This invention relates to circular knitting machines of the type having a complementary pair of series of rib-knitting devices such as a needle cylinder provided with independent cylinder needles and a dial provided with independent dial needles or hooks and cast-offs which cooperate in forming ribbed fabrics.

It is the primary object of this invention to provide a novel arrangement of the dial cams and butts on the dial needles or hooks and cast-offs which arrangement facilitates the knitting by a continuous operation a stock of the half-hose type having a ribbed or plain knit top provided with a selvage knitted in advance of the top, a ribbed leg and instep and a plain knit heel, sole and toe.

It is another object of this invention to provide a machine capable of knitting continuously a succession of stockings, each stocking being complete, except for the closure of the toe seam, wherein complete courses of ribbed fabric may be knitted and wherein a selvage or make-up is initially formed at the top of the stocking and, thereafter, the entire leg of the stocking or any part thereof may be knitted in complete courses of ribbed fabric following which successive courses may be knitted wherein each of said successive courses formed is substantially half of plain fabric and the other half thereof being formed as ribbed fabric.

Hereinafter, in order to produce a seamless stocking having portions parts of rib and parts of plain fabric; for example, a ribbed leg and ribbed instep and a plain or ribbed welt or top, it has been necessary to commence knitting at the toe instead of at the top of the stocking in order to obviate the necessity of transferring loops from the dial to the cylinder needles, it merely being necessary, heretofore, that the dial needles, which had previously been inactive as the corresponding cylinder needles were active in plain knitting, would merely be actuated to move outwardly and pick up the loops from the cylinder needles, which is not normally considered as a loop transfer operation.

However, this picking up of the loops by the previously inactive dial needles has resulted in indentations at the walewise junctures of the inwardly facing stitches and the outwardly facing stitches in the wales at the point at which the rib has commenced. More important, however, is the fact that, since the top of the stocking was the last portion of the stocking to be knitted, the edge of the top would be raveled and it was necessary that the upper edge of the stocking undergo an additional operation in which the upper edge of the stocking was provided with a selvage by a sewing operation.

Thus, more specifically, it is the object of this invention to provide means for knitting a complete stocking from top to toe, thereby facilitating the formation of a selvage at the upper edge of the stocking during ordinary rib knitting and wherein the leg or any portion thereof may also be knitted as a ribbed fabric and, upon approaching the heel of the stocking, substantially half of the stitches carried by the dial needles are transferred to the cylinder needles while the remaining active dial needles remain active during the formation of the instep course. Of course, upon approaching the toe of the stocking, the stitches carried by said remaining active dial needles are then transferred to the cylinder needles for the formation of the ring toe and the toe pocket. This overcomes an obvious defect of circular rib knitting machines currently in use and such as are disclosed in the R. W. Scott Patent Nos. 1,641,101 of August 30, 1927 and 1,641,364 of September 6, 1927. This also produces a fabric wherein the junctures of the rib knit areas and the plain knit areas, wale-wise, are substantially smoother than any rib knit stockings heretofore manufactured.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawings in which—

Figure 1 is a front elevation of the upper portion of a circular knitting machine and a dial mechanism associated therewith and showing parts of the improved means for controlling certain of the dial cams;

Figure 2 is a right side elevation of the machine, partly in section, showing the connections between the dial cams and the main pattern drum;

Figure 3 is an enlarged fragmentary vertical sectional view through the dial and the sinker head and being taken substantially along the line 3—3 in Figure 2;

Figure 4 is a fragmentary plan view, partly in section, taken substantially along the line 4—4 in Figure 1, showing the dial cap and operating connections, the latch ring, the yarn feeding fingers and the yarn severing and clamping means;

Figure 5 is an enlarged fragmentary view of the lower right-hand portion of Figure 4;

Figure 6 is a development of the cylinder cams showing the relative positions of the needles as affected by the cylinder cams;

Figures 7 and 8 are sectional plan views through the dial cams showing the preferred re-
lation of the dial cams to the cylinder cams by comparison with Figure 6; Figure 9 is a schematic plan view showing the relative positions of the dial hooks and the cylinder needles, the positions of the dial hooks corresponding to the dial cam arrangement in Figure 7 with the exception that all the cams in Figure 7 would be in full operative position; Figure 10 to 15, inclusive, are enlarged vertical radial sections illustrating successive positions of the respective hook and cast-off type of dial needles during the motions of knitting; Figure 16 is a fragmentary vertical sectional view taken substantially along the line 16—16 in Figure 5, illustrating the manner in which the new dial cams are mounted; Figure 17 is a fragmentary elevation taken substantially along the line 17—17 in Figure 2, but showing the main pattern drum revolved substantially 125 degrees from the position in which it is shown in Figure 2; Figure 18 is a side elevation of a stocking knitted according to the principles of the present invention; Figure 19 is a greatly enlarged fragmentary view of the area 19 defined in broken lines in Figure 18, showing the stitch formation at the junctures of the ribbed knit and plain knit portions of the stocking; Figure 20 is a view similar to Figure 7, but showing the dial cams as arranged for controlling latch-type dial needles instead of the hook and cast-off type of needles; Figures 21, 22, and 23, inclusive, are enlarged vertical radial sections illustrating successive positions of the latch-type dial needles during the motions of knitting; Figure 24 is an enlarged fragmentary plan view similar to the lower portion of Figure 4, but showing how the dial cams for controlling latch-type dial needles are mounted; Figure 25 is an enlarged vertical sectional view taken substantially along the line 25—25 in Figure 24.

The knitting machine in association with which the present invention is shown is very similar to that shown in said Patent Nos. 1,641,101 and 1,641,584. Reference is also made to Patents No. 1,182,850 dated December 7, 1951, No. 1,148,058 dated July 17, 1915, and No. 1,282,958 dated October 29, 1918 for a further disclosure of the type machine with which the embodiment of the present invention is adapted to be associated. It is to be understood, however, that the present invention is capable of use with many different types of knitting machines, the present invention being shown in association with one type of circular knitting machine by way of illustration only.

The machine illustrated is of a type having the cylinder needle provided with independent needles which cooperate with either latch needles or hooks and cast-offs of a dial, the improvement residing particularly in the arrangement of the dial cams, means for controlling certain of the dial cams and the needles which are provided with both varying lengths or heights to cooperate with the cylinder needles in forming rib-knit tubular fabrics as embodied in the men's half-hose shown in Figure 18.

The men's half-hose or stocking illustrated in Figure 18 comprises successively knitted portions including a top selvage edge or make-up, an elastic or ribbed top I, a ribbed leg L and a ribbed instep I which is knit simultaneously with a plain-fabric sole S. The stocking also includes a plain knit heel H, and a plain knit toe T, the heel and toe being knitted by reciprocating knitting on the cylinder needles only and the selvage, top, leg, instep, and sole being knitted by rotary knitting wherein some of the stitches are formed by the dial needles and the remaining stitches are formed by the cylinder needles.

Of course, the stocking shown in Figure 18 also includes the usual ring heel courses R, which are half plain fabric and half ribbed fabric and the usual ring toe courses R, which may be suitably secured by knitting. The particular stocking shown in Figure 18 merely illustrates one of many different types of ribbed fabrics which may be knitted on the present machine, it being understood that the ribbed top I may be substantially longer than that shown relatively, that the leg is, if so desired, certain groups of courses or alternate courses in the top and leg of the stocking may be entirely plain fabric while those courses between said alternate or spaced groups of courses may be of entirely ribbed fabric and, also, by use of the present invention, the portion of the stocking may be provided with spaced plain knit areas between which rib-knit areas are provided and the leg and top of the stocking may be entirely ribbed fabric.

**General description of the machine**

Referring to Figures 1, 2, and 3, the machine comprises a frame broadly designated at 50 comprising a bed plate or cam plate 51 which supports a vertically movable sock horn 52. The frame 50 also rotatably supports a conventional drive shaft 53 having bevel gears 54 and 55 fixed thereon. The gear 54 meshes with a bevel gear 56 rotatably supported by the bed plate 51 and which drives a conventional needle cylinder 57. The gear 55 meshes with a relatively small bevel gear 58 which is fixed on the lower end of a vertical shaft 61 rotatably mounted in an upright bracket 62 carried by the bed plate 51.

Suitable conventional connections, not shown, extend from the upper end of shaft 61 for driving a dial spindle 63 and a dial broadly designated at 64 fixed on the lower end of the dial spindle 62. The dial spindle 62 is rotatable in a bearing 63 of a conventional bracket 65 so the dial spindle 62 and the dial 63 are concentric with the needle cylinder 57. The driving connections between the vertical shaft 61 and the dial spindle 62 may be substantially as shown in said Patent No. 1,641,101 and the remaining parts heretofore described may all be substantially as shown in said Patent No. 1,282,958. As shown in said Patent No. 1,641,101, the dial spindle 62 and the dial 63 are driven in unison with the needle cylinder 57.

The bracket 65 is fixed upon a dial ring or latch ring bracket 66 which carries the conventional latch ring 67 encircling the upper portion of a stationary dial cam cap 70 which is substantially the same as the dial cap D shown in said Scott Patent No. 1,641,101, but is modified to accommodate the present invention as will be later described.

The dial ring bracket 66 is pivotally rotated about the shaft 71 which is suitably secured to the bearing 64 of the bracket 65. The latch ring bracket 66 is pivoted at its rear end on the upper end of a post 72 and the front end of the bracket 66 rests upon a front post 73, the posts 72 and 73 being suitably fastened to the upper surface of the bed 50 or cam plate 51 of the frame 50. Thus, the dial
ring bracket 66, the dial 63, and their attachments may be lifted away from relation to the other parts of the machine.

The knitting machine also includes a conventional pattern drum 75 fixed on a shaft 76 carried by the frame 50. The pattern drum 75 is provided with suitable driving connections including a gear 77 fixed to one end of the main pattern drum 75 and which meshes with a gear 79 which, in turn, meshes with a gear 81, the gears 79 and 81 being mounted on respective shafts 52 and 83. The means for rotation and reciprocating the drive shaft 53, the pattern drum 75 and its driving connections 77, 79, 81; and the structure of cam shaft 53 and its attachment, the primary pattern chain, not shown, may be as shown in said Patents Nos. 1,152,850 and 1,282,958.

The usual vertically movable independent cylinder latch needles, which work in the usual slots or grooves of the needle cylinder 67, are generally designated as N, these needles being divided into a long-butt segment for the instep and a short butt segment for knitting the heel and toe in the usual manner. The needles N cooperate with the usual sinkers 85 carried by a conventional sinker head 86 supported on the upper end of the needle cylinder 57 and provided with screws 87 which engage opposite sides of the post 73 to limit reciprocatory movement of the sinker head 86 as caused by the needle cylinder 57.

The bracket 66 pivotally supports the usual main or body yarn feed fingers which extend through the usual throat gap 61 in the latch ring 67 and which are controlled by conventional thrust rods 92 which engage the lower surfaces of the fingers 89 and extend downwardly through a suitable guide member 83 carried by a rod 84 fixed to the frame 50. The lower ends of the thrust rods 92 are alternately engaged by suitable cams, not shown, on the main pattern drum 75.

**Cylinder needle cams**

The cylinder needle control cams (Figure 6) are conventional, substantially as shown in said Patent No. 1,641,101, and are arranged to encircle the lower portion of the needle cylinder 57. The cylinder needle control cams are suitably supported by the bed or cam 61. These cylinder needle control cams include a cam ring 109 which extends entirely around the needle cylinder 57 and is formed with a pair of inverted V-shaped openings 101 and 102 in the lower edge thereof in which respective first and second needle jack elevating cams 103 and 104 are disposed. Cam 103 is preferably radially movable and cam 104 may be stationary.

The first needle jack elevating cam 103 is spaced further from the needle cylinder than the second needle jack elevating cam 104 so that spaced short butt jacks J-1 remain in lowered position as they move past the first needle jack elevating cam 103 and will subsequently be elevated by the second needle jack elevating cam 104. On the other hand, long butt jacks, indicated at J-2, disposed between the short butt jacks J-1, are engaged and elevated by both the first and the second needle jack elevating cams 103 and 104.

In this instance, it will be observed in Figure 6 that alternate needles have a long butt jack J-2 therebeneath while the needles between every alternate pair of the needles having the long butt jacks J-1 therebeneath. In other words, there is no jack beneath every fourth needle while each group of three needles separated by a single jackless needle has a long butt jack J-2 beneath each of the outside needles and each of the middle needles between said outside needles has a short butt jack J-1 therebeneath. There are other ways that the needle jacks J-1 and J-2 may be arranged, the arrangement shown in Figure 6 being provided to form a 1 x 3 ribbed fabric as will be evident as the description proceeds.

For purposes of clarity, the needles which are elevated by their butts traversing the second needle jack elevating cam 104, may be termed as ever-active needles and their butts are shown in open outline. The remaining needles, which are jackless needles, are indicated in black, and may be termed as occasionally-active needles.

The long butt jacks J-2 are provided for the sole purpose of elevating alternate needles to take elastic yarn R from an elastic yarn feed finger 105 which is shown only in Figure 6, since the structure and manner of operation of the elastic yarn feed finger 105 is well known. For this reason, the description and drawing are not necessary to constitute a part of the present invention.

A radically movable elastic yarn switch cam 108 is provided beneath and subsequent to the yarn feed finger 105 for the well known purpose of lowering the needles previously raised to take the elastic yarn R from the elastic yarn feed finger 105 in order to position the elastic yarn R beneath the nibs of the corresponding sinkers for laying the yarn in the fabric subsequently knitted from the body yarn.

Disposed to the left of the elastic yarn stitch cam 108 is a conventional radially movable switch cam 107 which is controlled in the well known manner to engage the butts of the long butt needles for either raising or lowering the same in the usual manner for knitting the heel H and the toe T. The cam ring 109 has an opening in the upper peripheral edge thereof defining inclines 110 and 111 and in this opening are the usual stitch cams including a right-hand stitch cam 112, a left hand stitch cam 113, a top center cam 114 and a bottom center cam 115.

In advance of the stitch cam 112 there is provided a radially movable switch cam 116. Disposed above and subsequent to the high point of the needle jack elevating cam 104 is a radically movable needle raising cam 117. The cam ring 109 has a mean upper edge 120 to which the butts of the needles are lowered by a radially movable needle lowering cam 121 after the needles have been elevated by the incline 111.

The various movable needle cams hereinafter described may be controlled by the means shown in said Patents Nos. 1,152,850 and 1,282,958 and a further description as to the manner in which they are mounted and controlled is therefore deemed unnecessary. It is evident that the usual widening and narrowing picks, not shown, may be provided to perform the usual narrowing and widening operations in the heel and toe of the stockings shown in Figure 18.

**Dial mechanism**

As hereinafter stated, the dial 62 is fixed to the dial spindle 62. As is well known, the dial 62 is provided with the usual radially extending grooves in which conventional dial needles 123 and 124 are mounted. In this instance the dial needles 123 and 124 are so-called respective short butts and long-butt two-part needles. Each short-
but needle 123 comprises a hook 125 and a cast-off 126, and each long-butt dial needle 124 comprises a hook 127 and a cast-off 128. The hooks 125 and 127 and the cast-offs 126 and 128 are mounted for radial sliding movement in the dial 92 independently of each other.

The particular dial needles illustrated in Figures 10 to 15, inclusive, are substantially the same as those shown in Scott Patent No. 1,641,289 of July 26, 1921. It is to be understood, however, that the latch-type of dial needles may be employed in lieu of the hook and cast-off types of dial needles 123 and 124, as desired, in which instance, slight modifications may be made in the arrangement of the dial cams as will be later described.

In this instance, the dial 53 and the dial needles 123 and 124 are substantially as shown in said Patent No. 1,641,289, with the exception that substantially half of the hooks, including all of the hooks 125, are provided with relatively short butts 125a (Figures 10, 11, and 12) and the corresponding half of the cast-offs, including all of the short butts 125c, thus forming a segment 136 (Figure 9) of the short-butt dial needles 123. The remaining hooks 127 and cast-offs 128, which collectively form a segment 151 of the dial needles 124 are provided with respective long butts 127a and 128a.

As is well known to those familiar with the art, there are as many dial needles 123 and 124 carried by the dial 53 as there are jackless or occasionally-active cylinder needles N. During rib-knitting, these jackless needles are lowered by the dividing cam 116 as they move from right to left in Figure 6 to pass beneath the stitch cams 112 and 113, the relative rotative positions of the needle cylinder 97 and the dial 53 being such as to bring each dial needle 123 or 124 into the same radial plane as the diameter projected needle. Thus, the ever-active cylinder needles N; those with jacks, work in the radial planes bisecting the angles defined by adjacent dial needles 123 and/or 124 and, with them, constitute the face-vaile series of needles and the back-vaile series respectively cooperating with the yarn to knit ribbed fabrics. As shown in Figure 9, there are three ever-active cylinder needles N between adjacent dial needles, and, therefore, the rib pattern is 1 x 3.

**Dial cams**

The dial cap 78 carries a conventional stationary outer cam ring 135 and a conventional stationary inner cam ring 136 defining between them a broad concentric groove 137. Interposed in the broad groove 137 is a segmental butt separating cam 140, one end of which is spaced from a group of knitting cams comprising a cam 141 which operates upon both the hook members 125 and 127 and the point members or cast-offs 126 and 128 of each of the respective dial needles 123 and 124. The knitting cams also comprise a cam 142 for advancing the cast-offs 126 and 128 of the needles 123 and 124 and a cam 143 for advancing the hooks 125 and 127 members 125 and 127. The knitting cams 141, 142, and 143 may be constructed and operated in a manner similar to the cams 12 and 13 shown in Figures 4 and 5 of said Patent No. 1,641,101.

It will be observed in Figure 4 that the dial cap 10 has an opening 144 therethrough through which the cams 141, 142, and 143 of the knitting cam group extend and which are suitably secured on a carrier block 148 (Figure 4) which block 148 has holes guided on vertical pins 146 and 147 on the dial cap 78. The block 148 has a housing 159 over the pin 147 and a suitable spring, not shown, but being shown in said Patent 1,641,101, normally urges the housing 150 upwardly against the inner end of a conventional lever 151 pivotedly mounted on a shaft 152 suitably secured to a bracket 153 attached to the inner end of the guide 93 (Figure 2) and is successively engaged by the periphery of the pattern drum 75 and stepped cams 160 and 161 and a cam 162. The cams 160, 161, and 162 are suitably secured to the periphery of the pattern drum 75. Although the cams 141, 142 and 143 of the knitting cam group and the mechanical connections from the same to the pattern drum are substantially as shown in said Patent No. 1,641,101, the cams 160, 161, and 162 are particularly arranged to cause the knitting cams to cooperate with the varying lengths of butts 125a, 125c, and 127a and 128a as will be later described.

Now, in order to transfer the stitches from the half or segment 130 of the dial needles 123 to the corresponding jackless needles, such as in knitting the ring heel courses R/h of the stocking shown in Figure 15, there is provided in the broad groove 137 a group of stitch transfer dial cams (Figures 7 and 8) which are peculiar to the present invention. The stitch transfer cams comprise a cast-off advancing or throw-out cam broadly designated at 165 and a hook advancing or throw-out cam 166, the cams 165 and 166 being vertically movable in unison from inoperative position to step into operative position only.

The cast-off advancing cam 165 comprises a toe or pointed portion 167 which is disposed in engagement with or immediately adjacent the pointed end 170 of the segmental butt separating cam 140, opposite the end adjacent which the knitting cam 141 is disposed. The inner edge of the cast-off advancing cam 165 is provided with a recess 171 in which a relatively vertically movable tear-shaped hook withdrawing dial cam 172 is disposed, the cams 165 and 166 being vertically movable to two different operative positions relative to the cam 172 and all the cams 165, 166, and 172 being movable to inoperative position.

It will be noted that the separating cam 140 is spaced from opposite walls of the broad groove 137 sufficiently to permit the butts 125a and 125c of the hooks 125 and 127 and the butts 126a and 126c of the cast-offs 126 and 128 to pass between the butt separating cam 140 and the corresponding cam rings 135 and 136. The dial needles 123 and 124 then occupy the idle position shown in Figures 10 and 11. As the hooks move in a counterclockwise direction in Figure 8, the hook advancing cam 166 extends outwardly at an angle into a substantially V-shaped opening 173 defined by the junctures of the toe 161 and the point 170 of the respective cams 165 and 166.

It will be noted that the cam 172 extends inwardly at an angle relative to the direction of travel of the butts of the hooks 125, 127 and means, to be presently described, are provided to, at times, position the hook withdrawing cam 172 and the cams 165 and 166 in partially operative position for engaging the long butts 127a only of the hooks 127. At other times, the cams 165 and
move into fully operative position to engage both the long butts 127a and short butts 128a of the corresponding hooks 127 and 125. However, the cam 112 never moves into fully operative position as compared to the cams 165 and 166. The cast-off advancing cam is also provided with a heel portion 170, a inner edge of which is spaced from the inner cam ring 135 substantially the same distance as the innermost edge of the separator cam 140 to permit the butts 125a and 127a of the hooks 125 and 127 to pass therebetween. The outer surface of the heel portion 174 of the cast-off 165 is spaced substantially further from the axis of the dial cap 70 than the outer surface of the toe or pointed portion 167 thereof to thus throw the butts 125a and 126a of all of the cast-offs 126 and 128 outwardly into a recess 175 formed in the inner edge of the cam ring 135.

For rib knitting, in the specific form in which the dial needles are operative as secondary needles, it is contrived to knit upon them in the radial plane y (Figures 6, 7, and 8) following, in the rotation of the machine, the radial plane x at which the cylinder needles N knit. The dial needles are thus supplied with yarn by the runs of yarn lying between the hooks of the cylinder needles, and the rib or back-wales b-3, b-7, b-11, etc. (Figure 19), knit by the dial needles are formed of these runs of yarn.

The transfer cams 165, 166, and 172 are mounted to work through an opening 176 in the dial cap 70, as observed in Figures 3, 4, 5, and 16. The cast-off advancing cam 165 is suitably secured to the lower surface of a vertically movable carrier block 177, as by a screw 178. In this instance, a suitable spacer block 180 of substantially the same configuration as the cast-off advancing cam 165 is provided between the cam 165 and the vertically movable carrier block 177.

The carrier block 177 is slotted to receive an upwardly projecting stem portion 181 integral with the hook throw-out cam 166, this stem portion 181 being fixed in the carrier block 177, as by a screw 182 (Figure 5). The carrier block 177 is normally held elevated by a spring 183 disposed within a cavity 184 in an upwardly projecting or raised portion 177a integral with the carrier block 177. The lower end of the spring engages the upper end of a pin 185 which is slidable positioned within the cavity 184 to permit slight rotation of the carrier block 177 for adjustment thereon (Figure 16). The lower end of the pin 185 has a shoulder 186 integral therewith which bears against the upper surface of the dial cap 70 and the lower end of the pin 185 is threadably imbedded in said dial cap (Figure 16).

The block 177 is mounted for vertical sliding movement on a guide pin 187 fixed at its lower end in a link 186, slotted at 191, as by a screw 191. Rotation of the block 177 on the pin 185 radially adjusts the cams 165, 166, and 172 so far as the opening 176 permits.

The book withdrawing cam 172 has an upwardly projecting stem 193 integral therewith which is mounted for vertical sliding movement in the block 177 and the raised portion 177a thereof, as shown in Figures 5 and 16. The cam 172 is normally urged upwardly to inoperative position by a tension spring 184 connected at its lower end to the upper end of the stem 193 and connected at its upper end to an arm 185 suitably secured to a conventional horizontal bearing portion 196 of the bracket 65 (Figures 1 and 3).

The arm 195 also serves as a stop for a pair of control levers 200 and 201, each of which has an adjustment screw or blunt nut 202 which normally bears against the lower edge of the arm 195. It will be observed in Figures 2 and 4 that the control levers 200 and 201 are oscillatory mounted intermediate their ends, as at 204, in a pivot block 205, the outer or rear end of which is mounted on the shaft 192 and the front end of which is suitably secured, as by a screw 206, to the bracket 65. The abutments 203 on the front end of the levers 200 and 201, are adapted to, at times, be moved downwardly into engagement with the upper edges of respective auxiliary dial cam control levers 210 and 211, respectively.

The outer ends of the auxiliary levers 210 and 211 are pivotally mounted, as at 212, on a substantially L-shaped bracket or angle slip 213 which is also suitably secured to a substantially vertical portion of the bracket 65, as by a screw 215. It will be observed in Figures 1 and 4 that the auxiliary lever 210 is substantially longer than the auxiliary lever 211 and the free ends of the auxiliary levers 210 and 211 are provided with respective downwardly projecting toe portions 216 and 217. The toe portion 210 of the auxiliary lever 210 engages the upper surface of the raised portion 177a of carrier block 177 and is so formed that it will not then engage the upper surface of the stem 193 of the hook withdrawing cam 172.

On the other hand, the toe portion 217 of the auxiliary control lever 211 engages the upper edge of the seat 193 of the hook withdrawing cam 172, but is so formed that it will not engage the upper surface of the raised portion 177a of the carrier block 171. Of course, the upper end of the stem 193 projects substantially above the upper surface of the raised portion 177a of the carrier block 171.

Referring to Figures 2 and 4, it will be observed that the outer or rear ends of the transfer cam control levers 200 and 201 are provided with followers 220 and 221 which are adapted to be engaged, at times, by the upper ends of respective thrust rods or thrust bars 222 and 223 which extend downwardly at the rear of the machine (Figure 2) and, at times, are urged into engagement with the upper surface of the main pattern drum 75 by springs 224, only one of which is shown in Figure 2.

At other times, the lower ends of the thrust rods or bars 222 and 223 are successively engaged and elevated by cams 225 and 226 suitably secured to the periphery of the main pattern drum 75. The cam 226 is provided with stepped surfaces 226a, 226b, and 226c which surfaces 226a and 226b being successively engaged by the lower ends of both of the thrust rods 222 and 223. However, it will be observed in Figure 17 that the surface 226c is of less width than the surfaces 226a and 226b and is engaged only by the lower end of the thrust rod 222, which controls the transfer cams 165 and 166.

The cam 225 is also provided with stepped surfaces 225a, 225b, and 225c which surfaces 225a and 225b are successively engaged by both of the thrust rods 222 and 223 and the surface 225c being engaged only by the thrust rod 222, since the cam surface 225c is offset relative to the surface 225b in the identical manner in which the cam surface 225c is offset relative to the cam surface 225b.

Method of operation

In knitting a stocking such as is exemplified in Figure 16, the selvage is formed in the usual man-
ner of knitting a make-up course, knitting with all of the cylinder needles N, or the x 3 rib may be formed commencing with the make-up course in x x ribbed stock in the elastic top T and the leg L. Thus, it is to be assumed that, upon starting knitting, the main pattern drum 76 is rotated to cause the cam 169 to elevate the thrust rod 155 and the protective cylinder 137 and the dial 63 to rotate, the cam 160 (Figure 2) being set so the knitting cams 141, 142, and 143 are moved downwardly, the short butts 152c and 12b of the dial needles 123 in segment 132 to subsequently be engaged by the long butts 15c and 12c of the dial needles 124 in segment 131 (Figure 3), to thereby cause the long butts 127a and 126c to engage and be actuated by the corresponding knitting cams 141, 142, and 143 in the usual manner of rib knitting.

The first needle jack elevating cam 103 (Figure 8) is also moved into operative position for engaging the butts of the long buts jacks J-2 and the needle cams 106, 116 and 124 are also in operative position. The elastic yarn feed finger 105 and the body yarn feed finger 90 then move into operative position, wherein the needles raised by the jack indicators on the first needle jack elevating cam 103 are caused to take the yarn from the elastic yarn feed finger 105 and are subsequently lowered by the cam 106 as the corresponding jacks 12 are lowered in engagement with the left-hand incline of the inverted V-shaped opening in the cam ring 108.

Thereafter, the jackless cylinder needles remain in a lowered position as the ever-active needles therebetween are raised by the corresponding long-butts and short-butts jacks J-1 and J-2 rising up the second needle jack elevating cam 104. These groups of three needles, elevated by the jacks J-1 and J-2, then pass above the dividing cam 116 and the stitch cam 112 and successively pass beneath the top center cam 118 and the stitch cam 113 to take the body yarn from the body yarn feed finger 90 and to form stitches therewith of k.

In the meantime, the spaced jackless needles, which are every fourth needle in this instance, are elevated by the needle elevating cam 117 in advance of the transfer zone at the radial plane 12c (Figures 6 and 8), and are then directed downwardly by the dividing cam 116 so as to pass beneath the stitch cam 112, the lower or bottom center cam 115 and the stitch cam 113. Thereafter, the dial needles above said jackless cylinder needles form stitches at the radial plane y in the usual manner as set forth in said Patent No. 1,681,010.

Thus, a x 3 ribbed fabric is formed including the rib or back wales b-3, b-7 and b-11 (Figure 19) and the ever-active cylinder needles form the face wales f-1, f-2, f-4, f-8, f-6, etc. (Figure 19). Of course, when the desired number of courses have been knit to form the top T, the cams 106 and 103 and the elastic yarn feed finger 105 are withdrawn from operative position to inoperative position, in a well-known manner, whereupon the long-butts jacks J-2 traverse the same path as the short-butts jacks J-1 to disengage the needle jack elevating cam 103 and, in which instance, the needles above the long-butts jacks remain in lowered position riding adjacent the mean upper surface 120 of the cam ring 108.

However, the jackless needles and the groups of three needles between adjacent jackless needles will be controlled in the identical manner to that heretofore described as they move in the vertical planes of the cams 104, 117 and 116 and the stitch cams to continue the formation of complete circular courses of x 3 ribbed fabric throughout the knitting of the leg L of the stocking shown in Figure 18.

Now, as heretofore stated, there have been no means provided heretofore for rendering half or a segment of the active dial needles inactive while permitting the remaining half or segment of the dial needles to remain active, as in knitting the ring heel courses R3, the heel h, the instep I and sole s, after having knitted complete circular courses of ribbed fabric, as is necessary in order to facilitate the forming of an anti-ravel selavage S when commencing the knitting of a stocking.

During the knitting of a final or last complete course in the leg L of the stocking, a portion of which course is indicated at L-1 in Figure 19, all three of the transfer cams 155, 156 and 172 move into partially operative position as the thrust rods 222 and 223 are successively engaged by the surfaces 225c and 255b on the cam 226. This occurs as the dial needles 123, having the short butts 32a and 12a thereof, are transferred to the transfer cams 155, 156 and 172. Thus, the butt 127a of the leading long-but hook 127 and the long butts 127a of the succeeding long-but hooks 127 are successively engaged and thrust outwardly by the hook advancing or throw-out cam 155 and, thereafter, engage the cams' 156 and 172 as the long butts 125c of the corresponding cast-offs 125 engage and are thrust outwardly by the cast-off advancing or throw-out cam 155. This causes the long-but dial needles 124 including the long-but hooks and cast-offs 127 and 128, to successively occupy the relative positions shown in Figures 13, 14 and 15. Thus, the long-but dial needles 122 retain the stitches in the hooks 127 thereof.

However, after the hooks and cast-offs 127 and 128, having the respective long buts 127a and 125a thereof, have started moving past the transfer cams 166, 165 and 172, the surface 225c of the cam 225 moves into engagement with the lower end of thrust rod 222 (Figures 2 and 4) to further elevate the same and to thereby cause the auxiliary transfer cam control lever 210 to simultaneously move the hook advancing or throw-out cam 155 and the cast-off advancing cam downwardly to fully operative position while the hook withdrawing cam 172 remains in the original partially operative position, since the surface 225d extends past the surface 225c (Figures 2 and 17) in the vertical plane of the thrust rod 223.

Thus, the relatively short butts 125a on the hooks 125, following the long-but hooks 127, successively engage the inner surfaces of the portions 167, 171 and 174 of the cast-off advancing cam 165 as these short butts 125a pass between the auxiliary hook withdrawing cam 172. This is an extremely important feature of the present invention, since the hooks 125 and cast-offs 126, having the respective short butts 125a and 126a thereon will successively occupy the relative positions shown in Figures 10 to 12, inclusive, to thereby pass the first short-pass segment 130 of dial needles 123 to the corresponding jackless cylinder needles N at the radial plane 12c (Figures 6 and 8).

In other words, the hooks 125 and cast-offs 126 are in their idle position as shown in Figure 10 as the short butts 125a and 126a thereon move
As the dial needles 123 continue to move in a counterclockwise direction past the separator cam 140 in Figure 6, the short-butt hooks 125 are successively advanced or moved outwardly as the short butts 125a engage the hook advancing transfer cam 165. This causes the short-butt hooks 125 to move outwardly to substantially the position shown in Figure 11, relative to the dial 70, while the cast-offs 126 remain in the position shown in Figure 10 relative to the dial 70, in which position the last previous dial loop d-1 (Figure 11) will have slipped up upon the shaft of the hook 125 and, thus, will be in position to be entered from within and lifted by the point p-1 of the corresponding cast-off 126 as the short-butt cast-offs 126 are moved outwardly or advanced relative to the hooks 125 and as the parts 125 and 126 of the short-butt dial needles 123 reach the radial plane at Ia in Figure 8 (Figure 11).

As the short-butt dial needles 123 reach the radial plane Ia, the corresponding dial loop d-1 on each of these dial needles is cast off of the hooks as the hooks are withdrawn, due to the short butts 125a of the hooks 125 moving in engagement with the inner surface of the heel portion 174 of the cast-off advancing cam 165. At this time, the short-butt cast-offs 126 are moved outwardly or advanced substantially beyond the outer ends of the corresponding hooks 125 as the butts thereof move in engagement with the outer surface of the heel portion 174 of the cast-off advancing cam 165.

As the loops are cast off of the short-butt hooks 125 by the points p-1 of the short-butt cast-offs 126, the short-butt jackless cylinder needles, which are being elevated by the cam 117, occupy the position shown in Figure 12 at the radial plane Ia in Figures 6 and 8. Thereafter, the cam ring surface 175 engages the butt 125a of the short-butt hook 125 causing the short-butt needles 123 to move inwardly to occupy the position shown in Figure 13, upon approaching the radial plane indicated at I3a in Figure 8.

It will be noted that the short-butt jackless cylinder needles N corresponding to each of the dial hooks 125, from which the loops have been cast by the cast-offs 126, are then in a raised position such that the cast-off loops d-1 are taken in the hooks of the corresponding short-butt jackless cylinder needles. Thus, the stitches or loops carried by the short-butt dial needles 123 in the group or segment 130 are transferred to the corresponding short-butt jackless cylinder needles N while the long-butt dial needles 124 in the group or segment 131 remain active during the knitting of the instep course of the stocking shown in Figure 16. Of course, since the short-butt jackless cylinder needles N which have taken the loops from the short-butt group I30 of dial needles 123 must form face-wale stitches in each succeeding course in the ring heel Rh, the heel h and the sole s, the dividing cam 116 is partially withdrawn to inoperative position so that the needle cases 112 of the short top center cam 114 to take the yarn from the body yarn feed finger 90 and to subsequently form stitches therewith as the butt thereof pass beneath the stitch cam 113 at the radial plane k.

Of course, the long-butt jackless cylinder needles N may ride up the stitch cam 112 or may ride up the stitch cam 113 which is the same as the short top center cam 114 to take the yarn from the body yarn feed finger 90 and to subsequently form stitches therewith as the butt thereof pass beneath the stitch cam 113 at the radial plane k. However, the needle dividing cam 116 is fully withdrawn from operative position along with the needle cases 112 and 114, during the knitting of the heel h so that all of the short-butt needles pass through the stitch cams upon each reciprocatory stroke of the needle cylinder, it be-

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ing understood that the number of active short-butt cylinder needles N are reduced from course to course by the usual narrowing pickets, not shown, in the narrowing at the heel h, and, thereafter, the usual widening picker, not shown, functions to again gradually increase the number of active short-butt needles to complete the knitting of the heel h.

The sole s and the instep I are formed in the identical manner in which the ring heel R is formed. To this end, the needle cams 111 and 121 return to fully operative positions as the dividing cam 116 returns to partially operative position to again engage and lower the long-butt jackless cylinder needles N so they pass beneath the stitch cams 112 and 113 in forming the instep I. The remaining or short-butt jackless cylinder needles are permitted to pass above the stitch cam 112 and at this time the cam 162 (Figure 2) moves into engagement with the lower end of the thrust rod 156 to move the dial knitting cams 141, 142 and 143 into partially operative position to again engage the long-butt dial needles 124. The transfer cams 165, 166 and 172 remain in raised or inoperative position during the knitting of the instep I and sole s.

Upon completion of the knitting of the instep I, it is necessary to commence knitting on all of the cylinder needles N, including all of the jackless cylinder needles to knit the ring toe Rt in Figure 18. To this end, the dial knitting cams 141, 142 and 143 are first permitted to move to inoperative position due to the cam 152 (Figure 2) moving out of engagement with the lower end of the thrust rod 156. Secondly, the transfer cams 165 and 166 move into partially operative positions, above the short-butt dial needles 123, to engage the long-butt dial needles 124 and the hook withdrawing cam 172 is lowered only slightly so that it does not engage either the long-butt or short-butt dial needles 123 or 124. This is caused by the surfaces 228a, 229b successively moving into engagement with the lower ends of the thrust rods or bars 222 and 223 and, thereafter, the surface 229c moves into engagement with the lower end of the thrust rod 223 to move the cam-off advancing cam 155 and the hook advancing cam 156 to where they will successively be engaged by the long-butts 127a and 128b of the respective hooks 127 and cast-offs 125. This causes the long-butt hooks and cast-offs 127 and 128 to successively assume the successive positions in which the short-butt hooks and cast-offs 125 and 126 are shown in Figures 10, 11 and 12.

This causes the loops to be cast off of the long-butt hooks 127 having the long-butt 127b thereon at the radial plane 12a in Figures 6 and 8, since the jackless long-butt needles will be elevated by the cam 117. Thus, the loops cast off of the long-butt hooks 127 will be transferred to the corresponding long-butt cylinder needles at the radial plane 12a in Figures 6 and 8. Thereafter, the dividing cam 116 will lower the jackless dial needles so that they pass beneath the stitch cams 112 and 113 during the transfer course at the juncture of the instep I and the ring toe Rt.

In the knitting of the next succeeding course following the knitting of the transfer course, the cam dividers 117 and 121 (Figure 6) are withdrawn to fully inoperative position so that all of the long and short-butt needles, including the jackless needles, successively pass above the stitch cam 112, between the top and bottom center cams 114 and 115 and beneath the stitch cam 113 to form plain stitches in the ring toe Rt. After a few plain courses have been knitted, the cam 226b, at the heel h, and, thereafter, the usual widening picker, not shown, in the narrowing at the toe t, is engaged to again gradually reduce the number of active short-butt needles, including the jackless needles, successively pass above the stitch cam 112, between the top and bottom center cams 114 and 115 and beneath the stitch cam 113 to form plain stitches in the ring toe Rt.

In order to knit ribbed fabrics in accordance with the principles of the present invention, latch-type dial needles may be used equally as effectively as the hook and cast-off type dial needles heretofore described. However, since the latch-type dial needles each have a single butt thereon, the dial needles are necessarily arranged somewhat differently to accommodate the latch-type needles. The modifications necessary in the original form of the invention to accommodate the latch-type dial needles are illustrated in Figures 20 to 25, inclusive. Since the means for supporting the dial needles and the dial cams and the means for controlling the dial cams and the dial needles and cylinder needles are the same in both forms of the invention, the same reference characters will apply to identical parts in both forms of the invention. Additional reference characters will be applied to certain parts of the modified form of the invention which differ from the original form of the invention.

As is the case in the original form of the invention, the latch-type dial needles are inserted into segments of substantially half long-butt latch needles, each of which is broadly designated at 250 and the remaining latch needles are short-butt latch needles each of which is broadly designated at 251 (Figures 21 and 20). The latch-type dial needle segments are mounted in the usual radially extending grooves in the upper surface of the dial 63 in lieu of the hook and cast-off dial needles. All of the latch-type dial needle segments 250 and 251 are each provided with a hook portion 252 at the outer end thereof and a pivot pin 253 which, at times, occupies the closed position against the hook 252 as shown in Figure 21 and, at other times, the latches are swung or pivoted inwardly to open position as shown in Figures 22 and 23. The long-butt and short-butt dial needle segments 250 and 251 differ in that each of the long-butt dial needle segments 250 is provided with a long-butt 250a and each of the short-butt dial needle segment 251 is provided with a relatively short butt 251c.

In order to accommodate the latch-type dial needles, the dial cap, indicated at 170 in the modified form of the invention, carries a pair of outer cam ring segments 255 and 256 spaced from each other at one end thereof to accommodate a needle withdrawing knitting cam 231, a portion of which projects inwardly substantially beyond the circular plane at the outer surface of the cam ring segment 255 and against which one end of an auxiliary outer cam ring segment 250 is positioned. The outer surface of the auxiliary outer cam ring segment 250 bears
against the inner surface of the outer cam ring segment 256. It will be noted that the inner surface of the knitting cam 261 is cut away at its juncture with the cam ring segment 255 to form a recess in which a needle advancing knitting cam 261 is disposed. The needle advancing cam 261 is vertically movable to operate in the same manner in which the knitting cams 141, 142 and 143 are employed in the original form of the invention. A stationary inner cam ring 262 is concentrically positioned on the dial cam cap 270 in the modified form of the invention and, thus, the outer cam ring segment 255 and the auxiliary outer cam ring segment 256 define the outer wall of a concentric groove 263, the inner wall of which is defined by the periphery of the stationary inner cam ring 262. It will be noted that the inner cam ring is provided with recesses or notches 264 and 265 at the outer edge thereof coinciding with the innermost portions of the respective knitting cams 257 and 261. The knitting cams 257 and 261 operate upon all of the latch needles 256 and 251 in the usual manner to cause the same to form rib stitches from the yarn at the radial plane y in Figure 20, which radial plane coincides with the radial plane of the same reference character in Figures 6 and 7.

It will be observed in Figure 34 that the dial cap 270 is provided with an opening 281 which corresponds substantially to the opening 144 in the dial cap 70 when used to accommodate the original form of the invention as shown in Figure 4, since the needle withdrawing stitch cam 281 may remain stationary and the needle advancing knitting cam 281 is movable from an operative position to first and second operative positions and vice versa, as indicated by the cams 169, 101 and 162 in Figure 2.

The vertically movable knitting cam 261 extends through said opening 261 and is suitably secured on a carrier block 270 (Figure 24) which block 270 has holes guided on vertical pins 271 and 272 on the dial cap 76. The carrier block 270 is normally urged upwardly in the identical manner to that of the carrier block 145 of the original form of the invention and wherein a suitable spring, not shown, normally urges a housing 273 integral with the carrier block 270 upwardly against the lower surface of the inner end of the conventional lever 151, the lever 151 being mounted and controlled in the identical manner in both forms of the invention.

Now, in order to transfer the stitches from one segment of the short-butt dial latch needles 251 to the corresponding jackless needles (Figure 6), which segment of needles may include substantially half the latch-type dial needles, so as to knit the ring heel courses 8th of the stocking shown in Figure 10, there is provided in the groove 263 a group of stitch transfer dial cams (Figure 20) which are peculiar to the modified form of the invention. The stitch transfer cams comprise a vertically movable first needle advancing or throw-out cam 271, a vertically movable latch dial needle advancing or throw-out cam 271 and a stationary or second latch dial needle advancing or throw-out cam 271. A recess 270 in ring 263 accommodates one end of transfer cam 275.

The proximal portions of the ends of the cam ring segments 255, 256 and the auxiliary cam ring segment 258, remote from the ends between which the knitting cams 281 and 261 are disposed, are cut away to form a recess 280 in which the transfer cams 275, 276 and 271 are disposed. The second or stationary needle advancing cam 271, which may also be termed as a dividing cam, is suitably secured to the lower surface of the cap 70. However, the needle advancing cam 271 is vertically movable independently of the needle withdrawing cam 275 and steps into fully operative position in the same manner in which the cams 165 and 166 of the original form of the invention step into operative position. On the other hand, the needle withdrawing transfer cam 275 is vertically movable relative to the cam 271 to move into operative position a lesser distance than the cam 271 in a manner similar to the cam 172 of the original form of the invention.

The transfer cams 275 and 276 are mounted to work through an opening 281 in the dial cap 70 which opening corresponds substantially with the opening 176 (Figure 5) in the dial cap 70 of the original form of the invention. However, the opening 281 is somewhat smaller than the opening 176 since the cam 271 remains stationary and, obviously, does not work through the opening 281. The latch needle advancing transfer cam 275 extends upwardly through said opening 281 and is fixed on a carrier block 282 which is normally held elevated by a spring 284 (Figures 24 and 25) disposed within a cavity 285 in the carrier block 282. The carrier block 282 is mounted for vertical movement on pins 286 projecting upwardly from the upper surface of the dial cap 70.

The lower end of the spring 284 (Figure 25) engages the upper end of a guide pin 286 which is slidably positioned within the cavity 285 to permit vertical movement of said carrier block 282 relative to the pin 286. As in the original form of the invention, the lower end of the pin 285 has a shoulder 287 integral therewith which bears against the upper surface of the dial cap 70 and the lower end of the pin 286 is threadably embedded in said dial cap 70.

Hereinafter stated, the needle withdrawing transfer cam 275 is constructed and operated in a manner similar to the hook withdrawing cam 172 of the original form of the invention and is provided with an upwardly projecting stem 290 integral therewith which is mounted for vertical sliding movement in the block 283. The cam 276 is normally urged upwardly in inoperative position by the tension spring 184 hereinafter described.

In the form of the invention shown in Figures 24 and 25, the upper surface of the carrier block 283 is engaged by the toe portion 216 of the auxiliary lever 210 and the upper surface or edge of the stem 290 of the needle withdrawing transfer cam 275 is engaged by the toe portion 217 of the auxiliary lever 211. Of course, the auxiliary levers 210 and 211 are controlled in the identical manner in both forms of the invention and the cams on the main cam drum 75 (Figure 2) are arranged in the same manner for controlling the operation of both forms of the invention.

The radial planes indicated at letters y and k in Figure 20 correspond to these same radial planes of the cylinder needles in Figure 6. The radial plane 21a in Figure 20 corresponds to the radial plane 10a in Figures 6 and 8 and also corresponds to Figure 21. The relative positions of the dial needles and the cylinder needles in Figures 22 and 23 correspond to the radial planes 22a and 23a in Figure 20 and the radial plane 22a (Figure 20) also corresponds to the radial plane 22a in Figure 6, insofar as the cylinder needles are concerned.
The knitting cams 251 and 251a and the transfer cams 275 and 277 control the operation of the latch-type dial needles 250 and 251 in substantially the same manner in which the knitting cams and transfer cams of the original form of the invention (Figures 7 and 8) control the hook and cast-off type dial needles. Of course, during normal 1 x 1 rib knitting, the knitting cam 261 occupies fully operative position to direct all of the needles outwardly as they move in a counterclockwise direction in Figure 20 and, thereafter, these needles are directed inwardly to form stitches therewith at the radial plane y.

Now, as in the original form of the invention, the half or segment of the long-butt latch dial needles 250 remain active while the remaining or short-butt latch dial needles 251 are controlled to transfer the stitches thereto from the corresponding jackless needles in knitting the ring heel courses xh. During the knitting of the final or last complete rib course in the leg of the stocking L, both the needle advancing transfer cam 275 and the needle withdrawing transfer cam 276 move downwardly to partially operative position above the butts 251a of the segment of short-butt needles 251.

Thus, the butt 250a of the leading long-butt latch needle 250, and the long butts of all of the succeeding long-butt latch needles 250, are successively engaged and thrust outwardly by the latch needle advancing cam 275 and, thereafter, engage the cam 275a, thus moving the long-butt dial needles 250 inwardly before the loop carried thereby has reached the free end of the latch 253 of each of the corresponding dial needles 250. Thus, the long butt latch-type dial needles 250 retain the stitches in the hooks 252 thereof.

However, after the long butt latch-type dial needles 250 have started moving past the transfer cams 275 and 277, the dial needle advancing or throw-out cam 275 is moved downwardly to fully operative position while the dial needle withdrawing cam 276 remains in its original partially operative position. Thus, the relatively short butts 251a on the short-butt latch-type dial needles 251, following the long-butt latch-type dial needles 250, successively engage, and are thrust outwardly by the needle advancing or throw-out cam 275. However, the withdrawing cam 277 is disposed in the path of the long butts 250a only and, therefore, the short butts 251a will pass beneath the cam 270 and will then be advanced outwardly to substantially the position shown in Figure 23.

It will be noted that this causes the loops carried by the short-butt latch-type dial needles 251 to slide over the free ends of the latches 253 at the radial plane z in Figure 6 and at the radial plane a in Figure 20, whereupon the short-butt latch-type dial needles 251 will again be thrust inwardly to idle position to commence another ring segment of latch-type dial needles elevated by cam 117 in Figure 6.

The knitting cam 251 again returns to operative position and, again, the segment of long-butt dial needles 250 continues knitting while the segment of short-butt dial needles 251 remains inactive for knitting the plain sole s and the ribbed instep i.

Upon completion of the knitting of the instep i and the sole s, it is necessary to commence knitting on all of the cylinder needles N as heretofore described in the original form of the invention.

To this end, the dial knitting cam 251 is first permitted to move to operative position and, secondly, the transfer cams 275 and 276 again move into partially operative position above the short-butt latch-type dial needles 251, and then a segment of the dial needles may be rendered inoperative and, thereafter, all of the dial needles may be rendered inactive for knitting the plain sole s and the ribbed instep i.

This causes the long-butt latch-type dial needles 250 to successively assume the successive positions shown in Figures 21, 22 and 23, since the long butts 250a on the long-butt latch-type dial needles 250 will then be thrown outwardly by the cam 275, will pass beneath the cam 270 and again be thrown outwardly by the stationary transfer cam 277 to cause the loops to be pressed off of the long-butt latch dial needles 250 as they subsequently are moved inwardly by the ring segment 252 to idle position. Since the corresponding jackless needles will be elevated at the time that the loops are cast from the long-butt latch dial needles 250, the loops will be transferred to the corresponding long-butt jackless cylinder needles adjacent the radial plane 12α in Figure 6 which corresponds to the radial plane 23α in Figure 20. The stitches will then have been cast off all of the latch dial needles 250 and 251 and the ring toe Rt (Figure 18) will then be formed in the usual manner of plain knitting.

Although the function of the cylinder needles shown in Figure 6 has not been described in detail with respect to the latch dial needles 250 and 251, the cylinder needles function in exactly the same manner when used in association with either form of the invention and it is therefore believed that a repetitive description thereof is unnecessary.

It is thus seen that I have provided means for knitting hosiery or any ribbed fabric which facilitates the formation of a selvage or make-up or setting-up course, upon knitting each successive stocking, at the top of the stocking and, thereafter, rendering half or a segment of the dial needles inactive while the remaining dial needles remain active regardless of whether the latch-type dial needles are employed or the hook and cast-off type of dial needles are employed. Also, after a number of courses have been knitted wherein half of the stocking or fabric is formed as ribbed fabric and the other half thereof is formed of plain fabric in successive courses, the remaining active dial needles can then be rendered inactive to facilitate the knitting of plain knit fabric, such as in the ring toe of a stocking.

Of primary importance is the fact that it is possible to knit a fabric wherein an anti-ravel selvage may be knitted on the fabric prior to knitting the article and then a segment of the dial needles may be rendered inactive and, thereafter, all of the dial needles may be ren-
dered inactive while complementary cylinder needles are rendered active to knit in the wales previously formed by the formerly active dial needles.

In the drawings and specification, there have been set forth preferred embodiments of the invention and although specific terms are employed, they are used in a descriptive and generic sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

1. In a circular rib knitting machine having independent cylinder and dial needles, said dial needles each including a hook and a cast-off movable relative to each other, the hooks and cast-offs of a first segment of said dial needles being provided with long butts and the hook butts and cast-offs of a second segment of the dial needles being provided with short butts; the combination of a set of transfer cams including a hook advancing cam adapted to engage the long butt and short butt hooks in advance of the transfer point, a hook withdrawing cam spaced between the hook advancing cam and the transfer point and being adapted to engage the long butt hooks only to withdraw the same in advance of the transfer point, a cast-off advancing cam having a radially enlarged heel portion thereof at the transfer point and a relatively narrow toe portion thereof, said toe portion having a notch formed therein in which a portion of the hook withdrawing cam is positioned, an arcuate separating cam having a substantial portion thereof disposed in advance of the hook advancing cam and being adapted to engage the proximal edges of the butts on the hooks and cast-offs for maintaining the latter in fixed relationship radially of each other in advance of their approaching the hook advancing cam, and the proximal portions of the separating cam and the toe portion of the cast-off advancing cam being disposed in close proximity to each other to thereby insure proper relationship of each cast-off and its corresponding hook in advance of, and while passing, the transfer cams.

2. In a circular knitting machine having a dial mechanism including a dial cap, an outer cam ring and an inner cam ring on said dial cap and forming a broad substantially concentric groove therebetween, a set of knitting cams disposed in said groove, a set of transfer cams disposed in said groove and being circularly spaced from said set of knitting cams, a plurality of high butt cast-offs and corresponding high butt hooks, a plurality of low butt cast-offs and corresponding low butt hooks, said set of transfer cams including a hook advancing cam spaced in advance of the stitch transfer point of the dial mechanism, a hook withdrawing cam spaced between said transfer point and the hook advancing cam, and a cast-off advancing cam; the combination of a toe portion integral with said cast-off advancing cam and being disposed in a radial plane between the proximal portions of the hook advancing cam and the hook withdrawing cam whereby said toe portion insures proper alinement of the butts of the hooks with the hook withdrawing cam after they have been advanced by the hook advancing cam.

3. In a circular knitting machine having a dial mechanism including a dial cap, an outer cam ring and an inner cam ring on said dial cap and forming a broad substantially concentric groove therebetween, a set of knitting cams disposed in said groove, a set of transfer cams disposed in said groove and being circularly spaced from said set of knitting cams, a plurality of high butt cast-offs and corresponding high butt hooks, a plurality of low butt cast-offs and corresponding low butt hooks, said set of transfer cams including a hook advancing cam spaced in advance of the stitch transfer point of the dial mechanism, a hook withdrawing cam spaced between said transfer point and the hook advancing cam, and a cast-off advancing cam; the combination of a toe portion integral with said cast-off advancing cam and being disposed in a radial plane between the proximal portions of the hook advancing cam and the hook withdrawing cam, a segmental butt separating cam mounted in said groove and having one end thereof disposed in close proximity to the toe portion of said cast-off advancing cam and having its other end disposed adjacent the set of knitting cams, the inner and outer surfaces of the segmental butt separating cam being spaced from the proximal surfaces of the outer and inner cam rings to thereby form grooves through which the butts of the hooks and cast-offs pass in their course between the set of knitting cams and the set of transfer cams to thereby maintain the hooks and cast-offs in proper relationship radially of the dial mechanism, and whereby said toe portion insures proper alinement of the butts of the hooks with the hook withdrawing cam after they have been advanced by the hook advancing cam.

References Cited In the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>2,191,378</td>
<td>Getaz</td>
<td>Feb. 20, 1940</td>
</tr>
<tr>
<td>2,191,389</td>
<td>Hill</td>
<td>Feb. 20, 1940</td>
</tr>
<tr>
<td>2,316,832</td>
<td>Thurston et al</td>
<td>Apr. 20, 1943</td>
</tr>
</tbody>
</table>