ABSTRACT

Needle selecting apparatus for the selective raising of the needles of circular knitting machines wherein the needles are raised by jacks individually associated with the needles, the jacks having selecting butts of a plurality of progressively varying lengths disposed at a pair of levels on the shanks of the jacks, and wherein three pattern drum controlled radially positionable cams act progressively upon the selecting butts to raise selected jacks which, in turn, raise their associated needles. The selected needles knit a reinforce yarn in addition to the body yarn thereby to provide visible reinforce areas in hosiery while the non-selected needles knit only the body yarn. The jacks are arranged in a plurality of adjacent groups of jacks, each group of which contains a plurality of jacks and each of which has a common length selecting butt, at a first of the two levels thereof, with the length of the common length selecting butt being progressively varied in adjacent ones of the groups of jacks. Individual ones of the plurality of jacks of each group thereof, have progressively varying lengths of selecting butts at the second of the two levels thereof. A first of the jack-raising cams progressively raises the groups of jacks as a whole to an intermediate level, after which a second of the jack-raising cams progressively raises individual ones of the jacks of each group thereof to a higher level, and the remaining one of the jack-raising cams raises to the higher level those groups of jacks which have previously been raised to the higher level by the first two jack-raising cams.

6 Claims, 11 Drawing Figures
METHOD OF REINFORCING A HEEL IN KNITTED STOCKINGS AND THE LIKE

The present invention relates generally to the art of knitting, and more particularly to needle selecting apparatus for the selective raising of the needles of circular knitting machines, the apparatus being especially useful for the selective raising of needles of circular hosiery knitting machines for the formation of visible reinforce areas in the hose.

It is the principal object of the present invention to provide needles selecting apparatus for the selective raising of the needles of circular knitting machines wherein the needles of the machine are raised by jacks provided with selecting butts at a pair of levels, the jacks in turn being selectively raised by the action of three radially positionable cams on the selecting butts.

It is a further object of the present invention to provide the above set forth needle selecting apparatus, wherein the number of individual selections which can be made to raise different numbers of needles by the action of the three jacks upon the two levels of jack-selecting butts greatly exceeds the number of the jack-selecting butt levels.

It is also an object of the present invention to provide the above set forth apparatus wherein the selecting butts of the jacks at the two levels thereof are of a plurality of progressively varying lengths on individual ones of the jacks, wherein the jacks are arranged in a plurality of groups thereof, each of which contains a plurality of jacks having a common butt length at one of the two-butt levels and which have progressively varying lengths of butts at the other of the two-butt levels, the length of the common length butts progressively varied in individual ones of the plurality of groups of jacks, and wherein a pair of the jacks act upon the common length butts of the jacks of each group thereof while the third cam acts progressively upon the progressively varied butt lengths of the jacks of each group thereof.

The above and other objects and advantages of the invention will be fully apparent hereinafter, it being understood that the present invention is primarily concerned with needle selecting apparatus for circular knitting machines wherein the capacity of the apparatus is relatively great in relation to the amount of space occupied by the apparatus on the machine, all as will be described in detail hereinafter, as shown in the accompanying drawings which are illustrative of preferred embodiments of the invention and as set forth in the appended claims.

IN THE DRAWINGS

FIG. 1 is a schematic view showing the needle, cam and jack layout of a portion of a two-feed circular hosiery knitting machine wherein the needle selecting apparatus of the present invention is disposed at one of the feeds of the machine where it is used to select the needles to knit visible reinforce areas in hosiery. FIG. 1A shows the needle-raising jacks.

FIG. 2 is a view representing a six sided reinforce area in circular knit tubular hosiery as made with the needle selecting apparatus of the present invention.

FIG. 3 is a diagrammatic plan view of the butts at two butt levels on groups of the needle raising jacks used in the present invention showing the arrangement of the different butt lengths at each of the two levels thereof and also showing the raise cams which act upon the butts of different lengths to raise the jacks.

FIG. 4 is an enlarged detail view of a portion of FIG. 3.

FIG. 4A is a side elevational view of a group of side by side needle-raising jacks showing that portion of the jacks at which the two-butt levels of FIG. 3 are disposed and showing the arrangement of the different butt lengths at the two levels.

FIG. 5 is a schematic view showing the needle, cam and jack layout of a portion of an eight-feed circular hosiery knitting machine wherein the needle selecting apparatus of the present invention is operative at alternate feeds of the machine to select needles to knit visible reinforce areas in hosiery.

FIG. 5A is a view similar to FIG. 1A.

FIG. 6 is a diagrammatic view, generally similar to FIG. 3, showing an arrangement of jack butts and raising cams wherein the capacity of the needle selecting apparatus of the present invention is increased over that shown in FIG. 3.

FIG. 7 is a schematic layout of the stepped pattern drum cams which are used to control the radial positions of the jack-raising cams of the two-feed machine shown in FIG. 1.

FIG. 8 is a schematic layout of the stepped pattern drum cams which are used to control the radial positions of the jack-raising cams of the eight-feed machine shown in FIG. 5.

The circular hosiery knitting machine illustrated in FIG. 1 is provided with stitch cams 1 and 3 at the two feeds thereof for the lowering of the needles of a circle of conventional latch needles, certain of which are indicated at N and N1. The stitch cam 1 has a raise cam 5 associated therewith to act upon the needle butts to raise all the needles to latch clearing level, as shown at N1, where the needles take body yarn FN1 and are then lowered by stitch cam 1 to knit the yarn. Guard cams 7 and 9 are associated with the stitch cams 1 and 3, respectively, to prevent overthow of the needles by the stitch cams.

An upper or first needle raising jack 17, FIG. 1A, is placed below each needle in each slot of the needle cylinder of the machine. The jacks are each provided with spaced upper and lower butts 17A and 17B, respectively, and with a pair of spaced butts 17C disposed between the butts 17A and 17B. When jacks 17 are raised to their normal level in advance of stitch cam 3 by the action of cams 20 and 25 on the butts 17B of the jacks, the latter, in turn, raise the needles so that their butts move along the pathway NX, whereby the needles are raised to the same level to which they are raised by the raise cam 5 in advance of the stitch cam 1. Needles whose butts move along pathway NX are raised high enough to take only body yarn FN.

An inclined cam face 15, formed in cam ring 14, serves to lower the jacks 17 by engaging their butts 17A as the needles are lowered by stitch cam 3. A cam face 21, formed as part of the cam 20, serves as a guard cam for the jacks 17 with the downward movement of the jacks being limited by contact of their butts 17B with the cam face 21. Radially movable cams 23 and 24 are provided to act upon the butts 17B (of a plurality of lengths), to select the jacks and the needles to be raised during the knitting of certain portions of the hose.
A cam 25, movable to operative and to inoperative positions, is adapted to raise the jacks 17 in its operative position, thereby to raise the associated needles along the pathway NX to knit plain stitch fabric. When it is desired to knit mesh fabric, the cam 25 is moved to inoperative position and vertically spacedcams 16 and 18 are made operative, as required, to act upon the butts 17C of the jacks 17 to raise appropriate ones thereof and their related needles for the mesh fabric formation.

The two-feed machine and its operation as above described is conventional and the application of the needle selecting apparatus of the present invention to the machine will now be set forth.

A lower or second needle raising jack 27 is placed below each jack 17 in the cylinder slots. The jacks 27 act through the jacks 17 to raise the needles and when selected to do so, will raise the needles to a higher level than the level to which they are raised by the jacks 17 alone. Each jack 27 is provided with an upper level butt 29, a next lower level butt 31 spaced from the butt 29, and additional spaced butts 33A and 33B at a plurality of individual levels below the butt 31. The butts 33A, shown as three in number, may be selectively acted upon by appropriate ones of three pattern drum controlled radially movable jack-raising cams 35A. Similarly, the three butts 33B may be acted upon by three jack-raising cams 35B. The needle selection by the cams 35A and 35B may be used for the knitting of any desired designs in the hosiery.

While only a single length of butt is shown in FIG. 1A for the butts 29 and 31, it will be understood that these butts are of a plurality of different lengths upon individual ones of the jacks. As shown in FIG. 4A, there are jacks 27 having five progressively different lengths of butts 29, as indicated at 29G, 29F, 29E, 29C and 29B, as well as having five progressively different lengths of butts 31, as indicated at 31F, 31E, 31C, 31B and 31D. Considering five individual jacks 27, they will each have a common length of its butt 31 (any one of the five lengths thereof), and at the same time each of the five jacks will also have a different length of its butt 29. The jacks 27 are preferably arranged in individual groups of 10 jacks in each group, wherein, in each group, each adjacent pair of jacks are similar. Thus, all of the 10 jacks of the first such group will have butts 31D thereon, while the first pair of these jacks will also have butts 29B thereon, the second pair of jacks will also have butts 29C thereon, the third pair of jacks will also have butts 29E thereon, the fourth pair of jacks will also have butts 29F thereon, and the fifth and last pair of jacks will also have butts 29G thereon. The individual groups of ten jacks differ from each other only in the lengths of their common length butts 31, while the arrangement of their butts 29 remains unchanged.

Thus, the five groups of jacks may be identified by the lengths of their butts 31, as indicated at 31D, 31B, 31C, 31E, and 31F, in FIG. 3. The described arrangement of the jacks with their butt lengths is shown schematically in FIGS. 3 and 4 where the butts 29 and 31 have been shown in side by side relation for clarity. In FIG. 4, the bracket 29D embraces a group of 10 jacks, of which successive pairs are provided with butts of progressively varying lengths starting with the longest butts 29D and decreasing to the shortest butts 29G, these pairs of butts being on jacks, each of which also has thereon the common length butt 31E.

In order to selectively raise the jacks 27 by means of their butts 29 and 31, the cams 37, 39, 41, 43 and 45 are provided, FIG. 1. The cam 37, which extends around the cam shell or cam box as a continuation of the cam 39, is straddled by the butts 29 and 31 to lower any previously selected and raised jacks to a common pre-selection level at which the butts 29 pass along under the cam 41, the jacks moving in the direction of the arrow F1. The butts 29 pass between the cams 37 and 41 as the jacks are being lowered.

The cams 43 and 45 are each individually radially movable, under pattern drum control by the means shown in FIG. 7, into five operative positions from a sixth inoperative position. The innermost end of cam 45 is provided with the equivalent of a pair of cams in the arrangement of a radially spaced pair of adjoining circumferentially extending needle-raising cam faces 45A and 45B, the spacing therebetween being equal to the difference in length between any pair of butts of successive length, such as the difference in length between the butts 29C and 29B. The cam 43 is of lesser circumferential extent than cam 45 (and of cams 35A and 35B), and is disposed so that when it is in proper radial position, it will engage the butts 29 of those jacks 27 which will have been first partially raised along pathway 29X by the action of cam face 45A on butts 31. The cam 43 will thereafter further raise the so-engaged butts 29 along the pathway 29Y to a point where the butts 29 will engage cam face 38 of cam 39 and be further and fully raised thereby. The jacks 27 and 17 being thus raised by the cam 39, will raise the butts of their associated needles to a higher level along the pathway NY than the level to which they are raised by the jacks 17 alone (when jacks 17 are raised by cam 25), thereby raising the needles high enough to take the body yarn FN and to also take the higher fed reinforce yarn FS, both of which are knit by the selected needles as the latter are lowered by the stitch cam 3. The knitting of both yarns will provide stitches which are stronger than, and which are readily distinguishable from stitches knit of the body yarn, alone.

As to those jacks which are raised by the action of cam face 45A on their butts 31 so that their butts 29 move along the pathway 29X and whose butts 29 are not engaged by the cam 43 for the reason that cam 43 is not in the proper radial position to do so, such butts 29 continue along the horizontal pathway 29Y until they reach cam face 40 of cam 39 which acts on the butts 29 to lower the jacks to their common pre-selection level. Such jacks whose butts 29 move along the pathway 29Y are the non-selected jacks so that their associated needles are not raised high enough to take the reinforce yarn FS but, nevertheless, such needles are at the same time raised sufficiently high by the cam 25 acting upon their jacks 17 to take the body yarn FN.

As to those jacks 27 whose butts 31 are engaged by both the cam faces 45A and 45B, when the cam 45 is in the radial position wherein both such cam faces act upon the butts 31, such jacks are thereby raised sufficiently so that their butts 29 are thereafter engaged by the cam face 38 of cam 39 to be fully raised thereby. Similarly, those jacks 27 whose butts 33A or 33B are engaged by cams 35A or cams 35B, are also raised sufficiently thereby so that their butts 29 are engaged by the cam face 38 of cam 39 to be fully raised thereby.
The cams 43 and 45 are each provided with six individual radial positions relative to the needle cylinder, the outermost, or first position, is the inoperative position, and the remaining positions two through six are the operative positions, with position six being the innermost one thereof. In position two, the cam face 45A of cam 45 is operative (cam face 45B not being then operative) on butts 31D; in position three, the cam face 45A is operative on butts 31B while both cam faces 45A and 45B (these two cam faces being the equivalent of a separate cam) are operative on butts 31D; in position four, the cam face 45A is operative on butts 31C while both cam faces 45A and 45B are operative on butts 31D and 31B; in position five, the cam face 45A is operative on butts 31E while both cam faces 45A and 45B are operative on butts 31D, 31B and 31C; and in position six, the cam face 45A is operative on butts 31F while both cam faces 45A and 45B are operative on butts 31D, 31B, 31C, and 31E. Thus, except in its position two where cam face 45A partially raises butts 31D, the cam 45 in its other operating positions three through six will be partially raising some of the jacks by the action of cam face 45A, while at the same time it will be fully raising other of the jacks by the action of its cam faces 45A and 45B. As to those jacks which are partially raised by the cam face 45A, certain ones only will thereafter fully raised by the cam 43, depending upon the radial position of the latter.

In position two of the cam 43, it will engage and thereafter raise only the butts 29B of any group of jacks which will have first been partially raised by the cam face 45A of cam 45. Once the jacks have been so raised by cam 43, the cam face 38B of cam 39 will further raise them. In position three, the cam 43 will engage and raise the butts 29B and 29C of any group of jacks which will have first been partially raised by the cam face 45A of cam 45. In position four, the cam 43 will engage and raise the butts 29B, 29C, and 29E of any group of jacks which will have first been partially raised by the cam face 45A of cam 45. In position five, the cam 43 will engage and raise the butts 29B, 29C, 29E, and 29F, of any groups of jacks which will have first been partially raised by the cam face 45A on cam 45. And in position six, the cam 43 will engage and raise all of the butts 29B, 29C, 29E, 29F, and 29G, of any group of jacks which will have first been partially raised by cam face 45A of cam 45.

It will be understood that while, and during each time, the cam 45 remains in each of its five operative positions, the cam 43 will be passing through a cycle of its five operative positions. The stepped pattern drum cams for placing the cams 43 and 45 in their six positions are shown in FIG. 7, wherein cam profile D45 controls the positions of cam 45 and cam profile D43 controls the positions of cam 43. The levels D1 and D3 correspond to the inoperative positions in the drum and the levels D4 and D5 correspond to the operative positions in the drum and the cam 43 and 45, so that the latter may be moved radially of the machine in accordance with, and by the action of, the profiles D43 and D45 on the pattern drum.

The cam D43 has a series of five similar profiles D5 through D9, each of which is provided with a series of five steps D10 through D14 of equal length and of progressively increasing height, from left to right in FIG. 7. The cam D45 has a series of five profiles D15 through D19 of equal length and of progressively increasing height, from left to right in FIG. 7. The length of each profile D15 through D19 is equal to the length of each profile D5 through D9. The common distance on the cam profiles D43 and D45 indicated at G, (and which embraces step D10), represents one revolution of the needle cylinder of the machine. The pattern drum is preferably indexed once per revolution of the needle cylinder so that successive ones of the steps D10 through D14 act to change the position of cam 43 in successive revolutions of the needle cylinder. It will be seen that while the operative position of cam 43 is changed in each of five successive revolutions of the needle cylinder by the steps D10 through D14 of each of the profiles D5 through D9, the cam 45 remains in each of its five operative positions for five revolutions of the needle cylinder before being changed by each of the successive profiles D15 through D19.

While the needle selecting apparatus of the present invention may be used for any of the purposes for which needle selection is generally used, it is presently shown as being used to form a visible reinforce area in hosiery wherein portions of the outline of the reinforce extend at an angle to the wales. In FIG. 2, a six-sided outline is shown as representing the shape of the reinforce area desired to be made in the hosiery. The reinforce area comprises courses of stitches knit only of the body yarn FN1 at stitch cam 1, alternating with courses of stitches knit of the pair of yarns FN and FS at stitch cam 3. The start of the reinforce area is along the course line A which extends over a desired number of wales of the hose as made upon a like number of needles. In each succeeding course knit at stitch cam 3, the width of the reinforce area is increased by two wales made upon two added needles at each end of the course line A until the maximum width of the reinforce is reached. This results in the portions E, on each side of A, having outlines which extend at an angle to the wales of the hose. Thereafter, for the reversely shaped second half of the reinforce area, in each of the succeeding courses knit at stitch cam 3, the width of the reinforce area is decreased by two wales at each end thereof, by dropping two needles at each end of the line of needles until the last course, indicated at A1, is reached. The width of A1 is equal to the width of A.

The number of courses in one-half of the reinforce area is shown at C and the wales which are added to, and are taken away from, the base course A, are indicated at C1. While the reinforce area is being made, plain knitting of the body yarn only, is made at the stitch cam 1 on all of the needles.

In FIG. 3, the jacks 27 to be used and the layout of the butts 29 and 31 thereon, is shown for the formation of the reinforce area of FIG. 2. The total number of jacks 27 needed is between the ends of the line B1, and the jacks needed for the first and last equal length courses A and A1 is between the ends of the line A2. The jacks needed to be added to, and taken away from, the jacks A2 are shown between the ends of the lines B1 at both sides of the line A2. The jacks 27 along the line A2, designated as 29A, each have full length butts thereon equal in length to the butts 29B. The jacks 27 along the line A2, designated as 31A, each have full
length butts thereon equal in length to the butts 31D. To the right and left of 29A, there are five groups of butts 29 in each group, of which the butts are of different lengths, and are arranged as shown in Figs. 3 and 4. To the right and left of 31A, there are five groups of butts 31 in each group of which the butts are of the same length, while in each of these adjoining groups, the butts 29 are of different lengths, as shown in Figs. 3 and 4.

For the knitting of the first course A of the reinforce area of Fig. 2, the cam 45 is moved by cam D15 of Fig. 7 to its operative position two, and cam 43 is moved by the first of the steps D10 of the first profile DS to its operative position two. The cam face 45A of cam 45 will be in position to partially raise up pathway 29X, all of the jacks 29 which have full length butts 31 thereon, by acting upon such full length butts. These partially raised jacks comprise the groups 31A, 31D, and 31D. At the same time, the cam 43 will be in position to further raise up pathway 29Z, only those of the partially raised jacks 27 which have full length butts 29 thereon, and the latter comprises only the group 29A. Thus, the group of jacks 29A are then caused to move up the cam face 38 of cam 39 to raise jacks 17, which, in turn, raise their associated needles to the higher pathway NY to take both the yarns FN and FS.

The jacks of groups 31D, 31D, whose butts 29 were also partially raised along pathway 29X by cam face 45A, are not further raised by cam 43 since cam 43 is not in position to engage any of the butts 29 which are shorter than the full length butts 29B thereof. Consequently, the butts 29 of groups 31D, 31D, travel along pathway 29Y and are acted upon by cam 40 to lower the jacks to pre-selection level. However, the needles associated with the groups 31D, 31D, as well as all the remaining needles (except those associated with the group of jacks 29A which take the two yarns Fs and Fn) are raised to normal level along the pathway NY by the action of cam 25 on their jacks 17 to take and to knot only the yarn FN. It will be understood that for each such partial reinforce course knit at stitch cam 3, there is a plain course knot upon all the needles of yarn FN1 at stitch cam 1.

For the knitting of the second course of the reinforce area at stitch cam 3, the pattern drum is indexed in the next revolution of the machine to advance the cams of Fig. 7 one step with the result that cam 45 remains in its position two, and cam 43 is moved by the second of the steps D11 to its position three. The cam face 45A is operative as it was in the first revolution of the needle cylinder to partially raise groups 31A, 31D and 31D, however, cam 43 is now in position not only to further raise the jacks of group 31A, but also to further raise a pair of jacks of each of the groups 31D, 31D, these pairs of jacks being adjacent to, and on each side of, the central group of jacks 31A. Thus, the second course of the reinforce area to be knit at stitch cam 3 is wider by two wales at each end than is the first course.

For the knitting of the third reinforce course, the pattern drum is again indexed in the third revolution of the needle cylinder to advance the cams of Fig. 7 one step with the result that cam 45 remains in its position two (profile D15 still being in control of cam 45), and cam 43 is moved by the third of the steps D12 to its position four. The cam face 45 is still operative as it was during the first two revolutions of the machine to partially raise the same groups 31A, 31D and 31D, however, cam 43 is now in position not only to further raise the jacks of group 31A and the adjoining pairs of jacks having butts 29C, but also to further raise an additional pair of jacks of the groups 31D, 31D, having butts 29E, these pairs of jacks being adjacent to, and on each side of, the jacks of the groups 31D, 31D, which have the butts 29C thereon. Thus, the third reinforce course is wider by two wales added at each end of the second reinforce course.

Similarly, for the knitting of the fourth reinforce course, the pattern drum is again indexed in the fourth revolution of the needle cylinder to advance the cams of Fig. 7 one step, with the result that cam 45 remains in its position two, and cam 43 is moved by the fourth step D13 to its position five. The cam face 45A is still operative as it was during the first three revolutions of the cylinder to partially raise the same groups 31A, 31D and 31D, however, cam 43 is now in position not only to further raise the jacks of group 31A and the four jacks of the groups 31D, 31D, on each side of the group 31A having the butts 29C and 29E, but also, to further raise an additional pair of jacks of each of the groups 31D, 31D, having butts 29F, these jacks being adjacent to, and on each side of, the jacks of groups 31D, 31D, which have the butts 29E thereon. Thus, the fourth reinforce course is wider by two wales added at each end of the third reinforce course.

Similarly, for the knitting of the fifth reinforce course, the pattern drum is again indexed in the fifth revolution of the needle cylinder to advance the cams of Fig. 7 one step, with the result that cam 45 still remains in its position two (still being controlled by profile D15), and cam 43 is moved by the fifth step D14 to its innermost position six. The cam face 45A is still operative as it was during the first four revolutions of the cylinder to partially raise the same groups 31A, 31D, and 31D, however, cam 43 is now in position not only to further raise the jacks of group 31A and the six needles of the groups 31D, 31D, on each side of the group 31A having butts 29C, 29E, and 29F, but also to further raise an additional pair of jacks of each of the groups 31D, 31D, having butts 29G, these jacks being the last ones of the groups 31D, 31D, and being adjacent to, and on each side of, the jacks of groups 31D, 31D, which have the butts 29F thereon. In other words, cam 43 in its innermost position six further raises all of the jacks of groups 31D, 31D, which were partially raised by cam 45 in addition to further raising the jacks of group 31A which were also partially raised by cam 45. Thus, the fifth reinforce course is made with two more wales added at each end of the fourth reinforce course. The fifth reinforce course is knit by the needles associated with all of the jacks of groups 31A and the two groups 31D.

It will be understood that for groups 31D, 31D, all of the jacks were partially raised along pathway 29X during the fifth revolution of the machine by the cam face 45A of the cam 45 while it was in its position two, and that pairs of the jacks of these groups 31D, 31D, were progressively further raised along pathway 29Z as the cam 43 was progressively moved further radially inwardly from its position two through position six. For each position of cam 45 there are five positions of cam 43.
Similarly for each of the next five revolutions of the machine, the cam drum is indexed so that the profile D16 places cam 45 in position three wherein its cam face 45A partially raises the next adjacent groups of jacks 31B, 31B, and its cam faces 45A and 45B at the same time fully raise the jacks of groups 31A, 31D, 31D; and so that the five steps D10 through D14 of the profile D6 progressively places the cam 43 successively in its positions two through six wherein it progressively further raises and adds pairs of jacks of the groups 31B, 31B, to the fully raised jacks of the groups 31A, 31D, 31D.

Then for the next five revolutions of the needle cylinder, the profile D17 places the cam 45 in position four and profile D7 places cam 43 progressively in each of its five positions to add the jacks of groups 31C, 31C, to those previously selected to raise the needles.

Once again for the next five revolutions of the needle cylinder, the profile D18 places the cam 45 in position five and profile D8 places cam 43 progressively in each of its five positions to add the jacks of groups 31E, 31E, to those previously selected to raise the needles. And then, for the next five revolutions of the needle cylinder, the profile D19 places cam 45 in its position six while profile D9 places cam 43 progressively in each of its five operative positions to add the final groups of jacks 31F, 31F, to those previously selected to raise the needles.

After the aforesaid 25 revolutions of the needle cylinder, sufficient needles have been selectively raised to knit the full width course B at the midpoint of the reinforce area and it is time to knit the second half thereof. To do so, the pattern drum is provided with sets of profile in continuation of the profiles D9 and D19, such continuing sets of profiles (not shown), being reversely similar to the profiles D5 through D9, and D15 through D19, with the profiles D15 through D19 being in reverse order and the steps D10 through D14 of the profiles D5 through D9 also being in reverse order.

Under the control of the reversely similar sets of pattern drum profiles, the cams 43 and 45 will accordingly operate to progressively remove pairs of needles from each end of the previously selected needles knitting the two yarns FN and FS until the second half of the reinforce area is knit.

As illustrated schematically in FIG. 6, the capacity of the needle selecting apparatus of the present invention may be doubled by the provision of an additional row of butts 131 similar to the row of butts 31, and disposed on the jacks 27 in spaced relation to the butts 31. Also provided, is an additional cam 145 to act upon the added butts 131 in a manner similar to the manner in which cam 45 acts upon the butts 31.

A central group of jacks 27, indicated at K2, and a group of butts 131A on each side of K2, have maximum butt lengths as shown. The jacks of K2, plus those of groups 131A, are sufficient in number to extend beyond the groups of jacks 31F, FIG. 6, by the length of an additional group of jacks. Groups 131A are followed by groups 131B, 131C, 131E, and 131F, which are similar to the corresponding groups of the jacks 31. The first row of jack-butt groups 29 is correspondingly increased in length by adding groups of jacks as at 129, whose butts are similarly arranged.

In the operation of the jack butt arrangement in FIG. 6, the cams 43 and 45 first act upon the butts 31 and 29 in the manner already described in connection with FIG. 3, to selectively raise all of the needles associated with the jack-butts 29 and 31. Then the cam 45 is made inactive and cam 145 is activated, to act upon the butts 131 in the same manner that cam 45 acted upon the butts 31 while cam 43 continues to act in its regular manner upon the added group of jack-butts 129. After cam 145 has reached its innermost position, all of the needles associated with the jacks 27 whose butts 29, 31 and 131 are shown in FIG. 6, will have been raised high enough to take both body yarn and reinforce yarn to knit the same.

The needle selecting apparatus of the present invention may also be applied to an eight-feed circular hosiery knitting machine as shown in FIG. 5. In this machine, there are the stitch cams 51, 53, 55, 57, 59 and 61, and in addition to the stitch cams 1 and 3 which were also shown in the two-feed machine of FIG. 1. Those portions of the eight-feed machine of FIG. 5 which are similar to the two-feed machine of FIG. 1, are identified by the same characters. In FIG. 5, the needle selecting apparatus of the present invention is placed to work in conjunction with the stitch cam 3, and also with the stitch cam 57.

While body yarn FN is only shown as being fed in advance of stitch cam 1, it will be understood that it is also fed in advance of stitch cams 51, 55, and 59, to knit courses of body yarn only. While both body yarn and FN and reinforce yarn FS are shown as being fed in advance of stitch cams 3 and 57, it will be understood that they are also fed in advance of stitch cams 53 and 57 to knit partial courses of both yarns on the selected needles. A raise cam similar to the cam 5 in advance of stitch cam 1 is also provided in advance of stitch cams 51, 55, and 59. Needle guard cams similar to the guard cams 7 and 9 at stitch cams 1 and 3, are provided for the other stitch cams of the machine.

Cams 65, 67 and 69, similar to the cam 25 in advance of stitch cam 3, are provided in advance of stitch cams 53, 57 and 61. Also provided is a raise cam 63 which raises desired needles at the start of each hose. The several cams used in the first needle selecting apparatus shown to work with the stitch cam 3 are also shown in connection with a second similar needle selecting apparatus shown to work with the stitch cam 57, for example, the cam 43 is duplicated as cam 243, the cam 41 is duplicated as cam 241, the cam 45 is duplicated as cam 245, and so on.

The arrangement in the eight-feed machine is such that those needles which have been selectively raised in advance of stitch cam 3 by the selective raising of the jacks 27 to take both yarns FN and FS are also raised to take both yarns in advance of stitch cam 53 without a second selection of the jacks 27. And similarly, those needles which have been selectively raised in advance of stitch cam 57 to take both yarns FN and FS thereat, are also raised in advance of stitch cam 61 to take both yarns without a second selection of the jacks 27.

It will be recalled that the selectively raised jacks 27 have their butts 29 ride up cam face 38 of cam 39 to raise their associated jacks 17 and needles to bring the latter to the level at which both yarns FN and FS are taken in advance of cam 3. As these selected needles
and jacks continue to move in the direction F1, FIG. 5, the jacks 27 are partially lowered by the action of cam face 40 of cam 39 on the butts 31 of the jacks 27. Thus the butts 29 and 31 of the jacks 27 straddle the central portion 39B of cam 39 as the jacks move past stitch cam 51, (where all the needles knit body yarn only), with the result that these jacks 27 are in position to have their butts 29 acted upon and raised by cam face 38A whereby the same jacks once again raise their associated jacks 17 and needles to take both yarns in advance of stitch cam 53. Thereafter, these selected jacks are brought down to pre-selection level with their butts 29 under cam 241 by the action of cam 237 which is straddled by the butts 29 and 31.

In a similar manner, the jack selection made by the needle selecting apparatus in advance of stitch cam 57 is also used in advance of stitch cam 61. In this instance, the butts 29 of selected jacks 27 ride up cam face 238 of cam 239, to raise their associated jacks 17 and needles to take both yarns FN and FS in advance of stitch cam 61. Then the selected jacks are partially lowered by cam face 240 of cam 239 so that butts 29 ride along above cam 239B and butts 31 ride along below cam 239B past stitch cam 59 until these jacks are once again raised by the action of cam face 238A acting on the butts 29. After raising their associated jacks 17 and needles in advance of stitch cam 61, they are once again lowered to pre-selection level by the action of cam 37 which is straddled by the butts 29 and 31. Thereafter, the jacks are in position to be once again selected in advance of stitch cam 1 in the manner previously set forth.

The arrangement of the cam profiles on the pattern drum to control the positions of cams 43, 45, 243 and 245 for the eight-feed machine of FIG. 5, is schematically shown in FIG. 8. The cam profile D43M controls the six radial positions of cam 43, the cam profile D45M controls the six radial positions of cam 45, the cam profile D243M controls the six radial positions of cam 243, and the cam profile D245M controls the six radial positions of cam 245. The pattern drum is indexed once per revolution of the needle cylinder, and distance 2G represents the amount of drum movement for each indexing thereof. It will be noted that the shape and location of the profiles D43M and D243M are such that the cams 43 and 243 are not moved in unison, and, similarly, the cams 45 and 245 are not moved in unison. This difference in timing of the cam movements is necessary to secure the proper outline for the reinforce areas since, in an eight-feed machine, the body and reinforce yarns are knit at four feeds in one revolution of the needle cylinder, as distinguished from the knitting of these yarns at one feed only of the two-feed machine in one revolution thereof.

It will be understood that cam profiles which are reversely similar to the profiles shown in FIG. 8 may be provided in order to progressively decrease the number of needles being raised by the jacks 27. The action and placement of reversely similar profiles has been discussed in relation to the profiles of FIG. 7. It will also be understood that the needle selecting apparatus of the present invention may also be used on a single feed machine wherein, when the needle selecting apparatus is used for the formation of reinforce areas, there need not be courses of body yarn alone between the courses containing stitches of body yarn and of reinforce yarn.

What I claim is:

1. Needle selecting apparatus for the raising of selected needles of a circle of needles to a certain level in a circular knitting machine including a plurality of jacks individually associated with and adapted to raise said needles to said certain level, said jacks being arranged in a plurality of groups thereof, each of said jacks having selecting butts thereon at a first and at a second level, said first level selecting butts of the jacks of each group thereof being of a common length, said common length butts of each of said plurality of groups of jacks being of a plurality of progressively varying lengths, said second level selecting butts of the jacks of each group thereof being of a plurality of progressively varying lengths whereby said groups of jacks differ from each other only in the lengths of their common length butts, and including movable cams having first, second and third jack-raising faces and a fixed cam, said first cam face acting upon said first level jack butts and raising all of the jacks of selected groups thereof to a first level, said second cam face acting upon said second level jack butts and raising selected ones of the jacks of said selected groups thereof from said first to a second level, and said fixed cam face acting upon said second level jack butts and raising all of the jacks of selected groups thereof from said second to a third level, those of said jacks which have been raised to said third level being adapted to raise their associated needles to said certain level.

2. Needle selecting apparatus as in claim 1 wherein said third cam face acts upon those of said groups of jacks which have previously been acted upon by said first cam face.

3. Needle selecting apparatus as in claim 2 wherein said cam faces are movable to a plurality of operative positions radially of the machine, wherein said second cam face is progressively moved to certain of its said plurality of positions to act upon said second level jack butts during certain revolutions of said machine, and wherein said first and said third cam faces are progressively moved to certain of their said plurality of positions to act upon said first level jack butts in such manner that said first and said third cam faces remain in their respective positions during said revolutions.

4. Needle selecting apparatus as in claim 3 wherein said first and said third cam faces are spaced radially of said machine, wherein the distance between said first and said third faces is a fixed distance, and wherein said fixed distance is equal to the difference in length between the lengths of successively varying lengths of butts of said first level selecting butts.

5. Needle selecting apparatus as in claim 4, wherein the groups of said plurality of groups of jacks are adjacently disposed and include a central group of jacks, wherein the jacks of said central group thereof have their first and their second level selecting butts of maximum butt length, wherein each group of jacks of said flanking groups of jacks has its jacks so arranged that their second level selecting butts present a progressively decreasing order of butt lengths extending outwardly from said central group of jacks, and wherein each group of jacks of said flanking groups of jacks has its butts so arranged that said common lengths of their first level selecting butts also present a progressively decreasing order of butt lengths extending outwardly from said central group of jacks.
6. Needle selecting apparatus as in claim 4, wherein a body yarn is fed at a first level in said machine to all of the needles of said circle of needles, wherein a reinforce yarn is fed at a second and higher level only to those of said needles which are raised to said certain level, wherein both of said yarns are fed to said last mentioned needles, and wherein the needles taking one and taking both of said yarns are adapted to knit stitches thereof.

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