

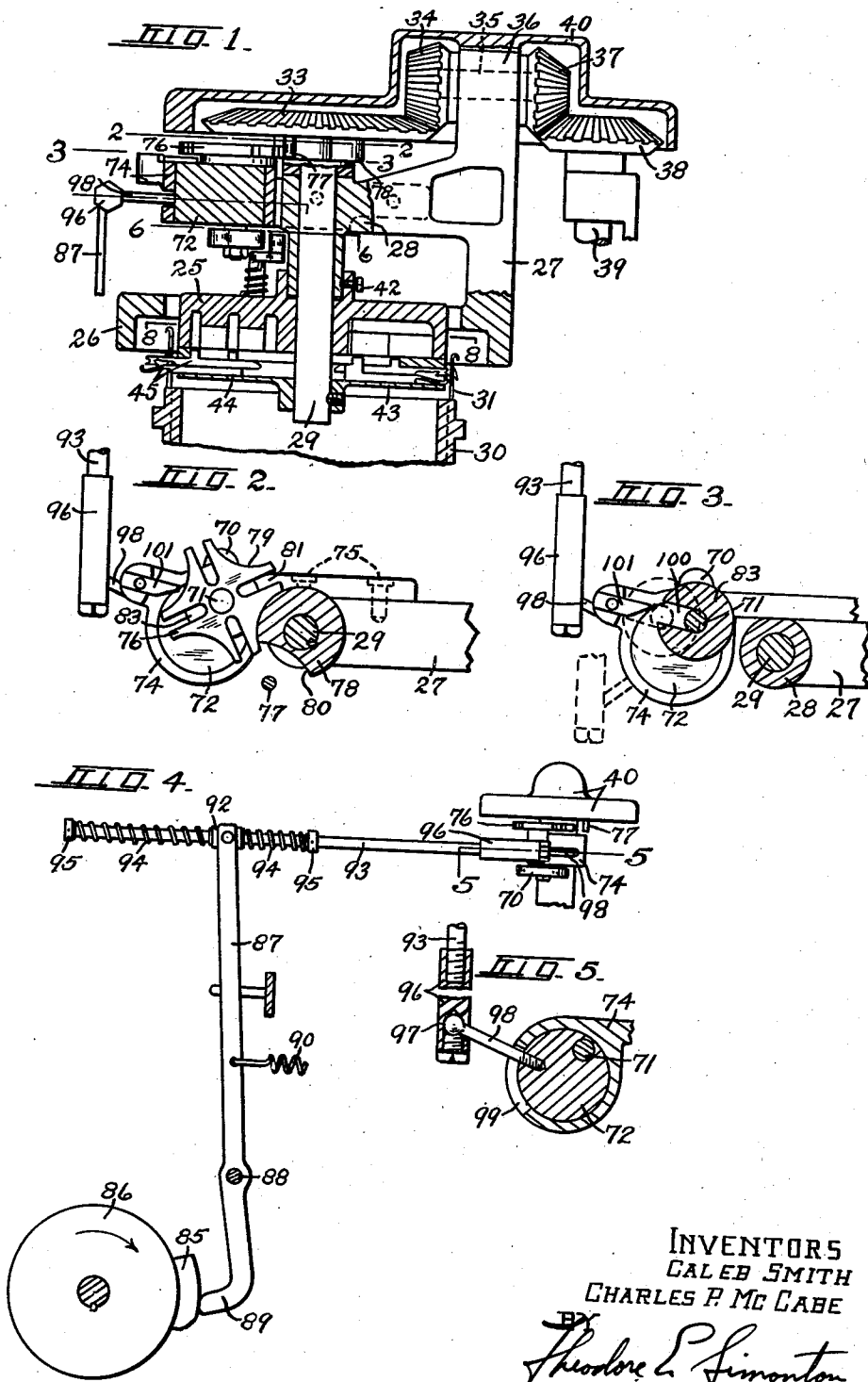
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C. SMITH ET AL
CIRCULAR KNITTING MACHINE

2,250,658

Filed Dec. 31, 1938

3 Sheets-Sheet 1



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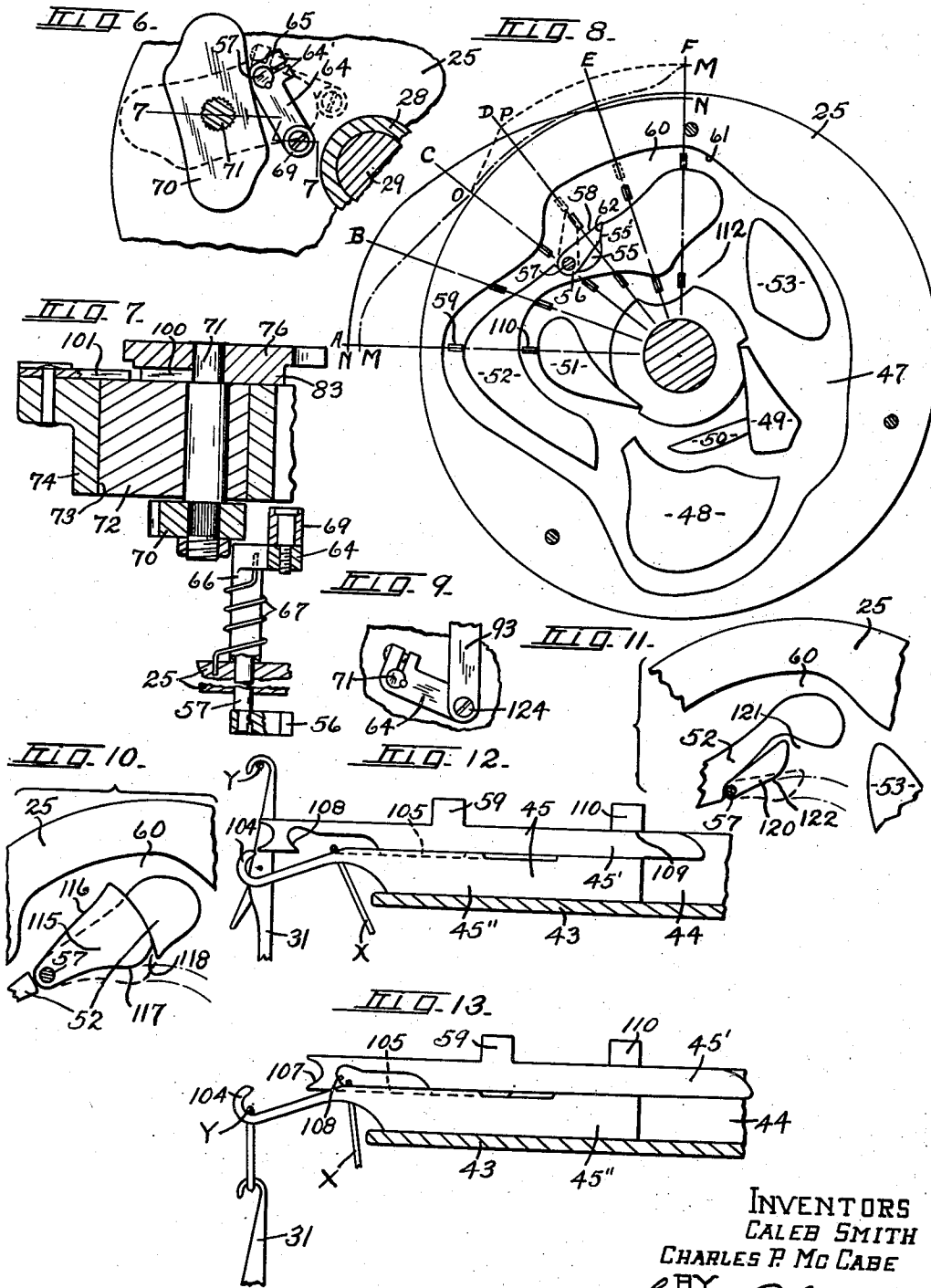
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3 Sheets-Sheet 2



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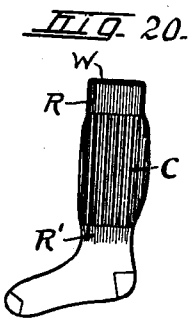
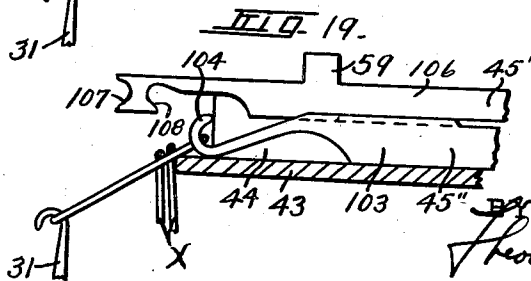
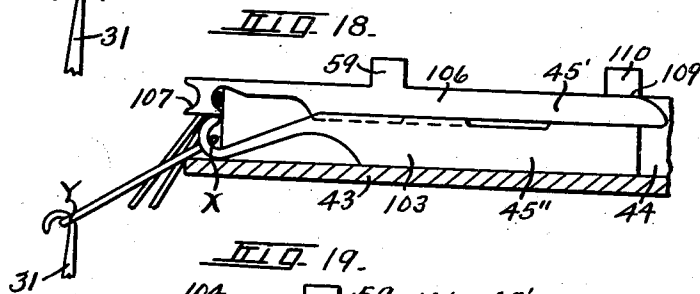
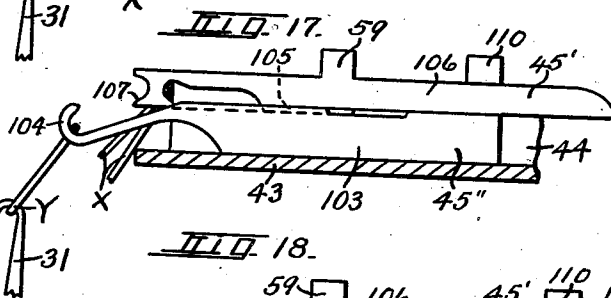
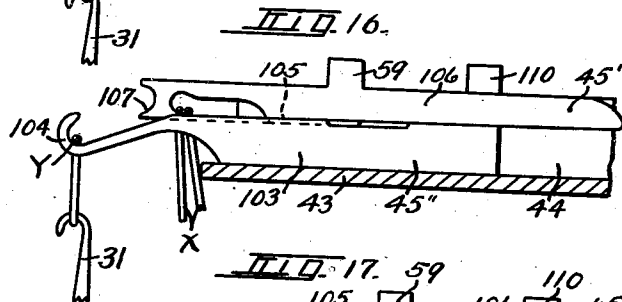
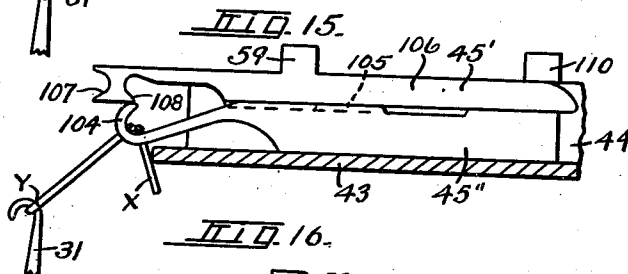
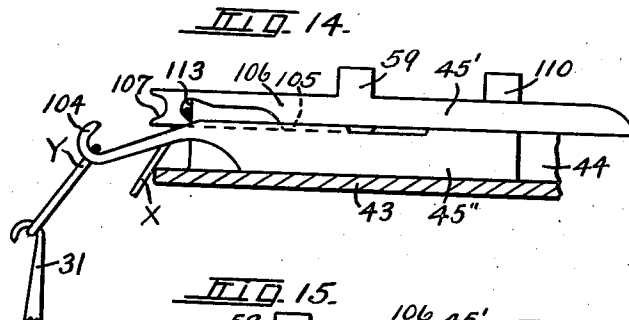
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,250,658

CIRCULAR KNITTING MACHINE

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Application December 31, 1938, Serial No. 248,685

19 Claims. (Cl. 66—13)

This invention relates to improvements in knitting machines of the circular type adapted to knit articles of hosiery or the like containing both ribbed fabric and plain fabric portions.

The invention pertains more particularly to that class of knitting machines adapted to knit long-legged or boot socks, the leg and foot including the heel and toe portions, thereon in one continuous operation and which embodies two sets of knitting needles, a vertical or cylindrical set and a horizontal or dial set. One of the sets of needles, usually the dial set, has each needle thereof of the type composed of two separate members, a body or hook member and a latch or cast-off member mounted in sliding engagement with each other.

Insofar as applicants are aware, knitting machines of the above mentioned class have not generally been used heretofore to knit boot socks or the like having plain fabric, plain ribbed fabric and half cardigan ribbed fabric portions in one continuous operation. Socks comprising these different knitted portions have usually had the ribbed fabric or leg portion knit on one machine and the plain fabric or foot portion knit on another machine. This has necessitated the transfer of the first knitted portion from one machine to the second machine which is usually accomplished with the aid of a transfer ring. When thus transferring a partially knitted portion, as the foot of a sock, from one machine to another, the foot portion extending above the heel often varies in width or length due to the quills of the transfer ring not always being engaged with the same course of stitches. This not only results in the finished socks having legs of different lengths but causes waste of yarn by the operator ravelling the portion of the previously knitted fabric which extends above the stitches engaged by the transfer quill.

It will be understood that various batches of yarn, although dyed substantially the same color, will vary somewhat in shade one from the other. The first formed sock portions are knitted in large quantities before finishing the second portions and if there is not enough yarn of a given batch remaining after the first portions have been knitted to finish the second portion of the socks, it is necessary for the operator to delay finishing these partly knitted portions until such time as he is enabled to find a batch of yarn which corresponds in shade substantially to that of the yarn of the first knitted sock portions. This has resulted in much time and effort being consumed in estimating the correct number of

sock portions to be knit on the first machine from a given batch of yarn in order to consume the remainder of the batch of yarn when knitting the remaining portion of the socks on the second machine.

The main object of this invention is to provide a machine employing two-part needles of the above mentioned class for knitting socks comprising plain fabric and plain ribbed fabric with means whereby the sock may be formed with a half cardigan ribbed fabric portion in addition to the other two portions.

Another object of the invention is to provide a device for producing a half cardigan ribbed fabric on a knitting machine for knitting boot socks or the like which is adapted to be used either on a two-feed or a single feed machine.

A further object of the invention is to provide a circular knitting machine for knitting a plain fabric, a plain ribbed fabric and a half cardigan ribbed fabric in one continuous operation which is simple, automatic and positive in operation and which may be economically and durably constructed.

Other objects and advantages pertaining to the form of the structure and relation of the parts thereof will more fully appear from the following description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a detail vertical sectional view, partly in elevation, through the dial needles and the associated drive mechanism therefor of a circular knitting machine embodying the various features of this invention.

Figures 2 and 3 are detail horizontal sectional views taken substantially on lines 2—2 and 3—3, respectively, of Figure 1, illustrating an intermittent drive for a dial needle switch cam.

Figure 4 is a side elevation of the structure shown in Figure 1, illustrating on a reduced scale more or less diagrammatically the manner of automatically moving the intermittent drive into and out of operation.

Figure 5 is a detail horizontal sectional view taken on line 5—5, Figure 4.

Figure 6 is a detail horizontal sectional view taken on line 6—6, Figure 1, illustrating the arm for operating the needle switch cam and a double cam for operating said arm in elevation.

Figure 7 is a detail vertical sectional view taken substantially in the plane of the line 7—7, Figure 6.

Figure 8 is a horizontal sectional view taken substantially on line 8—8, Figure 1, illustrating

the dial cam carrier or housing and the needle cams associated therewith.

Figure 9 is a detail plan view illustrating the arm for actuating the needle switch cam of this invention directly connected with a drive therefor whereby my novel invention is adapted to be used more particularly with a two-feed knitting machine.

Figure 10 is a detail plan view illustrating more or less diagrammatically a modified form of my novel needle switch cam which may be used to produce a half cardigan ribbed fabric.

Figure 11 is a detail plan view similar to Figure 10 illustrating a still further modified form of my novel needle cam.

Figures 12 to 19, inclusive, are enlarged vertical radial sectional views illustrating various positions of the respective needles during the operation thereof for producing a half cardigan ribbed fabric, said views being taken on Figure 8 as follows: Figure 12 on line A, Figures 13 and 16 on line B, Figures 14 and 17 on line C, Figure 15 on line D, Figure 18 on line E and Figure 19 on line F.

Figure 20 is an elevation of a boot sock knit in accordance with this invention.

The structure shown in the drawings, with the exception of that illustrated in Figure 9, is adapted more particularly for a single feed circular knitting machine of a well-known type for knitting articles of hosiery containing both ribbed fabric and plain fabric portions in one continuous operation such as that disclosed in Patent No. 1,641,101, issued August 30, 1927, to R. W. Scott and which employs a dial set of needles constructed of two parts substantially as disclosed in Patent No. 1,483,009, issued to A. E. Page February 5, 1924, or Patent No. 1,583,233 issued November 24, 1925, to R. W. Scott.

In other words, our improvement for knitting machines pertains more particularly to a circular hosiery knitting machine employing a cylinder set of needles of the conventional swinging latch type and a dial set of needles of the two-part type, a loop drawing part having a hook provided at one end and a latch or cast-off part provided with a pair of opposed return bent hooks mounted in sliding engagement with the first mentioned part. Knitting machines of this type, as disclosed in the patents above referred to, have heretofore been used for continuously knitting hosiery comprising both plain fabric and plain ribbed fabric in one continuous operation. However, these knitting machines have not been adapted to knit an article of hosiery containing a half cardigan ribbed fabric portion in addition to the plain fabric and plain ribbed fabric portions. When it has heretofore been desired to knit an article of hosiery of this latter type, it has been necessary to knit the foot portion of the article which is composed of plain fabric on one machine and the leg portion of the article which comprises plain ribbed fabric and half cardigan ribbed fabric on another knitting machine, as hereinbefore stated.

Applicants have, therefore, provided a simply constructed cam member which is associated with the usual cam elements of the dial set of needles for producing such relative movements of the hook and cast-off members of the two-part dial needles, and means for automatically operating said cam element that two loops will be formed on each operative dial needle in a single feed knitting machine and then simultaneously cast off the loops during succeeding revo-

lutions of the needles. In other words, we have constructed a simple attachment means for the dial needles of a circular knitting machine of the above mentioned class wherein cardigan stitches are formed on the dial needles and plain stitches are simultaneously formed on the cylinder needles cooperating with the dial needles to produce a half cardigan ribbed fabric.

The construction of the cylinder needles and the mechanism for operating said needles in conjunction with the dial set of needles may be of any well-known conventional form such as that disclosed in the hereinbefore mentioned Patent No. 1,641,101 and, inasmuch as this portion of the mechanism does not comprise any part of the instant invention, it is believed unnecessary to illustrate or specifically describe the cylinder needles or the mechanism for operating the same other than that which is shown in Figure 1 and illustrated more or less diagrammatically in Figures 12 to 19, inclusive, of the drawings.

In Figures 1 to 8, inclusive, we have illustrated a dial set of needles of the two-part sliding type and means for operating the same to produce alternate courses of plain stitches and half cardigan or tuck stitches on a circular knitting machine of the single feed type.

In the machine shown, the needle carriers rotate and the cams are relatively fixed, as illustrated in Figure 1 of the drawings. In this structure the dial cam housing or carrier, as 25, is positioned within a latch guard 26 mounted upon the frame (not shown) of the machine. The latch guard 26, as illustrated, is connected to a supporting bracket 27 having a bearing 28 in which is rotatably mounted a vertically disposed dial spindle 29 arranged to be in concentric relation with a cylinder, indicated at 30, for supporting cylinder needles 31.

The dial spindle 29 extends a short distance above the bearing 28 and has secured thereto a gear 33 which is in meshing engagement with a pinion 34 mounted on one end of the stub shaft 35 journaled in a bearing 36 connected with the bracket 27. The other end of the stub shaft 35 has secured thereto a pinion 37 which is in meshing engagement with a corresponding gear 38 provided on the upper end of a vertically disposed drive shaft 39 which may be rotated in unison with the cylinder 30 by any suitable mechanism such as that indicated in the hereinbefore mentioned Patent No. 1,641,101.

A suitable gear housing 40 may, as indicated in Figure 1, be connected with the bracket 27 for enclosing the gears 33, 34, 37 and 38. The cam housing 25 rotatably receives the dial spindle 29 therethrough and is removably secured to the bracket 27, as illustrated at 42, Figure 1, so as to remain stationary during rotation of the spindle.

Fixedly mounted upon the spindle 29 beneath the cam housing 25 is a dial 43 provided with radial grooves, as 44, for receiving the dial needles 45. There are at least as many of the grooves 44 in the dial 43 as there are occasionally idle needles 31 in the cylinder 30. During rib knitting the idle cylinder needles are withdrawn in the usual manner due to the particular construction of a switch cam (not shown) associated therewith beneath the level of the dial needles 45. The position of the dial 43 upon the dial spindle 29 is such that the dial needles 45 will be in cooperative alignment with the occasionally idle cylinder needles so that when it is desired

to transfer the stitches from the dial needles to corresponding cylinder needles, this may be readily accomplished in any well-known manner after operating the switch cam for the cylinder needles to bring said cylinder needles into operation.

The dial needles 45 are operated by suitable cams on the relatively stationary cam housing 25 which is provided with a recess 47 extending inwardly from the lower side thereof adjacent the dial 43. The cam members for the dial needles comprise three transfer cam elements 48, 49 and 50 which actuate the dial needles when transferring the stitches carried thereby on to corresponding needles mounted in the cylinder 30. Cam elements 51 and 52 are for operating the dial needles when producing a plain ribbed fabric. The transfer cam elements 48, 49 and 50 are usually mounted in the housing recess 47 so as to move from a lower operative position where they function to actuate the dial needles to an upper inoperative position out of operative engagement with the dial needles during the knitting operation. Likewise, the knitting cam elements 51 and 52 are movable from a lower operative position where they actuate the dial needles to effect knitting to an upper inoperative position out of operative engagement with the dial needles during the transfer operation and during the knitting of plain fabric. The cam elements 48, 49, 50, 51 and 52 may be moved from their lower operative position to the upper inoperative position by any suitable means and, inasmuch as this means for moving the cam elements to and from the operative position is well known to those skilled in the art and does not directly constitute a portion of this invention, it is believed that it is unnecessary to further show or describe such a mechanism.

The cam element indicated at 53 is fixed relative to the housing 25 and recess 47 and functions in the usual manner to maintain the dial needles in the inoperative position out of the path of movement of the cylinder needles during the knitting of plain fabric. Also, this cam 53 positions the parts of the dial needles, as 45' and 45'', during each revolution of the dial 43 and needles carried thereby so that the butts of said needles will be maintained in their respective paths of movement through the housing recess 47 to properly engage corresponding transfer cam elements or knitting cam elements when either of said cam elements is moved from the inoperative to the operative position.

As shown in Figure 8, the knitting cam elements 51 and 52 are constructed in the conventional manner to actuate the dial needles during the stitching operation to produce a plain stitch, with the exception of cam element 52 which is provided with a recess 55 extending inwardly from the outer vertical face thereof behind the cam element 51. In the recess 55 is mounted a cam element 56 which, together with the means for actuating said element, comprises the novel structure of this invention.

The cam element 56 is secured to the lower end of a vertically disposed spindle 57 which extends downwardly through the upper wall of the housing 25 into the recess 55 adjacent the advance side of said recess. The cam element 56 has the outer side 58 thereof conforming in contour substantially to that of the normal contour of the corresponding side portion of the cam element 52 so that when the cam element 56 is in its innermost position, as indicated by full lines in

Figure 8, said side 58 will extend across the open side of recess 55 for guiding the butts, as 59, of the dial needle cast-off parts 45' in the conventional manner for stitching as said butts travel forwardly through the cam track or groove 60 formed intermediate the cam element 52 and the adjacent side wall 61 of the recess 47.

The forward end portion of the cam element 56 is preferably beveled, as at 62, so as to engage a correspondingly beveled portion 55' of the side wall of the recess 55 for limiting the inward swinging movement of cam 56 with respect to the cam 52. The cam 56 is adapted to swing from its innermost position within the recess 55 to an outer position, as indicated by broken lines in Figure 8 during the production of a cardigan stitch. For this purpose, the spindle 57 is extended some distance above the housing 25, as shown more particularly in Figures 1 and 7, and has secured to the upper end thereof a crank arm 64 as by a screw 65 mounted in a suitable aperture provided in split portions 64' formed on the arm 64 adjacent the spindle 57, as illustrated in Figure 6.

The crank arm 64, as shown in Figure 7, is provided with a pendent sleeve 66 which receives the upper end portion of the spindle 57 therein and has coiled thereon a spring 67 which has one end connected with the arm 64 and the other end with the housing 25 for yieldingly urging said arm and the spindle 57 in a direction to maintain the cam 56 in its innermost position against the stop surface 55' of the recess 55. The arm 64 extends inwardly from the spindle 57 toward the dial spindle 29, as indicated by full lines in Figure 6 and has secured to the inner end thereof a roller 69, as illustrated in Figure 7. The roller 69 projects upwardly from the adjacent end of the arm 64 into the path of movement of a double faced cam 70 which is secured, as illustrated, to the lower end of a vertically disposed stub shaft 71. The stub shaft 71 extends upwardly through an eccentric disk 72 rotatably mounted in a circular aperture 73 provided in a bracket 74 which is secured, as illustrated more particularly in Figure 2, by screws 75 or other suitable means to the bracket 27 adjacent the bearing member 28. The stub shaft 71 is arranged in eccentric relation with the disk 72 and has the upper end thereof extending a short distance above said disk and secured to a star wheel 76 comprising a portion of a Geneva movement for intermittently operating the cam 70.

The star wheel 76, as indicated more clearly in Figure 1, is positioned a short distance below the lower face of the gear 33 so as to be actuated by a drive pin 77 secured to said gear 33 to extend downwardly therefrom at one side of the axis of rotation thereof. The gear 33 is provided with a circular pendent hub 78 which is adapted to be received in peripheral recesses 79 of the star wheel 76, as illustrated in Figure 2, for maintaining the star wheel against rotation during the idle portion of the movement of drive pin 77. The hub 78 is provided with an arcuate recess 80 in the side thereof adjacent the pin 77 which is adapted to align with the portions of the star wheel 76 adjacent the radial slots 81 formed in said wheel and to receive said portions therein during the rotation of the star wheel produced by the operation of the drive pin 77 thereon, as will be readily understood. The star wheel 76 is provided with a pendent hub portion 83 of sufficient diameter to extend over the upper face

of the bracket 74 adjacent thereto for limiting the downward movement of the stub shaft 71 and the disk 72.

It will now be understood that when the star wheel 76 is in the position illustrated in Figure 2, in position to be actuated by the drive pin 77, the cam 70 will be alternately moved from the inoperative position, indicated by full lines in Figure 6, out of engagement with the roller 69 to the operative position, indicated by broken lines in said figure, into operative engagement with the roller whereby the arm 64 is rocked about the axis of the spindle 57. Rocking of spindle 57 produces movement of the cam 56 from the inner or inoperative position, indicated by full lines in Figure 8, to the outer or operative position thereof indicated by broken lines in said latter figure. This actuation of the star wheel 56 produced by the drive pin 77 will occur upon each revolution of the drive pin and gear 33, so that during one revolution of the gear 33 and the spindle 29 and dial 43 connected with said gear, the cam 56 will be maintained in its innermost position by the action of the spring 67, and during the succeeding revolution of said gear, spindle and dial, the cam 56 will be moved to and maintained in its outermost position against the action of the spring 67 by the engagement of the cam 70 with the roller 69.

It therefore follows that, upon the third revolution of the gear 33 and members associated therewith, the star wheel 76 will be actuated to move the cam 70 out of holding engagement with the arm 64 and permit the cam 56 to be returned to and maintained in its innermost position by the action of the spring 67. This periodic movement of the cam 56 to and from the inner positions thereof is for the purpose of actuating the dial needles in conjunction with the cylinder needles to produce a half cardigan ribbed fabric in the manner which will hereinafter be more fully explained.

When it is desired to utilize the dial needles 45 in the conventional manner in conjunction with the cylinder needles 31 to produce a plain ribbed fabric, it is necessary to render the drive mechanism for the cam 70 ineffective so that the cam element 56 will be maintained in its innermost position, as by the action of the spring 67 during succeeding revolutions of the dial 43 and the needles carried thereby.

The means for accomplishing this result comprises a cam 85 secured in any well-known manner to the usual pattern drum 86 indicated diagrammatically in Figure 4 and which is driven by any suitable mechanism (not shown) in predetermined relation to the rotation of the cylinder 30 and dial 43, as will be readily understood by those skilled in the art. The cam 85 actuates a vertically disposed rock lever 87 which is pivotally mounted upon a suitable pin or shaft 88 secured to the frame of the machine, the lower end of the lever 87, as indicated in Figure 4, may be provided with a laterally disposed portion 89 adapted to form a cam follower for engagement with the cam 85. The lever 87 is normally rocked about its pivot 88 for maintaining the cam follower 89 in operative relation with the cam 85 by a tension spring 90 secured at one end to the lever above the pivot 88 and its other end to a relatively stationary portion of the machine as the frame thereof.

The upper end of the lever 87 is pivotally connected to a thrust collar 92 slidably mounted upon a horizontally disposed thrust rod 93. The

collar 92 is mounted intermediate a pair of pressure springs 94 mounted upon the rod 93 between a pair of collars 95 secured to said rod at opposite sides of the collar 92. The thrust rod 93 has one end thereof provided with a sleeve 96 which has a socket 97 formed therein. Socket 97 receives one end of a drive pin 98 which extends through an elongated slot 99 formed in the bracket 74 and into threaded engagement with the disk 72, as illustrated in Figure 5.

It will now be understood that when the rock lever 87 has moved to its rearward position by the cam 85, the disk 72 will be maintained in such a position that the star wheel 76 will be in operative relation with the drive pin 77. On the other hand, when the rock lever 87 is released by the cam 85, the disk 72 will be rotated with respect to the bracket 74 to bring the star wheel 76 out of operative relation with the drive pin 77 by forward movement of the thrust rod 93 produced by the action of spring 90 upon the lever 87. In other words, the star wheel 76 will be moved from its innermost position, as indicated by full lines in Figures 2 and 3, to its outermost inoperative position, as indicated by broken lines in Figure 3.

When the star wheel 76 is thus moved from its innermost position to its outermost position, it will obviously be moved out of engagement with the hub 78 and, in order that the star wheel be maintained against accidental rotation when in its outermost inoperative position, we have provided the hub 83 of said star wheel with a radially disposed slot 100 which receives a lock plate 101 secured to the bracket 74 at one side of the aperture 73, as illustrated in Figures 2 and 3.

Furthermore, the arrangement of the slot 100 and lock plate 101 with respect to each other and to the cam 70 is such that the star wheel 76 can be moved to its outermost inoperative position only when the cam 70 is out of holding engagement with arm 64 and thus prevent injury to parts of the device which might otherwise occur if cam 70 should be in the operative position when moved by rotation of disk 72 toward roller 69. This is due to the peripheral surface of hub or disk 83 coming into contact with lock plate 101 should the lever 87 be released by cam 85 when slot 100 is out of alignment with the lock plate. This engagement of the disk and lock plate prevents action of spring 90 upon lever 87 from rotating disk 72 sufficiently to move the star wheel 76 out of operative relation with drive pin 77 until slot 100 and lock plate 101 align with each other and cam 70 is in the inoperative position illustrated by full lines in Figure 6.

The dial needles 45, as hereinbefore stated, are of the type illustrated in the hereinbefore mentioned Patent No. 1,641,101 and comprise a loop drawing or hook part 45' and the sliding latch or cast-off part 45''. The loop drawing part 45' comprises a shank 103 having a hook 104 at one end facing upwardly and a groove 105 in its upper face which slidably receives the lower side portion of the cast-off part 45' therein.

The cast-off part 45' comprises a shank 106 provided with a forwardly extending hook 107 at one end and a rearwardly extending hook 108 spaced a short distance rearwardly from the hook 107. These hooks 107 and 108 are adapted to cooperate with the yarn loop received or drawn by the hook 104 for maintaining said loops on the hook part 45' or for casting said loops therefrom. The shank portion 106, in addition to having sliding engagement in the groove 105 in

the hook part 45'', also slides in a longitudinally extending recess 109 provided in the rear end of the shank portion 103 of the hook part. The hook part 45'' is provided with a butt 110 at the rear or inner end thereof, while the cast-off part 45' is provided with the hereinbefore mentioned butt 59 which extends upwardly therefrom intermediate the ends thereof.

It will now be understood that when it is desired to produce an article of hosiery such as the boot sock illustrated in Figure 20, the transfer cam elements 48, 49 and 50 mounted in the dial housing 25 will be moved to their inoperative position out of the path of travel of the dial needle butts 59 and 110, while the stitch cam elements 51 and 52 will be moved to the operative position for engagement with said butts of the dial needles.

Furthermore, it will be understood that the stitch cams 51 and 52 of the dial needles will function in cooperative relation with the usual cams for the cylinder needles 31 for actuating both sets of needles to produce a plain ribbed fabric in the usual manner when the cam element 56 is in its innermost position in the recess 55, as indicated by full lines in Figure 8.

Assuming that the machine is adjusted for making the illustrated boot sock shown in Figure 20, the principal operations are first, to begin knitting by cooperation of the dial and cylinder needles for a set up course; second, to make fabric for the welt W while needles of one set remain idle; third, to knit the plain ribbed fabric R; fourth, to make the half cardigan ribbed fabric C; fifth, to make the plain ribbed fabric R' at the lower end of the half cardigan ribbed fabric C; sixth, to transfer the dial loops to the cylinder needles; and seventh, to complete the sock by knitting the lower portion of the leg, the heel, foot and toe for the sock on the cylinder needles.

By referring now to Figures 8 and 12 to 19, inclusive, it will be understood that when knitting the upper plain ribbed fabric R of the sock, star wheel 76 will be maintained in its outer position and the cam 56 will be maintained by spring 67 in its innermost position in recess 55. The butt 59 of the cast-off part 45' of each dial needle will travel through the outer cam track 60 in the normal manner and the path of movement of the outer end of each cast-off member or, more specifically, each rearwardly extending hook 108 will be substantially that defined by the dot-and-dash line M—M when the dial needles are passing from line A to line F.

Furthermore, the butt 110 of the hook part 45'' of each dial needle will travel in the inner cam track 112 formed at the inner sides of the cam elements 52, 53 and 48, while the outer end or hook 104 of each needle will travel substantially in the path defined by the full line N—N during the period the butts 110 are passing from the line A to the line F. In other words, as the butts 59 and 110 approach the plane of the line A, both the hook and cast-off elements of the needle will be moved to their outermost positions, as indicated in Figure 12.

At the same time, the cam structure for the cylinder needles 31 will move the cylinder needle adjacent the corresponding dial needle 45 to its uppermost position for engaging the yarn Y. As the dial needle advances from the line A, the cylinder needle 31 will be drawn downwardly to form a cylinder loop and at the same time draw the yarn Y across the hook 104 of the dial needle. The cast-off element 45' of the dial

needle will also be drawn inwardly so that as the dial needle approaches the line B, the elements 45' and 45'' thereof will be in substantially the position illustrated in Figure 13. That is, the hook 104 of the needle will be in substantially its outermost position with the yarn Y resting in said hook while the dial loop previously formed on the needle will be engaged by the rear hook 108 of the cast-off element 45'.

As the dial needle advances from the line B to the line C, both the elements 45' and 45'' of the needle will be moved inwardly so that the dial loop X will be maintained by the hook 108 in engagement with the peripheral surface 113 of the dial 43 adjacent the groove 44 for said needle, as shown in Figure 14. At the same time, the inward movement of the hook element 45'' of the needle will draw the yarn inwardly to form a second dial loop X on said needle. Continued advancement of the dial needle with respect to the cam element 52 from the line C to the line E, causes cast-off element 45' to remain stationary with respect to the dial for holding the loop against the peripheral surface 113 of the dial, while the hook element 45'' of the needle will move inwardly to complete the formation of the dial loop.

In other words, the needle elements will be in substantially the position illustrated in Figure 18 when at line E, but instead of there being two loops engaged by the rear hook 108 of the cast-off part, as illustrated, there will be but one loop engaged by said hook. As the needle advances from the line E to the line F, the hook element 45'' of the needle will remain substantially stationary radially of the dial while the cast-off element 45' will be moved outwardly by the engagement of the butt 59 thereof with the high portion of the cam 52. The outward movement of the cast-off element 45' will carry the dial loop X supported by hook 108 beyond the hook 104 and cast the same from said latter hook, as illustrated in Figure 19, thereby completing the formation of the dial loop which it will be understood is formed in conjunction with an adjacent cylinder loop produced by the cylinder needle 31 adjacent said dial needle for forming a plain ribbed fabric of the sock.

It will be understood that during continued rotation of the dial needle 45 from the line F back to the line A, the elements 45' and 45'' thereof will be actuated in the conventional manner and as butts of the elements again engage the stitching cam elements 51 and 52 the needle elements will be actuated in the manner just described to produce a second dial loop in combination with a second cylinder loop produced by the corresponding cylinder needle 31. At the end of the formation of the upper plain ribbed fabric R of the sock, the cam 56 will be moved from its inner position shown by full lines in Figure 8 to its outermost position shown by dotted lines in said figure by the engagement of cam 85 with the rock lever 87, and rotation of cam 70 and arm 64 in the manner hereinbefore described. As each dial needle now moves from line A to line F the path of travel of the hook 104 will be as before substantially along line N—N, but the path of travel of hook 108 will be altered or substantially along line M—O—P—M.

It will now be obvious that the operation of the dial needle from the line A to the line C will be the same as above described for producing the plain ribbed fabric. That is, the hook element 45'' will move inwardly from the position shown

in Figure 12 to the position shown in Figure 14 with a second dial loop X partially formed thereon while the cast-off element 45' of the needle will be moved to its innermost position for maintaining the previously formed dial loop X in engagement with the rear hook 108. As the dial needle advances from the line C, the hook element 45'' will continue its normal gradual inward movement due to the engagement of the butt thereof with the inner side surface of the cam 52. The cast-off element 45', however, will be quickly advanced by the engagement of the butt 59 thereof with the surface 58 of cam 56 so that when the needle reaches the line D the hook and cast-off elements thereof will be in the position illustrated in Figure 15, whereby the loop X formerly carried by the hook 108 will be deposited therefrom back onto the hook 104 of the needle element 45''.

It is now evident that the hook element 45'' will continue its inward movement as the needle moves from the line D to the line F to complete the formation of the second dial loop X, so that there will be two dial loops carried by the hook element during the movement of the needle through the inoperative portion of its path of movement. As the needle again approaches the line A, the hook element 45'' will again be moved outwardly in the normal manner to engage the yarn Y as said yarn is brought onto hook 104 of the dial needle by the downward movement of the corresponding cylinder needle 31. As the dial needle 45 now moves from the line A to the line B, the cast-off element 45' will be moved inwardly to bring the hook 108 with the two dial loops X carried by the hook element, as shown in Figure 16. Continued movement of the needle from the line B to the line C causes the cast-off element 45' to continue its inward movement and bring the two loops into engagement with the adjacent peripheral surface 113 of the dial 43 while the hook element 45'' will begin its inward movement to form an additional dial loop, as illustrated in Figure 17. When the dial needle reaches substantially the line C, the engagement of the drive pin 77 with the star wheel 76 will produce rotation of said star wheel and effect movement of the cam 56 from its outermost position to its innermost position.

It will now be apparent that as the needle moves from the line C to the line D, the cast-off element 45' will remain in its innermost position and, at the same time, the hook element 45'' will be moved to its innermost position to complete the formation of the new dial loop X carried thereby, as illustrated in Figure 18. As the needle moves from the line D to the line F, the hook element 45'' will remain in its innermost position while the cast-off element 45' will be moved outwardly so as to cast the two-cylinder loops X carried thereby from the hook element 45'', as illustrated in Figure 19.

It now follows that the one dial loop X will remain on the dial needle through the inoperative portion of its path from the line F back to the line A where the hook element is again moved to the outermost position to again engage the yarn Y. During movement of the needle from the line A to the line C, the elements thereof will move from the position shown in Figure 12 to that shown in Figure 14 to partially form a new loop on the hook element and to move the previously formed dial loop onto the hook 108 of the cast-off element 45'.

As the needle approaches the position of the

line C, the drive pin 77 will again engage the star wheel 76 and produce movement of the cam 70 to again move the cam 56 to its outermost position. Movement of the needle from the position of line C to that of line D will again cause the quick outward movement of the cast-off element 45' so that the loop carried thereby will be deposited upon the hook 104 of the element 45'', as illustrated in Figure 15, prior to said hook element reaching its innermost position.

These unusual and usual movements of the cast-off element 45' of each dial needle to first cast a single dial loop carried thereby upon the hook element 45'' during one revolution of the needle and then to cast the two loops carried thereby from hook element 45'' during the second revolution of the dial needle to produce a half cardigan ribbed fabric may continue until the section C of the leg of the sock has been completed. After this section C of the sock is completed, the cam 85 will be moved out of engagement with the rock lever 87 by rotation of the pattern drum 86. Spring 90 now actuates lever 87 and thrust rod 93 to move the star wheel from its innermost operative position illustrated in full lines in Figures 2 and 3 to its outermost inoperative position, as indicated by broken lines in Figure 3.

This movement of the star wheel brings the same out of the path of movement of the drive pin 77 so that the cam 56 will be maintained in its innermost position by the spring 67, whereupon the dial needles will function in the usual manner in conjunction with the cylinder needles to produce the lower plain ribbed fabric R' of the sock. After the lower plain ribbed portion R' of the sock has been formed, it will be understood that the cam elements 51 and 52 may be moved inwardly or upwardly into the recess 47 out of operative relation with the butts of the dial needles. Also, the transfer cam elements 48, 49 and 50 may be moved downwardly with respect to said recess into operative relation with the butts of the dial needles for effecting transfer of the dial loops carried by the dial needles onto corresponding cylinder needles prior to the upward movement of cams 51 and 52 in the usual manner so that continued operation of the knitting machine may produce the plain fabric of the lower portion of the leg of the sock and the foot portions thereof.

As above described, the tuck or half cardigan stitches are formed by the dial needles due to variations in the normal operation of the cast-off elements of the needles during every other revolution of the dial. It will be evident, however, that the same result may be obtained by either varying the normal operation of both the hook and cast-off elements of the needles during every other revolution of the dial or by varying the normal operation of the hook element alone.

In Figure 10, we have illustrated a modified form of cam structure which is associated with the stitching cam element 52 for varying the normal operation of both the hook and cast-off elements of the dial needles during the movement thereof from the position indicated by line C to the position indicated by line E. In the structure illustrated in Figure 10, the cam element 52 has mounted therein a swinging cam 115. The outer side face 116 and inner side face 117 of cam 115 is constructed so as to conform in general outline substantially to that of the normal outer and inner side face, respectively, of

the corresponding portion of the conventional cam 52. The cam 115 is mounted in a transversely disposed recess 118 formed in the cam element 52 and has the rear end thereof secured to the lower end of the cam spindle 57 so as to swing with said spindle above the axis thereof from a normal innermost position with the outer and inner side surfaces 116 and 117 thereof in coincidental relation with the normal contour of the corresponding portion of the cam 52 to an outer position with the cam surface 116 thereof projecting into the normal cam track 60 while the inner cam surface 117 of the cam extends outwardly beyond the normal adjacent surface of the cam 52. The cam 115 may be operated in the same manner as the cam 56 by the action of the cam 70 upon the arm 64, as produced by cam 85 or spring 90 upon lever 87.

When the cam 115 is in its normal innermost position, it will be observed that the cast-off and hook elements 45' and 45'' of the dial needles will move in a conventional manner for cooperating with the cylinder needles for producing a plain ribbed fabric. When the cam 115 is moved to its outermost position, the operation of the dial needle elements will be altered from the normal operation thereof so that the outward movement of the cast-off element 45', when passing from the position indicated by line C to that indicated by line E, will be less than when the cam 56 is moved to its outermost position by the cam 70. That is, the cast-off element will be moved outwardly from its innermost position only a distance sufficient to cast off the dial loops X carried by hook 108. At the same time, the hook element 45'' will not be moved inwardly as far as when the cam 115 is in its normal position, so that the hook 104 of the needle element will be in position to receive the dial loops thereon as said loops are cast from the cast-off hook 108.

In the structure shown in Figure 11, the cast-off elements 45' of the dial needles will move through substantially their normal path, as indicated by line M—M, Figure 8, during the formation of the half cardigan stitch as well as during the formation of the plain rib stitch. The path of movement of the hook elements 45'' of the dial needles will, however, be altered during alternate revolutions of the dial so that the dial loop carried by the cast-off hook 108 will be deposited upon the hook element 45''.

The means for accomplishing this altered movement of the hook elements of the dial needles consists in providing a cam 120 which is mounted in a recess 121 provided in the inner side of the cam element 52 in close relation to the rear end thereof. This cam 120 is mounted like cams 56 and 115 upon the lower end of the cam spindle 57 so as to be alternately moved from the outermost operative position with the inner cam face 122 thereof in substantially the plane of the normal corresponding face of the cam element 52.

When the cam 120 is moved to its innermost position, as indicated by full lines in Figure 11, the inner cam face 122 thereof extends inwardly beyond the corresponding cam face of the cam 52 and thereby permits the hook elements 45'' to remain in sufficient outward positions to receive the loop cast off the cast-off hook 108 during the normal operation of the cast-off element. It therefore follows that inasmuch as the cam 120 is operated by the coaction of the drive pin 77 and star wheel 76 from the outer-

most operative position thereof to its innermost inoperative position during every other revolution of the dial, the dial needles will function to produce a cardigan stitch during said every other revolution and to produce a plain rib stitch when the cam is moved to its outermost position during the intermediate revolution of the dial.

As hereinbefore stated, the mechanism and operation of the dial needles thus far described are adapted more particularly for a single feed knitting machine. If it is desired to utilize a two-feed machine to form a half cardigan ribbed fabric, this may be readily accomplished by using cam 56 or cam 115 or cam 120 in conjunction with the cam mechanism for one of the feeds, while the knitting cam mechanism for the other feed remains as conventionally constructed. When one of these cam elements is thus associated with the knitting cams of one feed in a two-feed machine, the cam is moved to its operative position for effecting a tuck or cardigan stitch at the beginning of the knitting of the half cardigan ribbed fabric and will remain in said operative position until the knitting of the half cardigan ribbed fabric is completed.

Upon the completion of the half cardigan ribbed fabric, the cam element is moved to its inoperative position so that the dial needles may be actuated by the cams of both feeds in conjunction with the corresponding cylinder needles to produce a plain ribbed fabric. This movement of the cam may be readily accomplished by connecting the thrust rod 93 directly with the outer or free end of the rock arm 64, as indicated at 124, Figure 9. When the thrust rod 93 is thus connected with the arm 64, said cam will be operated directly by the action of the cam 85 or spring 90 upon the lever 87 to and from the operative position thereof.

While there has been shown and particularly described the preferred embodiments of our invention, we do not wish to be limited to the exact construction shown as various changes, both in the form and relation of the parts thereof, may readily be made without departing from the spirit of the invention as set forth in the appended claims.

We claim:

1. In a single feed knitting machine having complementary sets of knitting needles arranged for knitting a plain ribbed fabric, the needles of one of said sets being each composed of a hook member and a cast-off member relatively movable with respect to each other, knitting cams for moving the parts of said needles respectively to draw single loops and to cast off said loops, in combination, drive mechanism for producing relative movement of the needle parts and said knitting cams, an additional cam adapted to be moved into relation with said needle members to move them respectively to draw two loops successively and to cast off said two loops simultaneously for the purpose of knitting half cardigan ribbed fabric, actuating means for moving the additional cam to and from an operative position including a star wheel, means for operatively connecting the star wheel with the additional cam, and a drive element connected with said drive mechanism for actuating the star wheel.

2. A device as in claim 1 having means actuated by the drive mechanism for moving said star wheel into and out of operative relation with the drive element.

3. In a knitting machine of the single feed type employing two sets of needles and operating

means for producing relative movements of the needles for knitting a plain ribbed fabric, one of said sets having two-part needles, one part to carry an old loop from the second part and over a new loop on said second part, the operating means including a cam mechanism associated with the two-part needles having a cam element adapted to be moved into relation with at least one of the parts of the needles of said one set to alter the movement of said latter part with respect to the other needle part to maintain the old loop on the second needle part with the new loop, and actuating means intermittently operated by said operating means for alternately moving said cam element into and out of said relation with said one of the needle parts.

4. In a knitting machine of the two-feed type employing two sets of needles and operating means for producing relative movements of the needles for knitting a plain ribbed fabric, one of said sets having two-part needles, one part to carry an old loop from the second part and over a new loop on said second part, the operating means including a cam mechanism associated with the two-part needles having a cam element adapted to be moved into relation with at least one of the parts of the needles of said one set to alter the movement of said latter part with respect to the other needle part to maintain the old loop on the second part with the new loop, and actuating means operated by said operating means for moving the cam element into said relation with one of the needle parts at the end of the knitting of the plain ribbed fabric to produce a half cardigan ribbed fabric and to move said cam element out of said relation with said one of the needle parts at the end of the knitting of the half cardigan ribbed fabric.

5. In a knitting machine having a set of knitting needles of the two-part type, a hook part and a cast-off part slidable with respect to said hook part at the open side thereof, operating mechanism including a pair of cam tracks engageable with butts on the needle parts respectively for actuating said needle parts, in combination, a movable cam element associated with one of said cam tracks to constitute a portion thereof, said cam element being of such a character that when in one position the needle parts of the butts engaged by the latter track are operated in the usual manner to produce a plain stitch and when in a second position the normal operation of said latter needle parts is altered to cause the needle parts to produce a tuck stitch, and means for moving the cam element from one of said positions to the other.

6. A knitting machine as defined in claim 5 wherein said latter means includes a pair of drive members, one of said drive members being connected with the operating mechanism to be actuated thereby, and means operatively connecting the other drive member with the cam element and with the first mentioned drive member, said drive members and connecting means being so constructed and arranged that they intermittently function to periodically produce said movement of the cam elements.

7. A knitting machine as defined in claim 5 wherein said latter means includes a pair of drive members, one of said drive members being connected with the operating mechanism to be actuated thereby, and means operatively connecting the other drive member with the cam element, said drive members and connecting means being so constructed and arranged that they intermit-

tently function to periodically produce said movement of the cam element, and means for producing movement of one of said drive members with respect to the other drive member to bring said members into and out of cooperative driving relation with each other.

8. In a knitting machine having a set of knitting needles of the two-part type, a hook part and a cast-off part slidable with respect to said hook part at the open side thereof, operating mechanism including a pair of cam tracks engageable with butts on the needle parts respectively for actuating said needle parts, in combination, a movable cam element associated with both of said cam tracks to constitute a portion thereof, said cam element being of such a character that when in one position the needle parts of each needle are operated in the usual manner to produce a plain stitch and when in a second position the normal operation of both parts of each needle is altered to cause said needle parts to produce a tuck stitch, and means for moving the cam element from one of said positions to the other.

9. A knitting machine as defined in claim 8 wherein said latter means includes two pairs of coacting drive and driven members operatively connected with the cam element and with the operating mechanism respectively, said drive and driven members being so constructed and arranged that they intermittently engage each other to periodically produce said movement of the cam element.

10. In a knitting machine having a set of needles of the two-part type, a hook part and a cast-off part relatively movable with respect to each other, two cam tracks for moving the parts of said needles respectively, drive mechanism comprising separate supports for the cam tracks and needle parts and a shaft connected with one of said supports for producing relative movement of said parts of each needle with respect to each other, a movable cam element associated with at least one of said cam tracks to constitute a portion thereof, and means for moving said cam element to alter said relative movement of the needle parts to produce either a plain stitch or a tuck stitch including an actuating member connected with the cam element, a second actuating member connected with said shaft to move therewith, and separate operating means adapted to be intermittently actuated by said second actuating member and having a cam action on the first mentioned actuating member for periodically producing said movement of the cam element.

11. A knitting machine as defined in claim 10 having means for moving the said separate operating means into and out of cooperative relation with the first and second mentioned actuating members.

12. In a knitting machine comprising needle carriers and needles movably associated therewith arranged for knitting plain ribbed fabric, the needles of one carrier having independently movable latch and hook parts, in combination, cam means for moving the parts of said needles respectively to draw loops and to cast off loops, said cam means including a cam element adapted to be moved into relation with at least one of said parts of the needles of said one carrier to move them with respect to each other to draw two loops successively and to cast off said two loops simultaneously for the purpose of knitting half cardigan ribbed fabric.

13. In a knitting machine of the class described having complementary sets of knitting needles arranged in cooperative relation with each other, the needles of one of said sets being each composed of a hook part and a cast off part at the open side of the hook part relatively movable with respect to each other, cam means for actuating said needles to produce a plain stitch, said cam means including cam elements associated with the hook and cast off parts of said latter set having movement with respect to each other so constructed and arranged that upon said relative movement of said cam elements the normal operation of at least one of said needle parts of said last mentioned set may be altered with respect to the other needle part of the same set so as to produce a cardigan stitch, and means for producing said relative movement of the cam members.

14. In a knitting machine of the class described having complementary sets of knitting needles arranged in cooperative relation with each other, the needles of one of said sets being each composed of a hook part and a cast off part mounted at the open side of the hook part relatively movable with respect to each other, cam means for actuating said needles to produce a plain stitch, said cam means including cam elements associated with the hook and cast off parts of said latter set having movement with respect to each other so constructed and arranged that upon said relative movement the normal operation of at least one of said needle parts of said set may be altered with respect to the other needle parts of the same set to produce a cardigan stitch, and means including an intermittent drive mechanism for producing said relative movement of the cam elements at the end of successive knitted courses to produce tuck stitches.

15. In a knitting machine of the class described having complementary sets of knitting needles arranged in cooperative relation with each other, the needles of one of said sets being each composed of a hook part and a cast off part at the open side of the hook part relatively movable with respect to each other, in combination, cam means for actuating said hook and cast off members in predetermined order for producing a plain stitch, said cam means including a movable cam element of such a character that the normal operation of said latter needle parts will be altered upon movement of the cam element from a first position to a second position, and actuating means for moving said cam element from one of said positions to the other at the end of con-

secutive courses of stitches for knitting a half cardigan ribbed fabric.

16. In a knitting machine having a set of knitting needles of the two part type, a hook part and a cast off part at the open side of the hook part and slidable with respect to each other, in combination, an operating mechanism including a pair of cam tracks engageable with butts on the needle parts respectively for actuating said needle parts, a movable cam element associated with at least one of the cam tracks to constitute a portion thereof, said cam element being of such a character that when in one position the needle parts are operated in the usual manner to produce a plain stitch and when in a second position the usual operation of the parts of each needle with respect to each other is altered to cause said needle parts to produce a tuck stitch, and means for moving the cam element from one of said positions to the other.

17. A knitting machine as defined in claim 16 wherein said latter means includes a pair of drive members, one of said drive members being connected with the operating mechanism to be actuated thereby, and means operatively connecting the other drive member with the cam element and with the first mentioned drive member, said drive members and connecting means being so constructed and arranged that they intermittently function to periodically produce said movement of the cam elements.

18. A knitting machine as defined in claim 16 wherein said latter means include two pairs of coacting drive and driven members operatively connected with the cam element and with the operating mechanism respectively, said drive and driven members being so constructed and arranged that they intermittently engage each other to periodically produce said movement of the cam element.

19. A knitting machine as defined in claim 16 wherein said latter means include two pairs of coacting drive and driven members operatively connected with the cam element and with the operating mechanism respectively, said drive and driven members being so constructed and arranged that they intermittently engage each other to periodically produce said movement of the cam element, and means for producing movement of the drive and driven elements of one pair with respect to the drive and driven elements of the other pair to bring said members into and out of cooperative driving relation with each other.

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