused to move their needles to knit single feed at the main feed.

The lower sliders which have long transfer butts are raised by transfer cam 84 and immediately lowered by 88 to effect, in cooperation with the cam 66, a conventional transfer operation locating alternate needles in the upper cylinder. Cam 94 then lowers the raised sliders to active level so that they move with the sliders which still control needles. The knitting butts of the lower sliders are depressed by center cam 68 and stitch cam 70, thence rise over cam 98 to be depressed by cams 78 and 80 at the auxiliary feed. The knitting butts then pass up cams 100 and 102 and over the reverse stitch cam 72.

By reason of the above the needles in the lower cylinder take yarn at the main feed and also take the draw thread at the auxiliary feed. The needles in the upper cylinder take yarn only at the main feed, thus producing the draw thread stitches described in the Bentley et al. patent. This draw thread is knit only for approximately one and one-half courses so that it may be readily pulled out to separate the stockings. The welt is then formed by removal of the draw thread and by withdrawal of cams 78 and 120. The result of this is that the needles in the lower cylinder knit single feed taking yarn at the main feed only. They pass through the same wave as in the formation of the loopers rounds, but the yarn is, of course, taken only by alternate needles. The upper sliders move through the central race, missing all cams 120, 138, 112 and 130, their needles holding the loops from their last course of knitting. By the subsequent reengagement of these loops, the conventional welt 2 is formed.

After the formation of, say, four courses, of the welt, the formation of the 1 x 1 rib top 4 is begun with two feed knitting in both the upper and lower cylinders, changes being made to yarns at both feeds suitable for the knitting of the top. To effect this action, cams 78, 112, 116, and 120 are moved into action.

The knitting butts of the lower sliders then move down cams 68 and 70, up cams 98 and 82, down 78 and 80 and up 100, 102, and 72. The knitting butts of the upper sliders move up cams 108 and 110, down cams 112 and 114, up 116 and 118, and down 120 and 122, and are then raised by cam 124 to a position to be reengaged by cam 108.

Following the formation of the rib top, the ribbed leg 6 is knit, the set-up in the present case being suitable to form the usual 6 x 3 rib arrangement. In passing to the formation of the leg, except for yarn changes if yarn changes are desired, there is no variation in the knitting waves, there being merely transfers of needles to secure the desired arrangements in the upper and lower cylinders. Two feed knitting continues for the rapid formation of the leg. To effect the shift of needles both the lower and upper transfer cams 84 and 85, respectively, are moved inwardly, the former to engage all of the lower transfer butts both long and short and the latter to engage long transfer butts only. As a result of this, all of the butt-carrying sliders in the lower cylinder are moved upwardly to needle transferring position. However, since the needles corresponding to the long butt lower sliders are already in the upper cylinder, the transfer effects shift only of the needles engaged by the short butt sliders. Immediately there are transferred to the lower cylinder all of the needles engaged by upper sliders having long transfer butts. As will be evident from consideration of Figure 5, this will result in having in the lower cylinder groups of six needles with intermediate groups of three needles, each, in the upper cylinder. The continued knitting, therefore, will result in the production of the 6 x 3 rib leg 6 which is illustrated. At this point it may be noted, as pointed out above, that by more elaborate control of the transfer, particularly when a plurality of yarns are being fed to the needles to produce plating, there can be produced quite elaborate designs. It will be understood, therefore, that the reference to 6 x 3 rib at this point and in connection with the further discussions of the rib areas is only for the purpose of illustration and that there is possible great liberty of variation in the production of structural and design modifications. A "links and links" type of pattern may be produced, using in conventional fashion jacks above the upper sliders for controlling their movements under the action of special pattern means.

When the position 11 of the high splice is reached, the rotary motion of the needle cylinder is changed to reciprocatory motion and a heavier yarn is introduced at the main feed to be knit into the high splice at the rear of the stocking, the leg yarn being retained at the auxiliary feed to knit the instep. It may be noted that the sliders having intermediate length butts 148 control needles in the lower cylinder knitting plain fabric. Consequently the matter of formation of the suture is taken care of by the cams controlling the lower sliders.

At this point, cam 78 is moved out to engage long and medium butts only. Cam 116 is moved out to engage long butts, only. Cam 126 is moved in so that its set back portion will engage long butts. Cams 130 and 138 move in. Cam 92 is moved up to raise long butts.

The instep needles now knit at the auxiliary feed and the sole needles at the main feed. In their forward movements the long butt lower sliders carrying the instep needles move down cams 78 and 80, up cams 100 and 102 and are then raised by cam 92 above the level of cams 96 and 68. In their reverse movements they move down cams 78 and 82 and up cam 101 to be engaged by the cam 106 which carries them to a level above cams 68 and 96.

The short butt lower sliders miss cam 92 on their forward movement and passing over cam 72 run down cams 68 and 70 to be raised by cam 98. They then pass cam 78 without engaging it. On their reverse movement they miss cam 106 and after rising slightly over cam 70 pass down cams 68 and 72 to draw stitches, being thereafter raised by cams 99 and 103.

The intermediate butt suture needles provide the suture between the split portions of the fabric by taking yarn at both feeds. The intermediate butt slider which leads the short butt sole series in its forward movement starts from the position indicated at A in Figure 3. It is not raised with the long butt series preceding it by the cam 92 and accordingly engages picker 76 which raises it to the level of the long butt series above the center cam 68 so that on this movement it fails to knit yarn at the main feed. The cam 78 is in a position to engage it as well as the long butt sliders, and consequently it is

moved down by cam 78 and then by cam 80 and then upwardly by cams 100 and 102, finally arriving at the position indicated at B. On its reverse movement it engages cam 78 being depressed by this cam and cam 82 and is then raised by cam 101. Passing cam 106, which engages long butt sliders only, it passes beneath the picker 76 which is now riding on the preceding short butts of the short butt sliders. It will accordingly now pass with the short butt sliders through a knitting wave at the main feed, finally arriving at the position A. Thus during a complete reciprocation the corresponding suture needle will knit yarn twice at the auxiliary feed and once at the main feed.

The other suture needle slider leading the long butt series starts from the position indicated at A' in its forward movement, and missing cam 103, is depressed by cams 78 and 80 and raised by cams 100 and 102, then, missing cam 92, it rises over stitch cam 72 and is depressed by cams 88 and 70 and raised by cam 98 reaching its final position at B'. Upon its reverse movement, since it now leads the short butt needles, it will engage picker 74 after passing cam 106 and will be raised thereby above the level of cams 88 and 96 to engage cam 78 which, together with cam 82, lowers it. It then rises over cam 101 to reach its final position A'. Thus the suture needle associated with this slider also knits yarns twice at the auxiliary feed and once at the main feed during each reciprocation.

The upper long butt sliders associated with instep needles, starting from a position approximately above A', will rise over cam 132 and will then move slightly downwardly under the action of cam 114 to engage cam 116. By this cam and cam 118 they will be raised to take yarn at the auxiliary feed and wil then move downwardly under cams 120 and 122 to be raised slightly by cam 124 and then moved downwardly by the setback portion of cam 126. On their reverse movement the leading long butt needle will start from a position above B and the long butt sliders will engage the center cam 116 to be caused to pass through a knitting wave at the auxiliary feed, being then caused to miss center cam 108 by the actions of cams 132 and 134.

The short butt upper sliders in a forward movement start from the position A and are caused to move upwardly by cam 124. The short butts, however, miss the recessed portion of cam 126 and so engage center cam 108 by which together with cam 110, they are caused to have stitch drawing movements at the main feed. They are depressed by cams 112 and 114, and miss the auxiliary center cam 116. On their reverse movements they start from the position B' and are raised by cam 132 to engage cam 108 after missing cam 134. Accordingly, they again take yarn at the main feed, after which they are depressed by cams 138 and 140 and miss cam 116.

It will be noted that the cylinders have a range of reciprocation in excess of 180° so as to bring all of the needles of each series to proper final position to take yarns during the split knitting. This excess range of movement is also necessary for the formation of the Hirner type of heel as described hereafter.

After finishing the ribbed portion of the high splice and before starting the formation of the heel, it is desirable to knit one or more split courses to eliminate the ribs from the portions of the stocking knit by the needles taking part in the heel formation. These courses are indicated at 14. No change is now necessary in the cams which engage the knitting butts of the sliders. Needles, however, are transferred from the upper to the lower cylinder as follows:

Usually on a machine of this type about two revolutions of the cylinders are used for stepping the transfer cams in and out, whereas in the present instance a quick selective transfer is required during the reciprocatory knitting. Accordingly there is provided the auxiliary transfer cam 87 adapted to occupy three alternative positions. As the short butt series of sliders start moving counterclockwise from the position A, the cam 87 is moved to its innermost position so that it will lower the sliders carrying butts 167, the sliders carrying butts 168 being already to the left of cam 87 as viewed in Figure 3. Following lowering of the sliders of the short butt series there are also lowered the two trailing sets of long butt sliders carrying butts 169. Then the cam 87 is partially withdrawn so as to miss butts 167 but engage during the latter part of this forward stroke the sliders carrying butts 168 leading the short butt sliders and being located at the end of the stroke to the left of position B. At the end of this stroke, cam 87 is fully retracted. Thus short butt sliders do not start through the transfer a second time, and cam 87 does not engage any butts in the next reverse stroke. As a result of these operations, there will remain in the upper cylinder only the needles which form the ribs in the front of the extreme forward limits of the heel structure which is to be formed.

Following the formation of the courses 14, the narrowing for the formation of the heel portion 17 is begun. The heel yarn is introduced at the main feed and cams 78, 116, 124, and 132 now move out of action. Accordingly, all the upper sliders will pass by cam 116 without being raised thereby to cause their needles to take yarn. The short butt upper sliders no longer control any needles and pass idly below the cams. The long butt lower sliders will pass cam 78 and will remain at an idle level. The short butt sliders, on the other hand, continue to knit at the main feed and the pickers 74 and 76 operate in the usual fashion to produce narrowing.

Upon the completion of the narrowing operation, cam 92 is moved down and cam 106 moved out, while the lowering picker 104 is rendered active by a cam acting upon lever 194, which action causes it to move down to the level at which the inactive butts are moving. The widening action now takes place in conventional fashion, two needles being picked down and one picked up at each end of the short butt series upon each reciprocation. To form the Hirner type of heel the widening does not cease when all of the short butt needles have been brought into action, but the widening is continued without any further change in the cam set-up, bringing down sufficient long butt sliders to form the widened gore 19. When this has been completed, the lowering picker is again rendered inactive, whereupon the narrowing pickers 74 and 76 continue their action producing the narrowed gore 20. This narrow gore may extend to the position of the suture, as indicated in Figure 1.

At the beginning of the heel narrowing when cams 78 and 116 are withdrawn, the instep yarn which has been knitting at that feed is also with-

drawn and is clamped and cut. When the narrowed gore 20 has been completed and split knitting is to be resumed, the instep yarn is reinserted. If the Hirner gores are not incorporated in the stocking, then floating the instep yarn under take-up control in the conventional fashion is a satisfactory procedure. However, if long butt needles are picked down to form the special gore in front of the heel, it is preferable to clamp and cut the instep yarn as stated, reinserting it when split knitting is resumed after completion of the gores. The sutures will be interrupted by the gores and will not extend without a break along the corners of the heel sutures. Consequently there will not be a tendency to the formation of an open stitch at the heel corners providing weak points in the stockings.

When the narrowing is completed, there are preferably formed one or more courses, as indicated at 22, as a preliminary step to the formation of the ribs throughout the entire instep. To form these courses, 22, there are moved into action cams 92, 106, 78 (to engage long and intermediate butts only) and cam 116 (to engage long butts only). Reciprocatory knitting then takes place in the same fashion as in the formation of courses 14, plain knitting occurring throughout the sole and also in the instep in the region in front of the Hirner heel.

Following the formation of the courses 22 the only action necessary to continue knitting is the transfer of the two sets of rib needles on each side adjacent the suture line to the upper cylinder by the action of cam 86 on the special butts 170 of the corresponding sliders. The movements of the sliders in the formation of the split foot are essentially the same as in the formation of the high splice with the exception that since no ribs are being formed in the sole the short butt series of sliders in the upper cylinder move idly at a low level, cams 124 and 132 remaining out of action. The sutures between the instep and sole portions are formed as described above. If a sole yarn different from the heel yarn is desired, a yarn change takes place at the main feed.

Following the formation of the foot, the ring toe may be produced, preferably in two steps by rotary knitting single feed. First cams 78, 92, 116 and 126 are moved out of action and cams 94 and 124 are moved into action. The result of this will be cessation of knitting at the auxiliary feed with knitting by yarn at the main feed by needles under the control of both upper and lower sliders. This knitting, which may proceed for one or more courses, will involve the formation of ribs at the instep. Immediately, however, cam 85 is moved in to engage the shortest transfer butts of the upper sliders. Thereafter, plain fabric is knit at the main feed by needles controlled by the lower sliders only. If desired a new yarn may be introduced at the main feed for the formation of this ring toe.

Following the formation of the ring toe, reciprocatory knitting is again resumed for the formation of the special right or left toe. The cam changes involve the reinsertion of cam 126, the removal of cam 124, the raising of cam 92 to its upper position to engage and raise long butt sliders to an inoperative level, and the removal of cam 94. The upper sliders will then move below all of the upper cams. Control of the lowering picker 106 is now effected by the devices described above so that it will be operative when reciprocation in one direction takes place. In the direction of reciprocation in which it is inoperative the suture slider leading the short butt series will be raised by a raising picker to the level of the long butt sliders and with these sliders will fail to cause its needle to take yarn at the main feed. Upon reciprocation in the reverse direction, the lowering picker will be operative to engage the first two sliders of the raised series which will be the suture slider leading the long butt series and the adjacent first long butt slider. Both of these will be brought down to trail the end of the short butt sliders. However, before reaching the center cam 68, the long butt slider thus brought down will be raised by either cam 106 or cam 92 depending upon the direction of movement. The result will be that the suture needle will take yarn at the main feed with the needles of the short butt series. This action will be repeated at the unfashioned side, the suture needle under discussion being raised in one reciprocation and lowered in the next. Thus no narrowing at its side of the short butt series will take place. At the same time, however, narrowing in the usual fashion takes place on the other side of the short butt series, a needle being raised in each reciprocation.

After a sufficient length of straight selvage has been produced along the line 33 reaching the point 34, the lowering picker is rendered inoperative, and consequently narrowing at both sides takes place along the line 35.

Following completion of the narrowing operation, the lowering picker is rendered operative on both sides by the action of a cam 196 on follower 194. Widening will now take place in the usual fashion, there being two needles lowered and one raised at each reciprocation. On the side on which narrowing did not take place during the first part of the toe formation, the lowering picker after the point 34 is again reached is unable to produce any further widening, since while it will lower two needles at each action, one of these will be a suture needle and the other an end needle of the long butt series. The latter is raised immediately after being lowered by the action of either cam 92 or 106, while in the next reciprocation the suture needle is raised by a raising picker, since it leads the short butt series. The result is that another straight selvage is produced at 33. Widening at the other side continues in the usual fashion.

At the end of the widening operation, cam 94 is moved in and cam 92 down and rotary knitting is resumed to form the loopers rounds heretofore described. The stocking after separation by removal of the draw thread is stitched at 33 and 38.

As a matter of styling, it may be desirable to have instead of the ribbed high splice 13 a plain high splice portion above the heel with the ribs continued through the instep. Such a modification is fragmentarily illustrated in Figure 12, which shows only the heel portion of a stocking which, except for the construction at this heel portion, may be identical with the stocking of Figure 1. The leg 8' is similar to the leg 8. Prior to the beginning of the plain high splice the ribs at the rear of the stocking are cut out for one or more courses of rotary knitting at two feeds, as indicated at 9'. The position 11' for beginning the high splice is then reached and split knitting is begun forming the plain high splice 13' while continuing the ribbed instep as at 12'. Following this there may be formed the

courses indicated at 14' corresponding to 14 and thereafter the heel 17' is begun.

Assuming the cam arrangement as described above for the formation of the 6 x 3 rib leg, the formation of the stocking of this modification may be described as follows with reference to the butt diagram of Figure 11 showing the slight modifications required as compared with Figure 5.

It will be noted that butts 167 are no longer required and only one length of auxiliary butts is necessary on the upper sliders, these occurring at 168 on the two groups of broad rib sliders on each side in the instep series.

The courses 9' are knit by rotary knitting with transfer of all the needles of the sole series from the upper to the lower cylinder by moving cam 85 inwardly to engage the intermediate length butts 160. Thus two feed knitting proceeds with plain knitting at the rear of the stocking and broad rib knitting continued at the front thereof.

After a few courses of such knitting, the rotary movement of the needle cylinders is changed to a reciprocatory motion and the cams are changed to substantially the conditions described above used in the formation of the split foot of the stocking of Figure 1. Cam 78 is moved out so that it will engage long and intermediate butts only. Cam 116 is moved out to engage long butts only. Cams 124 and 132 are moved out to avoid putting waves in the upper sliders and to prevent passage of the short butt upper sliders (which now control no needles) through a knitting wave at the main feed. Since cam 124 is moved out the position of cam 126 is immaterial. Cam 130 is moved in to clear stitches in reverse movements at the auxiliary feed. Cam 138 is inactive throughout the formation of this stocking, but if it is controlled to move in with cam 130, such movement does no harm. Cam 92 is moved in to raise long butt sliders over the cams at the main feed. Cam 106 is already in position to perform this same function, during reverse movements.

As a result of the above set-up, knitting of the ankle will take place in substantially the same fashion as the knitting of the foot of the modification of Figure 1, a plain high splice 13' being produced.

Following the formation of the high splice, courses 14' may be formed in the same fashion as the courses 14, transfer cam 87 being moved in to lower the two groups of rib forming needles of the instep series on both sides of the stocking. From this point on, the formation of the stocking is the same as in the modification of Figure 1.

In the formation of a high splice such as 13', it will generally be desirable to use a yarn of the same color as that used for forming the leg, but perhaps heavier. If a reenforced high splice is not desired, however, a true high splice need not be made at this point, but instead knitting as in the courses 9' may be continued to the formation of the courses at 14' immediately preceding the heel.

One of the most evident modifications of the product and method will be the formation of more elaborate designs than those secured by the mere formation of ribs running through the leg and instep. The 6 x 3 rib construction has been described as typical and involves no transfers of needles except in the regions of demarcation between different portions of the stocking. However, needles may be transferred from course to course in the well known fashions to produce what amount to various areas of plain and rib stitches, i. e., concatenations of the loops which involve passage through previously formed loops of other loops in selective opposite directions. Such patterns are, of course, produced by more elaborate control of the transfer operations and are secured by suitable set-ups of the transfer butts on both the upper and lower sliders with corresponding controls of the transfer cams. For more elaborate control, it will be obvious that the sliders can be associated with jacks having butts at different levels cooperating with pattern controlling cams. Such designs as well as ribs of the type specifically disclosed are characterized by the selective reverse concatenation of the loops.

The stockings described above are of quite elaborate character, and it will be understood that the principles of the invention are applicable to the formation of stockings of simpler type. For example, the Hirner gores may be omitted and/or conventional toes may be provided instead of the right and left toes described heretofore. Other forms of Hirner gores may also be readily incorporated, for example, the alternative type illustrated in Figure 6 of my Patent No. 2,170,078. From the description of the cam actions above it will be evident how such a modified gore may be produced by slight variation in the handling of the needles.

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

1. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles at spaced feed points, means at each of said feed points to control needle movements to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at both feed points while the cylinders revolve to produce two feed knitting containing reversely concatenated loops, and, second, control of needles located in at least one cylinder at one feed point and control of needles located in both cylinders at the other feed point while the cylinders reciprocate to produce split knitting.

2. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles at spaced feed points, means at each of said feed points to control needle movements to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at both feed points while the cylinders revolve to produce two feed knitting containing reversely concatenated loops, and, second, control of needles located in both cylinders at both feed points while the cylinders reciprocate to produce split knitting.

3. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles at spaced feed points, means at each of said feed points to control needle movements to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at at least one feed point while the cylinders revolve to produce knitting containing reversely concate-

nated loops, and, second, control of needles located in at least one cylinder at one feed point and control of needles located in both cylinders at the other feed point while the cylinders reciprocate to produce split knitting.

4. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for transferring needles from one cylinder to the other, means for feeding yarns to the needles at spaced feed points, means at each of said feed points to control needle movements to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at at least one feed point while the cylinder revolves to produce knitting containing reversely concatenated loops in both the front and rear of a stocking, secondly, transfer of needles while the cylinders revolve to interrupt the formation of reversely concatenated loops in the rear of the stocking, and then control of needles located in one cylinder at one feed point to form the rear of the stocking and control of needles located in both cylinders at the other feed point while the cylinders reciprocate to produce split knitting.

5. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles at spaced feed points, means at each of said feed points to control needle movements to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at at least one feed point while the cylinders revolve to produce knitting containing reversely concatenated loops, and, second, control of needles located in at least one cylinder at one feed point and control of needles located in at least one cylinder at the other feed point while the cylinders reciprocate to produce split knitting.

6. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles at spaced feed points, means at each of said feed points to control needle movements to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at both feed points while the cylinders revolve to produce two feed knitting containing reversely concatenated loops, and, second, control of needles located in only one cylinder at one feed point and control of needles located in both cylinders at the other feed point while the cylinders reciprocate to produce split knitting of which one section is plain and of which the other section contains reversely concatenated loops.

7. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles at spaced feed points, means at each of said feed points to control needle movements to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at at least one feed point while the cylinders revolve to produce knitting containing reversely concatenated loops, second, control of needles located in both cylinders at both feed points while the cylinders reciprocate to produce split knitting having reversely concatenated loops in both sections thereof, and, third, control of needles located in only one cylinder at one feed point and control of needles located in both cylinders at the other feed point while the cylinders reciprocate to produce split knitting of which one section is plain and of which the other section contains reversely concatenated loops.

8. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles, means to control needle movement to form stitches, means for transferring needles from one cylinder to the other during rotary movements of the cylinders, and auxiliary means for transferring needles from one cylinder to the other during reciprocatory movements of the cylinders.

9. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, sliders in said cylinders for controlling needle movements, means for feeding yarns to the needles, means to control needle movements to form stitches, means for transferring needles from control by the sliders of one cylinder to control by the sliders of the other cylinder during rotary movements of the cylinders, and auxiliary means for transferring needles from control by the sliders of one cylinder to control by the sliders of the other cylinder during reciprocatory movements of the cylinders.

10. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders, needles adapted to slide in said cylinders, means for feeding yarns to the needles, means to control needle movements to form stitches, means for transferring a set of needles from one cylinder to the other at one stage of the knitting operation and auxiliary means for transferring certain needles of said set from one cylinder to the other at another stage of the knitting operation.

11. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles at spaced feed points, means at each of said feed points to control needle movements to draw loops to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at least one feed point while the cylinders revolve to produce knitting containing reversely concatenated loops, and, second, control of needles located in at least one cylinder at one feed point and control of needles located in at least one cylinder at the other feed point to produce split knitting.

12. A circular knitting machine of the superposed cylinder type comprising upper and lower cylinders arranged to rotate and reciprocate in unison, needles adapted to slide in said cylinders, means for feeding yarns to the needles at spaced to control means at each of said feed points to control needle movements to draw loops to form stitches, and controlling means for effecting, first, control of needles located in both cylinders at both feed points while the cylinders revolve to produce knitting containing reversely concatenated loops, and, second, control of needles located in at least one cylinder at one feed point and control of needles located

in at least one cylinder at the other feed point to produce split knitting.

13. The method of knitting a split foot stocking having reversely concatenated loops forming design structure therein on a knitting machine of the superposed cylinder type which comprises knitting a portion of the stocking on needles in both cylinders by rotary knitting, and another portion of the stocking on needles in both cylinders by reciprocatory knitting.

14. The method of knitting a split foot stocking having reversely concatenated loops forming design structure therein on a knitting machine of the superposed cylinder type which comprises knitting a portion of the stocking on needles in both cylinders by rotary knitting, one portion of the split foot on needles in both cylinders by reciprocatory knitting, and another portion of the split foot on needles in one cylinder only by reciprocatory knitting.

15. The method of knitting on a knitting machine of the superposed cylinder two feed type the leg portion of a stocking, which leg portion has reversely concatenated loops therein forming design structure, which comprises knitting said leg portion partly by rotary knitting at both feeds and partly by reciprocatory knitting at both feeds.

16. The method of knitting a split foot stocking having longitudinally extending ribs on a knitting machine of the superposed cylinder type which comprises knitting a portion of the stocking on needles in both cylinders by rotary knitting, and another portion of the stocking on needles of both cylinders by reciprocatory knitting.

17. The method of knitting a split foot stocking containing longitudinally extending ribs on a knitting machine of the superposed cylinder type which comprises knitting a portion of the stocking on needles in both cylinders by rotary knitting, one portion of the split foot on needles in both cylinders by reciprocatory knitting, and another portion of the split foot on needles in one cylinder only by reciprocatory knitting.

18. The method of knitting on a knitting machine of the superposed cylinder two feed type the leg portion of a stocking, which leg portion contains longitudinally extending ribs, which comprises knitting said leg portion partly by rotary knitting at both feeds and partly by reciprocatory knitting at both feeds.

19. The method of knitting a stocking on a knitting machine of the superposed cylinder type comprising knitting on needles in both cylinders during reciprocatory knitting, and, during said reciprocatory knitting, transferring needles from one cylinder to the other to alter the type of stitches knit thereby.

20. The method of knitting a stocking on a knitting machine of the superposed cylinder type comprising knitting on needles in both cylinders during reciprocatory knitting, and, during said reciprocatory knitting, transferring certain needles from one cylinder to the other and then back again to alter the type of stitches knit thereby.

21. The method of knitting a stocking on a knitting machine of the superposed cylinder type comprising knitting on needles in both cylinders during reciprocatory knitting, during said reciprocatory knitting transferring certain needles from one cylinder to the other to alter the type of stitches knit thereby, and rendering needles so transferred first temporarily inactive and then active, thereby to form a suture.

22. The method of knitting a stocking on a knitting machine of the superposed cylinder type comprising knitting on needles in both cylinders during reciprocatory knitting, during said reciprocatory knitting transferring certain needles from one cylinder to the other to alter the type of stitches knit thereby, rendering needles so transferred first temporarily inactive and then active, thereby to form a suture, and thereafter retransferring to the first cylinder the previously transferred needles.

HAROLD E. HOUSEMAN.

CERTIFICATE OF CORRECTION.

Patent No. 2,237,143. April 1, 1941.

HAROLD E. HOUSEMAN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 10, second column, line 14, claim 8, for "movement" read --movements--; line 67, claim 12, for "to control means" read --feed points, means--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of October, A. D. 1943.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.