

Nov. 30, 1965

J. A. CURRIER
KNITTING MACHINE

3,220,219

Filed Jan. 23, 1962

4 Sheets-Sheet 1

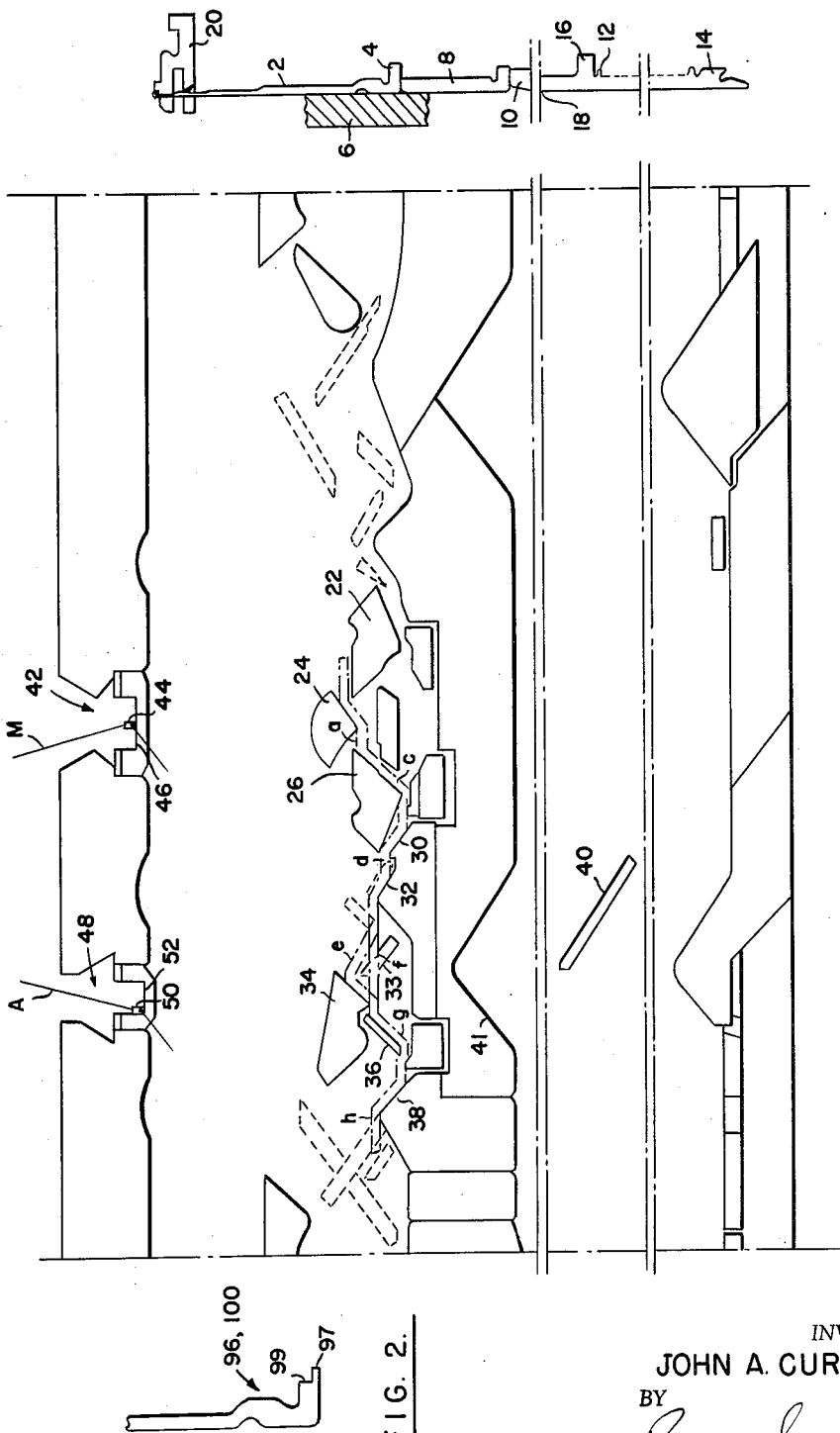


FIG. 1.

FIG. 2.

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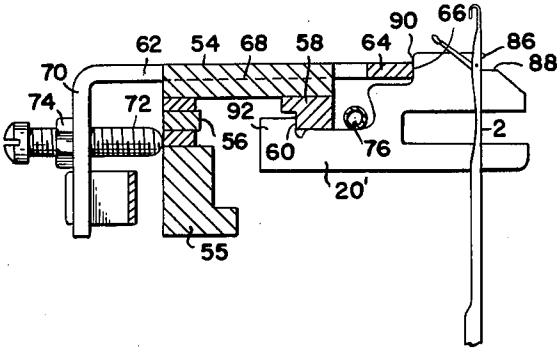
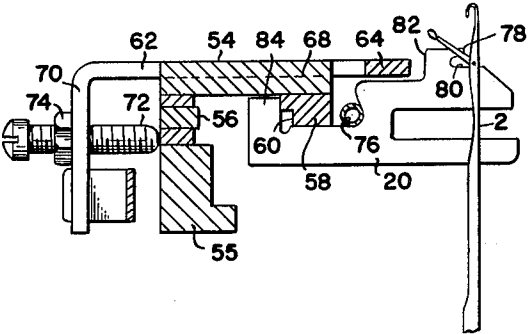
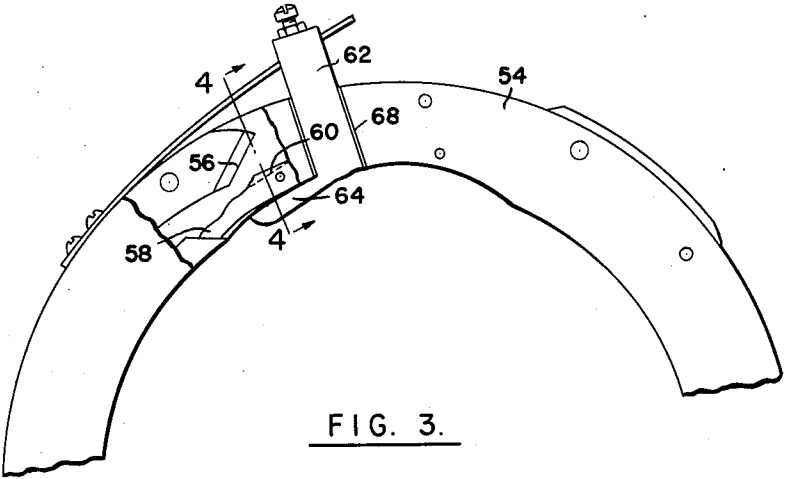
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

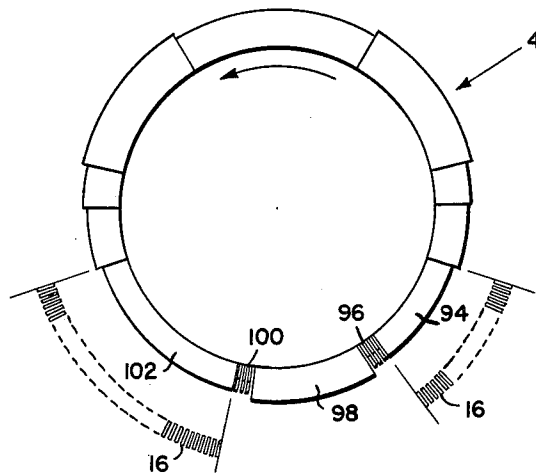


FIG. 6.

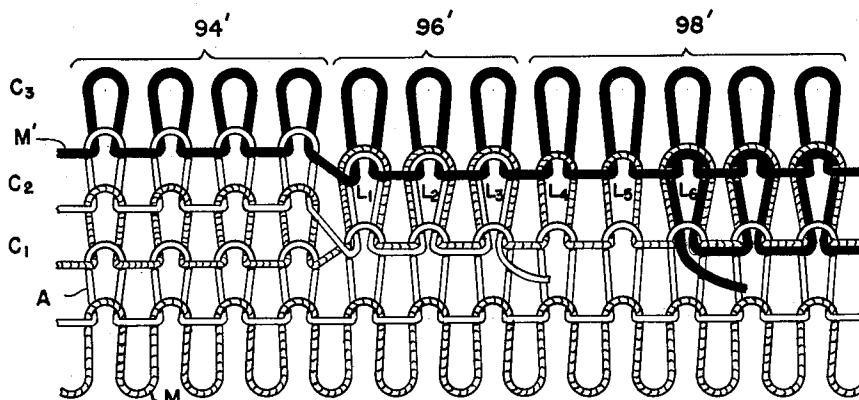


FIG. 7.

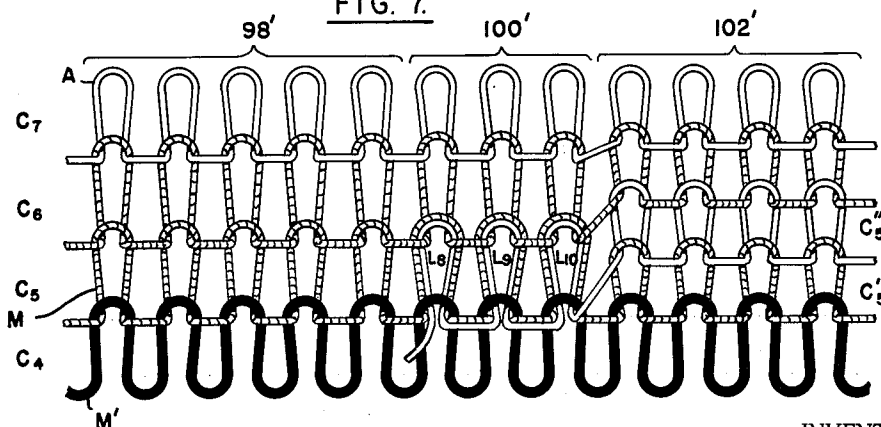


FIG. 8.

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4 Sheets-Sheet 4

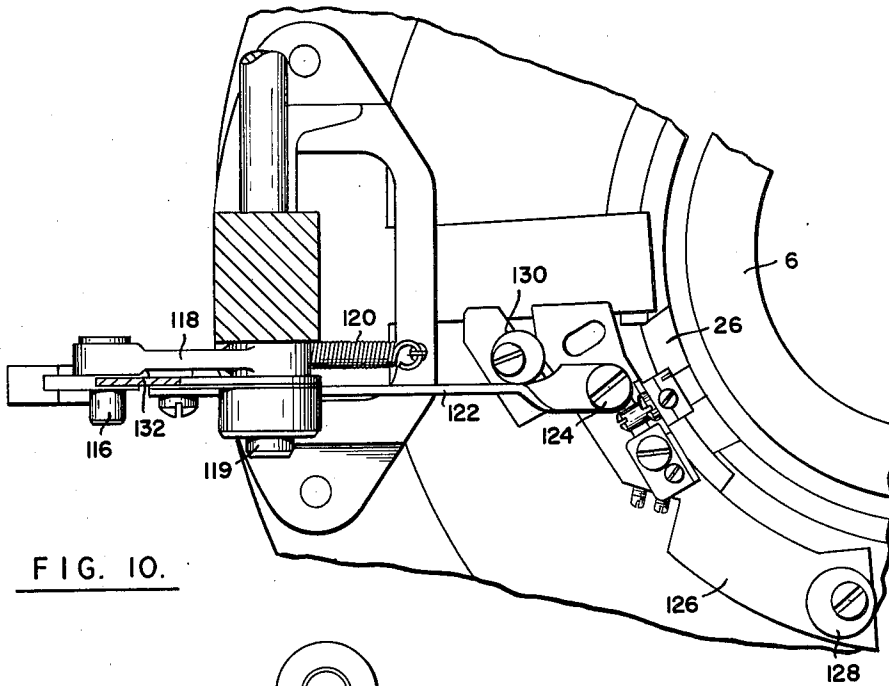


FIG. 10.

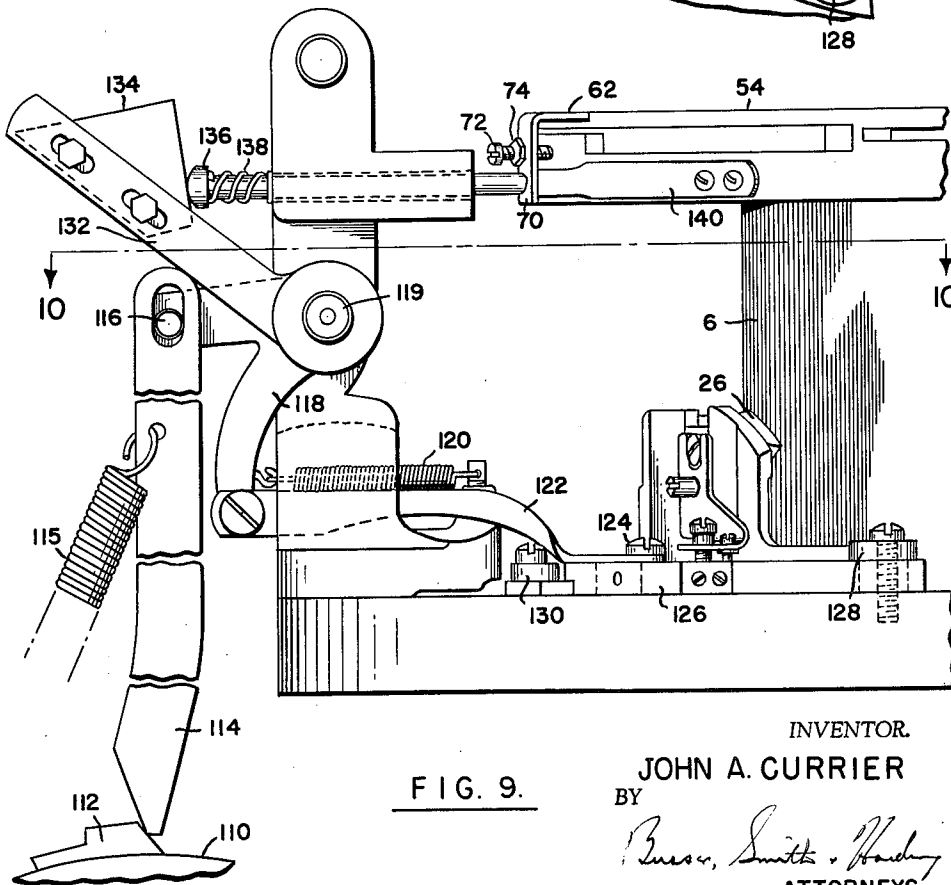


FIG. 9.

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1

3,220,219

KNITTING MACHINE

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Filed Jan. 23, 1962, Ser. No. 168,039

2 Claims. (Cl. 66—42)

This invention relates to knitting machines and has particular reference to the closing of "eyelets" which are ordinarily produced when an auxiliary yarn is introduced or removed in two-feed knitting operations.

Unless special precautions are taken the yarn ends produced upon introduction or removal of auxiliary yarn into and from two-feed knitting will reeve through the loops producing enlarged stitches which are known as eyelets and which are objectionable in the product. It is well recognized that to prevent such reeving the free yarn ends should be anchored. But since a course is either being cut out of operation or being started, it is by no means simple to secure proper anchorage of the yarn ends, and attempts made to do this have, generally, been by way of interlacing, or by reverse knitting of the yarn ends, or by knitting-in of the yarn ends under conditions in which probability plays a part in the sense that the operation is uncertain; for example, depending upon the sweeping of the yarn ends into needles by the action of closing latches, or the like. The difficulties of securing certainty of operation are increased when very fine yarns are used such as in the production of ladies' sheer hosiery.

Looking at the problem of preventing eyelet formations from a theoretical standpoint, it is immediately obvious that a completely positive tying in the free end of a yarn is impractical in a knitting machine having only conventional elements. The formation of actual knots is out of the question. From the very nature of knitted fabrics, yarns in loops would have a theoretical tendency to reeve, drawing inwardly a free yarn end. But considering aspects of friction, it is recognized that frictional restraint against reeving is greatly increased as an end of yarn to be reeved must pass through more turns of direction such as are presented by loops of the fabric, the friction being greater with each turn to the extent that the turn represents a larger angle of deviation from a straight passage. Consideration of interlacing will show that the angular deviations are small and hence even with extended interlacing over a large number of wales the yarn reeving may rather readily occur. On the other hand, if the end of the yarn is incorporated directly into loops by the main or base yarn of the fabric, the number of turns and the angles through which they take place for a given number of wales are greatly increased and reeving is quite effectively prevented. Obviously, it is desirable, to avoid unsightly appearance, to have the locking action against reeving take place through as little coursewise extent as possible. The securing of the desired result has presented many difficulties in the way of manipulation of the component yarns and in the way of securing certainty of operation. Furthermore, there has usually been the necessity of providing rather different operations for this purpose in inserting a yarn and in removing the same.

In accordance with the present invention, it is possible to secure with a minimum of change of conventional machine construction a very reliable anchorage of the yarn ends, this being accomplished, furthermore, in almost identical fashion whether inserting or removing a yarn; at least the same elements are involved. Furthermore, in accordance with the invention, the securing of the yarn ends is effected over only a few wales, the securing being

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quite complete and fully reliable if only three wales are involved in the operation. The result is that the special stitch construction is substantially unnoticeable in the fabric. A maximum amount of frictional resistance to reeving is produced per wale, the yarn ends being incorporated directly in complete stitches.

In the copending application of John J. Millar and myself, Serial No. 165,379, filed January 10, 1962, there is disclosed a machine and method, and product thereof, achieving the objectives just mentioned, and subject matter generic thereto and to the present application is claimed therein. The present application is directed to an improvement involving simplification by not requiring change of the main feed forward stitch cam from its conventional form.

The general object of the invention is the achievement of the result just indicated. This object, as well as others relating to details of construction and operation will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

FIGURE 1 is a developed view of needle and jack operating cams and other elements provided in accordance with the invention, there being shown, and described hereafter, only such elements as take part in operations in accordance with the invention, other elements being omitted or only sketchily shown, there being also indicated at the right of this figure, various of the elements rotating with the needle cylinder;

FIGURE 2 is a fragmentary view showing a special needle butt construction used in accordance with the invention;

FIGURE 3 is a plan view of the sinker cap of the machine, partially broken away to show sinker controlling cams;

FIGURE 4 is an axial section taken on the plane indicated at 4—4 in FIGURE 3 and showing operation involving an ordinary sinker;

FIGURE 5 is a section on the same plane but showing the operation of one of paired special sinkers, there being two pairs of such sinkers;

FIGURE 6 is a diagram illustrating the arrangement of needle butts and also of butts on pattern jacks;

FIGURE 7 is a diagram illustrating stitch structure in a two-feed stocking at the location of removal of an auxiliary yarn, the diagram showing the stocking as viewed from the inside thereof;

FIGURE 8 is a view similar to FIGURE 7 but showing the stitch formation which occurs at the introduction of an auxiliary yarn;

FIGURE 9 is a fragmentary elevation showing cam controlling means; and

FIGURE 10 is a plan view of the means shown in FIGURE 9.

As will become evident, the invention is applicable wherever eyelet closure or prevention is to be effected at the transition from one number of feeds to a different number; but for simplicity the description will be directed to the transition between single-feed and two-feed knitting, this being of most significance commercially.

Referring first to FIGURE 1, there are shown at the right thereof a conventional needle 2 provided with a butt 4, the needle cylinder 6 provided with slots in which the needles move, an intermediate jack 8, and a pattern jack 10, the jacks being located in the cylinder slots beneath their respective needles. It will be assumed, for purposes of description, that the cylinder rotates and reciprocates in conventional fashion, though it will be obvious that the invention is equally applicable to a machine in which the needle cylinder is stationary and the operating cams rotate and reciprocate. The butts 4 of the needles are differentiated in length and, in the case of a few of them,

in form, as will be more fully brought out hereafter. The pattern jacks 10 are generally conventional and are provided with the selectively removable butts 12 and the lower butts 14 which take part in the formation of patterns in conventional fashion which need not be described. Butts 16 are provided on certain of the jacks as hereafter indicated and do take part in the operation to which the present invention relates. Each pattern jack 10 is of the usual pivoted type provided with a fulcrum 18.

Sinkers 20 cooperate with the needles in the usual fashion, all of the sinkers being conventional except for four of them which are special and which will be later described in detail.

The camming of the machine is, except for minor changes, conventional and need not be described in full detail. It will be understood that since the machine is arranged for the formation of hosiery, the usual picking devices (not shown) are provided, and conventional driving means controls the selective rotation and reciprocation of the needle cylinder. Various adjusting devices for stitch size are also provided. Referring, now, to those elements which are concerned with the achievement of the objects of the invention, the usual reverse stitch cam is shown at 22 serving, as usual, for the clearing of needles during rotary knitting and forward strokes of reciprocation, the needle cylinder rotating counterclockwise so that the needle paths are from the right to the left in FIGURE 1. The usual center cam 24 is followed by the main feed stitch cam 26. This cam is radially movable and conventional except for its action on certain special needles as described hereafter.

Cams 30 and 32 serve to raise the needles after they pass the stitch cam 26, cam 32 raising the needles to tuck height. At the auxiliary feed there are the stitch cams 34 and 36 arranged to depress the needles. Beyond the cam 36 there is the cam 38 to raise the needles to tuck level. Arranged to engage the butts 16 of the pattern jacks is the cam 40 which is followed by the cam 41 arranged to act on the butts of the intermediate jacks 8 to effect lowering of both the intermediate jacks and the pattern jacks. Various other cams are outlined in FIGURE 1 but are completely conventional, taking part in patterning and heel and toe formation, and need not be described.

The main feed point of the machine is indicated generally at 42 and, as usual, there are provided at this feed point yarn feeding fingers selectively active, there being shown only the active finger 44 which feeds the main yarn M used in two-feed knitting of the leg and foot of the stocking. This yarn, as usual, passes to the needles from the throat 46 in the latch ring. The auxiliary feed point is indicated generally at 48 and shows the active yarn finger 50 for the auxiliary yarn A which is used to form the intermediate courses in the leg and foot, this yarn being fed from the throat 52 to the needles. Conventional clamping and cutting means are, of course, provided to hold and cut the yarns fed at both feeds.

Continuing description of the machine parts, reference may be made to FIGURE 3 which shows the sinker cap 54 located above the usual sinker dial and carrying the cams for operating on the sinkers to effect their radial movements. The sinker cams are generally conventional and need not be described except for those special ones which are involved in carrying out the invention. Beyond the position of drawing of stitches at the main feed there is the cam 56 engageable with sinker butts, there being indicated at 58 the conventional cam which limits inward movement of the sinkers. This cam, in accordance with the invention, is provided with an undercut portion 60 providing for special inward movements of the special sinkers hereafter described.

A slide 62 mounted in a groove in the sinker cap for radial movement is provided with an inner cam portion 64. Its outer downturned end 70 is tapped to receive a limiting stop screw 72 engageable with the portion 55 of

the sinker cap, this screw being held in adjusted position by a lock nut 74. Slide 62 is moved inwardly when stitch cam 26 is moved outwardly to secure the results described hereafter. The mechanism for accomplishing this is described hereafter. The usual spring band 76 serves to urge the sinkers radially inwardly in yielding usual fashion.

FIGURE 4 illustrates a conventional sinker 20 which is typical of all of the sinkers of the machine except for four special sinkers 20'. Each of the sinkers 20 is provided with the usual neb 78 projecting over the ledge 80 over which stitches are drawn. A vertical edge 82 is provided behind the neb 78 and has a reduced spacing from this neb as brought out more fully hereafter. Each sinker is provided with the operating butt 84 which may be acted upon by cam 56 if the sinker is not moved inwardly by spring band 76 and which butt ordinarily engages the cam 58.

FIGURE 5 illustrates one of the special sinkers 20'. The sinker 20' is provided with the neb 86 and the ledge 88, the same as the regular sinkers 20. However, there is provided space from the neb 86 the edge 90 which is arranged to be acted upon by the cam 64 to provide special inward movement of the sinkers 20'. It will be noted that the spacing of the edge 90 from the neb 86 is greater than the spacing of the edge 82 from the neb 78 of a regular sinker 20.

The butt 92 of each of the special sinkers 20' is short so that, as illustrated in FIGURE 5, it may pass below the outermost edge of the cam 58 and into the recess 60. As will appear hereafter, loops are drawn at the main feed over the ledges 80 of the conventional sinkers in usual fashion, and also in the same fashion over the ledges 88 of the special sinkers except at the locations at which eyelet closure occurs.

Conventional cams (not shown) impart to both types of sinkers the usual wave at the auxiliary feed point to provide drawing of stitches thereat over the sinker ledges 80 and 88.

The arrangement of needle butts 4 is illustrated in FIGURE 6.

The needle arrangement may be entirely conventional for the usual purposes of formation of heels and toes and other parts of a stocking, and special arrangements are involved only in the short butt heel-forming set of needles. This set comprises the groups of needles indicated at 94, 96, 98, 100 and 102 in FIGURE 6 in which butt lengths are diagrammed. The needles of the groups 94, 96 and 100 may, for example, have 0.240 inch butts, and the needles of groups 98 and 102 may have 0.270 inch butts, these measurements, of course, being entirely arbitrary but illustrative of the relationships of the butt lengths. The needles of groups 94, 96 and 100 have shorter butts and the needles of groups 98 and 102 have the longest butts of the heel-forming series, all of these butts being shorter than those of the remaining needles in the machine. The needles of the groups 96 and 100 are special, as shown in FIGURE 2. The butts 97 (of the same radial extent, e.g. 0.240 inch as those of group 94) have their upper edges cut away as indicated at 99, leaving effective butt lengths thereat which may, for example, measure 0.210. As will hereafter appear, this results in the selective imparting of limited downward movements to these needles by stitch cam 26.

The arrangement of the groups is quite arbitrary. As will appear, the needles of group 96 form stitches which produce auxiliary yarn anchorage to avoid eyelets and these desirably follow a substantial group of the needles 94. For the purposes of the present invention there need be only a few needles in the group 96, and it has been found very satisfactory to provide only three needles in this group, though even only two needles will afford substantial anchorage of yarn ends. It will be assumed in what follows that there are three needles in this group.

The angular extent of the group 98 is also arbitrary. The needles of the group 100 (again desirably three) provide yarn end anchorage upon insertion of the auxiliary feed yarn and are located to bring the double stitches at a desirable point at the rear of the heel. It is possible, however, to use only a single group of needles, as at 96, to take care of yarn end anchorage in both withdrawal and insertion of the auxiliary yarn. The group of needles 102 completes the heel-forming group.

As further indicated in FIGURE 6, jacks 10 having the butts 16 are associated only with the needles of the groups 94 and 102. The pattern jacks associated with all of the other needles may lack the butts 16 so far as operations of present concern are involved. Butts in such position, however, may be provided (and of different lengths if desired) for other purposes on others of the jacks. The special sinkers 20' are associated only with the needles of the groups 96 and 100. Only two of these special sinkers 20' are provided in each instance, flanking the middle needle of the three needle group.

The mechanism for moving the stitch cam 26 and the slide 62 is illustrated in FIGURES 9 and 10. The main cam drum 110 of the machine carries cams 112, of which only one is shown, arranged to act on a push rod 114, urged downwardly by spring 115, which push rod is slotted at its upper end to embrace a pin 116 carried by one arm of a bell crank 118 journaled on a shaft 119. A spring 120 urges the bell crank in counterclockwise direction as viewed in FIGURE 9. The depending arm of the bell crank is connected by link 122 at 124 to a movable cam ring section 126 which is pivoted on an adjustable eccentric bushing 128. The cam ring section 126 carries the cam 26 which has, effectively, a substantially radial movement relative to the needle cylinder 6 by reason of the considerable extent of the section 126. An adjustable stop 130 serves to limit the withdrawal movement of the cam 26.

The upper end of the push rod 114 is arranged to engage an arm 132 which is also journaled on shaft 119 independently of bell crank 118. Adjustably mounted on the arm 132 is a cam 134 engageable with the outer end of a push rod 136 which is urged outwardly by a spring 138. A leaf spring 140 serves normally to hold the slide 62 in its position to retract cam 64.

It will be evident from the foregoing that as a cam 112 lifts the push rod 114, which action is transient during a step of the main cam drum, the bell crank 118 is rocked to withdraw the stitch cam 26, while at the same time plunger 136 is moved inwardly to move into its operating position the cam 64, this movement taking place against the action of the spring 140.

The operation involved in withdrawal of the auxiliary feed yarn A may now be described. Usually this withdrawal will be desired at the beginning of a single feed heel and prior to the single feed knitting of the ring toe, though it will be understood that the withdrawal may be involved in any desired transition from two feed to single feed knitting.

Referring to FIGURE 7 in which the progress of knitting is from the bottom to the top and in which the needles and the corresponding fabric loops may be considered as moving from right to left during rotary knitting, as is also the case in connection with FIGURE 1, the rotation being counterclockwise as viewed in FIGURE 6, the two lowermost courses illustrated are those alternately knit from the main yarn M and the auxiliary yarn A in the last revolution preceding that in which the yarn change is to occur. The courses C₁ and C₂ as they appear at the left hand side of FIGURE 7 are portions of the last course of rotary knitting involving the removal of the auxiliary yarn at the beginning of the heel.

Considering this course, reference may now be made primarily to FIGURES 1 and 3, with reference, as required, to the other figures.

The path of needles of group 94 may be first considered, there being considered with these the last wales 94' formed by the trailing needles of this group. The needles of group 94 are cleared over the reverse stitch cam 22 and are lowered to tuck level as indicated at "a" beneath the center cam 24. They are then further lowered by cam 26, taking yarn M at the main feed and being drawn to the lowermost stitch drawing level "c." As the needles of this group are passing and being acted on by the cam 26 the cam is slightly withdrawn so that there will later occur special action on the butts of the needles of the group 96, this withdrawal being effected in conventional fashion by control from the main cam drum of the machine. The withdrawal, however, is not sufficient to affect the needles of group 94 so that all the needles of this group pass to the lower end of the cam 26 at "c." The needles of group 94 are then raised by cam 30 to the path "d" and are further raised to tuck level by the cam 32. As they reach the active location of cam 40 the butts 16 of their corresponding jacks are raised by this cam to cause the needle butts to follow the path "e" to cleared level so that the loops of the main feed yarn M drop below their latches. During the passage by the cam 33 this cam is withdrawn so that subsequent needles will not be cleared prior to the auxiliary feed which is going out of action. The cam 33 was theretofore in action to effect normal clearing of needles not associated with jacks carrying butts 16.

After clearing, the needles of group 94 are depressed successively by cam 34 and then by stitch cam 36 to follow the path "g" during which they take the auxiliary yarn A and draw loops thereof, casting off the loops previously drawn in the main feed. Thereafter they are raised to the tuck level path over the cam 38. The foregoing action results in a continuation of the two-feed knitting in the courses C₁ and C₂ in wales 94'.

During the foregoing operations the normal sinkers 20 associated with these needles were following their conventional path. Even though cam 64 is moved inwardly simultaneously with the withdrawal of stitch cam 26, as described, the normal sinkers 20 are not acted on thereby because of the inward location of the sinker edges 82.

The needles of group 96 follow the same path as the needles of group 94 in being cleared by cam 22 and depressed by cam 24 along the path "a." These needles are partially depressed by the cam 26, but because of its withdrawal as already mentioned so that it acts only on the extension of the butts beyond the shortened portions 99, they are not fully depressed by this cam but pass along a path at a level above level "c." In passing down the cam 26 they take the main feed yarn M. However, in view of the association with these needles of the special sinkers 20' there is a special action in the handling of the yarn. As already noted, as the cam 26 is withdrawn, the cam 64 carried by the slide 62 is moved inwardly. This effects a premature action in the movement of the special sinkers 20' by engagement with the edge 90 of these sinkers, as compared with the normal inward sinker movement imparted to the normal sinkers by the cam 56, which latter movement occurs only after the yarn has been drawn over the ledges 80. The premature inward movement of the special sinkers locates their nebs 86 sufficiently inwardly of the needle hooks so that the main yarn M is drawn over the tops of the nebs of the special sinkers, thus effecting a measuring of the yarn and drawing of loops of sufficiently large size to avoid later cutting. This premature inward movement of the sinkers 20' is permitted by the low butts 92 entering the cutaway portion 60 of cam 58.

The drawing of the main yarn over the tops of the nebs of the sinkers makes up for the fact that the needles of group 96 are drawn down only to the level "b" which, as will be seen from FIGURE 1, lies between the tuck level and the normal stitch-drawing level. Because of

the limited downward movement of the needles 96, the loops of auxiliary yarn which they carry below their latches are not cast off.

The needles of group 96 now join the preceding needles of group 94 at "d" and are raised with them to tuck level by cam 32. The loops of main yarn carried by the needles 96 are not cleared, these needles following the path "f" past the withdrawn clearing cam 33. The needles of group 96 now carry the main yarn M above their latches and take the auxiliary yarn A as they pass down cam 36 along the path "g." They are then raised to tuck level by the cam 38 to follow the path "h."

It will be evident from what has just been described that because the needles of group 96 were not cleared they will draw combined stitches of both the main and auxiliary yarns in passing down the cam 36, casting off the previously formed stitches of the auxiliary yarn A held on their shanks and not cast off at cam 26, i.e., stitches of the preceding complete course of the auxiliary yarn. The result, accordingly, is the formation of the double loops of both main and auxiliary yarns as indicated at L₁, L₂ and L₃ of FIGURE 7. The auxiliary yarn finger 50 is raised out of action by the usual controls immediately after the last of the needles 96 has engaged the auxiliary yarn.

The needles of the group 98 are cleared over the reverse stitch cam 22 and are then lowered by the center cam 24 and stitch cam 26, being lowered fully by the latter, taking the main yarn M, and casting off the auxiliary yarn loops of the preceding course. Yarn change is desirably effected near the beginning of the needles of this group, and as shown in FIGURE 7, the heel yarn indicated at M' is inserted on the third needle of the group, the first two stitches L₄ and L₅ being of the leg yarn, and then stitch L₆ and a few subsequent stitches carry both the yarn M and the yarn M' to provide the usual overlap, the leg yarn M being then withdrawn.

Proceeding with the needle path, the needles of group 98 are then raised successively by cams 30 and 32 to tuck level. A few of the first needles of this group may engage, and be lowered by, the cam 36, but this cam is withdrawn during the passage of this group of needles and the remaining ones move across it and over cam 38 at tuck level. It may be noted that depression of some of these needles by the cam 36 effects no result since the auxiliary yarn A is withdrawn immediately after the needles 96 pass, and even if the needle hooks engaged the yarn it will not be drawn into stitches since there is at this time no loop below the latches, clearing of the main yarn M having not yet occurred. In general, except for accidental involvement, which will do no harm, the auxiliary yarn A will be free after its final incorporation in the loop L₃.

During the passage of the needles of group 98 past the stitch cam 26, this stitch cam is restored to its full inner position, and simultaneously the cam 64 is moved radially outwardly to its inactive position. It will, accordingly, be obvious that the needles of the group 100 will follow the same path as those of the group 98, taking the yarn M', and leaving the left-hand end of FIGURE 1 at tuck level after passing idly the auxiliary feed. The same is true of the needles of the group 102. Clearing cam 40 is rendered inoperative, by withdrawal, as the needles of group 98 pass its location, so that no clearing of the needles 102 will occur as they and their associated jacks carrying butts 16 pass the location of cam 40. (As will appear later, the jacks having butts 16 associated with the needles 102 serves for a purpose later described.)

It will be evident from what has just been described that the cams are now arranged to produce single feed knitting at the main feed on all of the needles. If the operations just described are involved in the procedure of beginning the heel the instep needles are, of course, raised out of action in conventional fashion, and the next course to be knit will be the first reverse course,

knit on the heel needles, during reciprocation. The course C₃ shown in FIGURE 7 would then be knit in the reverse direction.

However, if the transition from two-feed to single-feed knitting occurs at the beginning of the ring toe, with change to a heavier yarn, all of the needles would remain active for several rounds of rotary knitting, and consequently the course C₃ shown in FIGURE 7 would represent a course of loops formed in rotary knitting.

The operation involved in passing from single-feed to two-feed knitting will now be described with particular reference to FIGURE 8 which shows what occurs, there being assumed for purpose of description that two-feed knitting of the foot is being resumed following the single-feed reciprocatory knitting of a heel.

The course C₄ represents the last course of the heel made with the heel yarn M' during a reverse stroke of reciprocation. C₅ represents the first round of rotary knitting using the leg yarn M, it being assumed that a conventional yarn change was made at the main feed prior to reaching the portion of the fabric represented in the figure.

In the beginning of the formation of the course C₅ the cams will be in positions suitable for conventional rotary single-feed knitting. During the passage of the needles of the group 94 and 96 cam 26 is in its full inner position so that needles of the group 96 operate normally to draw stitches at the main feed. Cam 33 remains inactive. Cam 36 is dropped in against the butts of the needles of group 94, after the passage of which it moves to its full inward position.

The special operations occur during the passage of the needles of group 98. These needles, cleared over cam 22, are moved downwardly by cams 24 and 26 to draw stitches of the main feed yarn M. During the passage of the needles 98 the cam 26 is drawn outwardly preparatory to its special action on the needles of group 100. The needles of group 98 rise to tuck level over the cams 30 and 32, miss cam 33, and are again lowered by cam 36 which, as just stated, has been moved inwardly to engage their butts which are longer than the butts of the needles of group 94. This action, however, is an idle one at this time, the needles of group 98 being again raised to tuck level over cam 38. As the needles of group 98 pass the position of cam 40, this cam is moved into its active position to engage subsequent butts 16 of the pattern jacks associated with the needles of group 102.

The auxiliary yarn A is inserted prior to the passage by the auxiliary feed of the trailing needles of the group 98. However, this insertion is ineffective so far as these needles are concerned since they have already drawn stitches of the main feed yarn and have not been cleared.

The needles of the group 100, cleared over the cam 22, are lowered by the center cam 24 and then by the stitch cam 26. However, the action of the stitch cam is as described previously, and these needles are not fully lowered but take the main yarn and draw it over the nebs of the sinkers 20', to effect loop measuring, these sinkers having their premature inward movement as previously described because the cam 64 is now active, having become so when the stitch cam 26 was partially withdrawn. The action, then, is that of drawing the main yarn into loops, but without the completion of stitches, the loops carried by the needles not being cast off. The needles then rise to tuck level over cam 32 and follow the path "f," cam 33 being still out of action, and engage the auxiliary feed stitch cam 36 to be drawn downwardly along the path "g," seizing the auxiliary yarn which then lies with the main yarn within the needle hooks. As they reach the bottom of the cam 36 stitches are drawn containing both the main and auxiliary yarn as indicated at L₈, L₉ and L₁₀ in the wales 100' in FIGURE 8. These stitches are drawn over the ledges of the sinkers 20' which follow the normal sinker wave in passing the auxiliary

feed. The needles of group 100 are then raised by cam 38 to the tuck level "h."

The needles of group 102 are cleared over cam 22 and lowered by cam 24 and then fully by cam 26 to draw stitches of the main yarn M, casting off the loops previously held thereon. They then rise to tuck level over cams 30 and 32 and are raised to cleared level on path "e" by the action of cam 40 on the butts 16 of their associated pattern jacks. As these needles rise along path "e" clearing cam 33 is moved into action so as to act subsequently on all of the needles for normal clearing during the ensuing two-feed knitting. The needles of group 102 are then lowered by cam 34 and then by cam 36 to take the auxiliary yarn A and draw stitches, being then raised to tuck level by cam 38. As will be evident, the arrangement is now that required for normal two-feed knitting, the cam 26 being restored to its full inner position immediately following the passage thereby of the needles of group 100. The beginning of the two-feed knitting is indicated at C'₅ and C''₅ in FIGURE 8. Subsequent two-feed courses are indicated at C₆ and C₇.

It will now be evident that in the case of both removal and insertion of the auxiliary yarn it is incorporated along with the main yarn in complete stitches. As has already been indicated, this incorporation need be in no more than three stitches to secure such reliable frictional restraint due to its tortuous configuration that reeving to produce eyelets is rendered quite impossible. Stresses imparted to the fabric are resisted by friction to such extent that the auxiliary yarn is merely tightened without any substantial stitch-enlarging movement. All of this is accomplished with only a very minor and unnoticeable deviation of the stitches from normal form, in fact without any deviation from normality of stitches other than such as is involved in ordinary overlapping yarn change as illustrated at the right of FIGURE 7. Furthermore, as will be evident, this is accomplished with only minor variations in the machine from its standard arrangement. While the drawing of the main yarn over the nebs of sinkers is highly desirable to maintain loops of standard size and avoid any possibility of cutting, this is not absolutely necessary, particularly when the main yarn is of a type having a moderate degree of elasticity.

It will be evident that variations in details of construction and operation may be made without departure from the invention as defined in the following claims.

What is claimed is:

1. A circular knitting machine comprising:

a needle cylinder,
independent needles mounted in said cylinder, said needles comprising three successive groups of needles, two of which flank an intermediate group, elements cooperating with said needles for the formation of stitches, including means for feeding yarns at least two feed points, and means for controlling said needles and elements, during a single round of knitting, to cause needles of one of said flanking groups to take yarn at only a first of said two feed points and draw single yarn stitches,

to cause the needles of the other of said flanking groups to take yarn at both the first and the second of said two feed points and draw single yarn stitches at each of said feed points, and

to cause a plurality of adjacent needles of the intermediate group to seize yarn at said first of said feed points and form bights thereof without casting off stitches already held on the needles, said controlling means comprising a stitch cam and means for moving said stitch cam radially, the needles of said intermediate group having stepped butts to be acted upon by said stitch cam to effect selectively the last mentioned action or movement of the same needles to cast-off position, then to seize yarn at said second of said feed points, and then to draw both of said seized yarns together through the stitches already held on the needles to form stitches containing both of said yarns so successively seized.

2. A circular knitting machine comprising:

a needle cylinder,
independent needles mounted in said cylinder, elements cooperating with said needles for the formation of stitches,

said elements including means for feeding yarns at at least two feed points,

and sinkers having nebs movable between the needles, and control means including:

means for effecting yarn drawing movements of selected needles at a first of said feed points to cause said selected needles to draw yarn thereat over the nebs of sinkers but short of cast-off of stitches on said selected needles, the last means comprising a stitch cam and means for moving said stitch cam radially, said selected needles having stepped butts to be acted upon by said stitch cam to effect selectively the last mentioned action or movement of the same needles to cast-off position,

means for raising said selected needles thereafter to a tuck level without clearing of said yarn drawn thereby, and

means for then effecting seizure of yarn and yarn drawing movements at the second of said feed points with cast-off of said stitches previously thereon, thereby to effect formation of stitches containing the yarns drawn at both of said feed points.

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