This invention relates to circular independent needle knitting machines and, more especially, to improved means for widening and narrowing in the fabric being knitted during reciprocation of a needle cylinder wherein needles which have previously been picked up out of knitting position are progressively moved back into knitting position and vice versa during the formation of sutures in tubular fabrics or seamless stockings.

Although the present invention is not limited to any particular type of circular knitting machine, the present invention is concerned with improvements in the active-needle-increasing mechanisms as well as improvements in the active-needle-decreasing mechanisms disclosed in my copending application entitled Knitting Machine, Serial Number 192,955, filed October 30, 1950, now Patent No. 2,757,526, of which the present application is a continuation-in-part.

In said copending application, the means for widening in the fabric includes two sets of widening picks each including a pair of coacting widening picks, each of which lowers two needles upon each revolution of the needle cylinder during reciprocatory knitting and wherein narrowing picks are provided which have a capacity to move two needles to inoperative or elevated position before the needles approach the stitch cams. This results in the yarn knitted in a substantially rectilinear area forming two additional wales in each succeeding course, in the knitting of Argyle fabrics.

The knitting machine disclosed in my copending application is provided with two narrowing picks each having means for varying the capacity thereof so they may pick up either one or two needles to move them out of action with each movement of the needle cylinder during reciprocation thereof. The aforementioned knitting machine also has two sets of widening picks each including a pair of coacting widening picks, each of which lowers two needles upon each revolution of the needle cylinder during reciprocatory knitting. Widening pick feed cams are provided for selectively lowering needles to where the butts of the leading needles corresponding to the direction of rotation of the needle cylinder engage and are lowered by one of the sets of widening picks with rotation of the needle cylinder in one direction and, as said one set of widening picks are lowered by the needles, they cause the other of said sets of widening picks to move into operative position thereby, upon the next movement of the cylinder in the other direction, the other set of widening picks is positioned so as to engage the butts of and lower the then leading needles directed thereto. The other set of widening picks also operates to move the first-named set of widening picks back into operating position and this continues through reciprocatory knitting.

Because of the fact that the widening picks of each set are moved into operating position by the other widening picks, it has been necessary, heretofore, to increase the number of needles in action with each revolution of the needle cylinder in which widening of the fabric is taking place during reciprocatory knitting with the result that each gusset, rectilinear area or triangular area formed from a particular yarn in knitting a stockings has had to be substantially symmetrical each side of the longitudinal center or centermost wale in knitting any given area, at least insomuch as the widened portions of such areas are concerned.

It is an object of this invention to provide a circular knitting machine of the type having two spaced sets of widening picks each having two or more widening picks, with pattern controlled means for moving the widening picks in either or both sets independently of each other into or out of operating position and to further provide means, under control of said pattern controlled means, for moving at least one of the widening picks in either or both sets into or out of operating position independent of all of the other widening picks. This greatly increases the patterning capabilities of the knitting machine, since the number of needles in action can be increased by one or more needles upon predeterminedly selected rotatory movements of the needle cylinder during reciprocatory knitting so the gusset, triangular area or rectilinear area thus knitted may be widened at one side only relative to a given wale or it may be widened a substantially greater number of needles from course to course at one side thereof than it is at the other side thereof or it may be widened an equal number of needles at each side of a given wale according to any desired preconceived pattern.

It is another object of this invention to provide individually controlled widening picks in a circular knitting machine in combination with variable-capacity narrowing picks whereby narrowing of the fabric by one or more wales may take place with successive movements of the needle cylinder in one direction and widening of the fabric by one or more wales may take place with intervening movements of the needle cylinder in the other direction during reciprocatory knitting.

It is another object of this invention to provide pattern controlled means for rendering the variable-capacity narrowing picks inoperative during reciprocatory knitting to enlarge the scope of patterns which may be knit and to provide better cooperation between the widening picks and the narrowing picks.

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

Figure 1 is a front elevation of a knitting machine of substantially the character shown in my said copending application and showing parts of the improved mechanism for controlling the position of the improved widening picks;

Figure 2 is an enlarged view with parts broken away looking substantially along line 2—2 at the left-hand side of the central portion of Figure 1;

Figure 3 is a fragmentary elevation looking at the right-hand side of Figure 1 substantially along line 3—3;

Figure 4 is an enlarged fragmentary detail, mostly in section, taken substantially along line 4—4 in Figure 3;

Figure 5 is a greatly enlarged view of the left-hand central portion of Figure 1;

Figure 6 is a sectional plan view taken substantially along line 6—6 in Figure 5;

Figure 7 is an enlarged fragmentary elevation, with parts broken away and partially in section, taken looking substantially along line 7—7 in Figure 6 and showing the pattern controlled means for engaging and controlling the position of the stems of the said left-hand widening picks;
Figure 8 is a fragmentary vertical sectional view taken substantially along line 8—8 in Figure 7;
Figure 9 is a fragmentary vertical sectional view taken substantially along line 9—9 in Figure 7;
Figure 10 is an enlarged fragmentary elevation, with parts broken away and in section, taken substantially along line 10—10 in Figure 6 and showing the pattern controlled means for engaging and positioning the stems of the right-hand widening picks;
Figure 11 is a fragmentary vertical sectional view looking substantially along line 11—11 at the right hand side of Figure 10;
Figure 12 is a fragmentary plan view of a rear portion of the top auxiliary pattern drum taken substantially along line 12—12 in Figure 5;
Figure 13 is a view of the widening picks shown in Figure 7 with some of the parts in different positions;
Figure 14 is a view similar to Figure 13 with some of the parts in different positions;
Figure 15 is an enlarged fragmentary detail, showing a means to render one of the narrowing picks inactive, taken substantially along line 15—15 in Figure 6;
Figure 16 is a side elevation of a men's half hose showing the improved widening and narrowing patterns which must be knitted when utilizing the improved widening and narrowing pick controls;
Figure 17 is a view similar to Figure 16 showing another of the patterns which may be knitted;
Figure 18 is a developed view of the patterned area of the hose shown in Figure 16;
Figure 19 is a schematic view of the needle cams surrounding the needle cylinder as if looking from the inside of the needle cylinder;
Figure 20 is a view of the patterned area of the hose shown in Figure 17.

Brief synopsis of the machine

As heretofore stated, the present invention is primarily concerned with the devices for increasing the number of needles in action during the widening of a fabric portion, that is, means for individually controlling each of a plurality of widening picks. The principles of the present invention may be readily applied to many different types of circular knitting machines. However, the utility of the present invention can best be expressed by application of the principles of the present invention to machines of the character disclosed in my co-pending application, Serial No. 118,964, filed September 30, 1949 and entitled Knitting Machine and Method of Knitting Hosiery and Other Fabrics, and the machine disclosed in my co-pending application, Serial Number 192,935, filed October 30, 1950 and entitled Knitting Machine. Accordingly, the present invention is shown in association with a machine of substantially the character disclosed in my co-pending application, Serial No. 192,935 and, since this machine is fully illustrated and described in the last-named co-pending application, many of the parts shown in the present drawings will not be described herein in detail and only the function of such parts will be hereinafter described sufficiently to define the manner in which they cooperate with the improved controls for the widening picks.

The machine to which the present invention is shown as being applied has many of the principles of knitting machines heretofore in use, many of the parts being adapted to the machine from a machine of the type made by Scott and Williams under Model No. B-5 and as shown in the patent to R. W. Scott, No. 1,152,850 of September 7, 1915.

As disclosed in my co-pending application, Serial No. 192,935, the present machine employs much of the conventional type of driving and clutch mechanisms of said patent for shifting from rotary to reciprocatory knitting and also employs the conventional type of main cam shaft having the usual pattern chain and main cam drum thereon for controlling the clutch mechanism. The usual type of needle cylinder and latch needles which move in individual slots in the periphery of the needle cylinder are provided, the needle cylinder being driven, at times, to rotate and at other times to reciprocate. The usual type of sinker head is employed having conventional sinkers therein which are controlled by conventional cams in a sinker cap associated therewith. A top or first auxiliary pattern drum, also termed a needle cam control pattern drum, is driven in a step-by-step manner and a clutch mechanism is provided on one end of the main drive shaft of the machine for engaging the needle cylinder at predetermined intervals. The yarn feeding, clamping and cutting means of the present machine may be identical to those disclosed in said co-pending application Serial No. 192,935 and the widening and narrowing picks associated with the present machine are similar to those disclosed in the last-named co-pending application.

The present invention resides in novel means for controlling the sets of widening picks so they may be brought into operation individually, severally or in their entirety and wherein the widening picks cooperate with the narrowing picks in increasing the number of needles in action from course to course during widening in the fabric being knitted. As a matter of fact, the improved controls for the widening picks enable such cooperative action between the widening picks and the variable capacity narrowing picks disclosed in said co-pending application Serial No. 192,935 to the extent that the number of needles brought into action with rotation of the needle cylinder in one direction may be increased by one or more needles while the number of needles in action may remain constant with movement of the needle cylinder in the other direction during reciprocatory knitting, or the number of needles in action with movement of the needle cylinder in either direction may be increased by one or more needles and decreased by one or more needles upon the next movement or revolution of the needle cylinder in the opposite direction. Figures 16, 17, 18 and 20 show two of many different types of varied patterned areas which may be formed in a tubular knit fabric or in men's hose by means of the improved pattern controlled widening picks cooperating with the variable-capacity narrowing picks.

Referring to Figure 1, the knitting machine comprises a frame 100 having a main base 101 supported on legs 102 and to which the lower ends of cast upright standards 103, 103a are suitably secured. A pattern chain 104 controls a conventional shifting mechanism generally designated at 105 which operates in a conventional manner to alternately transmit a reciprocatory motion from a driven pulley 106 to a bevel gear 107 through a shaft 108. The bevel gear, in turn, imparts corresponding movement to a conventional needle cylinder 110 (Figures 6 and 11) in the usual manner, as disclosed in said Patent No. 1,152,850 and in said co-pending applications.

The needle cylinder 110 carries the usual type of independent vertically movable latch needles such as is indicated at N in Figures 11 and 19. Each of the needles N has a butt 111 extending outwardly from the lower end thereof. The latch needles N are of the conventional type and alternate ones of the needles preferably have conventional jacks J (Figures 11 and 19) disposed therebelow which are employed in raising alternate needles for taking elastic yarn in the hooks thereof. The needles N cooperate with the usual sinkers in drawing stitches. The sinkers, not shown, are mounted in a conventional sinker head 113 (Figures 1, 2 and 5) supported in the usual manner on the usual needle cylinder 110 and above which a latch ring 114 is mounted.

The needle cylinder 110 extends through a conventional circular bed plate or cam plate 116 adjacent which an auxiliary bed plate 117 is disposed, the circular bed or cam plate 116 and auxiliary bed plate 117 being suitably secured to the upright members 103, 103a of the frame 100.
The circular bed plate 116 supports the various needle cams, the yarn feed fingers, the clamping and cutting mechanisms and the post to which the latch ring 114 is secured, all in a manner substantially as shown in said copending application, Serial No. 192,935. A conventional sock horn 120 is also mounted for vertical sliding movement in the circular bed plate 116, the sock horn 120 being raised and lowered in a conventional manner for effecting the desired amount of tension, or length of stitches, in the fabric being knit.

A plurality of yarns generally designated at Y are drawn from a suitable source, pass through suitable respective tensioning devices 121, 122 and, hence, downwardly through individual yarn holding and clamping fingers (Figures 1 and 5) each of which is designated at 123. The yarn holding and clamping fingers 123 may be of the type disclosed in said last-named copending application and are individually pattern controlled for directing the yarns Y, one at a time, through an opening 124 (Figure 19) formed in the side of the latch ring 114 for selectively directing the yarns to the needles N.

The lower portion of the needle cylinder 100 is surrounded by a plurality of stationary and movable needle and jack raising and lowering cams which are shown in Figure 19 as being arranged in substantially the same manner as disclosed in said last-named copending application. Referring to Figure 19, the inner or operating ends of the needle and jack controlling cams are shown, as though looking outwardly from the center of the needle cylinder, the set of stitch cams being disposed adjacent the rear of the needle cylinder as shown in Figure 6.

A conventional cam cylinder or ring 130, of substantially greater internal diameter than the external diameter of the needle cylinder 110, surrounds the needle cylinder 110 and has a jack guiding ring 131 fixed to the inner surface thereof whose lower edge is spaced upwardly from the lower edge of the cam cylinder 130 so as to provide a slot through which the butts of the needle jacks J may pass. The jack guide ring 131 is cut away at one side thereof and has a conventional jack lowering cam 134 and a needle guide cam 135 mounted in the space defined by the cut-away portion of the jack guide ring 131. The lower proximal portions of cams 134, 135 are cut away to form an inverted V-shaped opening in which an advancing jack cam 136 is disposed for raising the needle jacks J, alternate needles having a conventional needle jack J disposed in the same vertical plane for raising them so they may take the elastic yarn R (Figures 1 and 3) fed thereto by an elastic yarn feed finger 137, during the knitting of the elastic top of a stocking. The elastic yarn feed finger 137 may be controlled in identically the manner disclosed in said last-named copending application and a further description thereof is thus deemed unnecessary.

A segmental needle support race 140 is mounted atop the jack guide ring 131 and terminates at one end thereof in engagement with the cam 135. Conventional hardened cams 141, 142 are disposed at a point at the rear of the knitting machine, which, together, form a V-shaped opening from which sloping respective surfaces 143, 144 of hardened cams 141, 142 lead in opposite directions to return the butts of any needles, which may be passed into said opening during the knitting operation, to a mean horizontal plane.

A set of stitch cams defining a knitting station is disposed in the V-shaped opening defined by surfaces 143, 144, said knitting station or set of stitch cams being disposed below the yarn feed opening 124 in the latch ring 114. The stitch cams include bottom and top center cams 145, 146 and left-hand and right-hand stitch cams 147, 148.

Although conventional narrowing picks may be employed in the present instance, the effectiveness of the improved controls for the widening picks, to be later described, is best realized by utilization of variable-capacity narrowing picks of the type disclosed in said last-named copending application Serial No. 192,935. Accordingly, variable-capacity narrowing picks of this type are shown in Figures 6 and 19, the left-hand narrowing pick being broadly designated at 150 and the right-hand widening pick being broadly designated at 151. The narrowing picks 150, 151 will be later described in detail.

Reading from right to left in Figure 19, the needle cams include upper and lower stationary needle leveling cams 152, 153 which are provided to insure that needles will be directed to respective right-hand and left-hand widening pick feed cams 154, 155 at the proper elevation. The widening pick feed cams 154, 155 are shiftable radially inwardly and outwardly relative to the needle cylinder according to a predetermined pattern. As the needles N move from right to left in Figure 19, those needles whose butts 111 are disposed on a level between the leveling cams 152, 153 are lowered by the right-hand widening pick feed cam 154 when it is in operative position and those needles which are disposed on said mean horizontal plane, that is, below the level of the lower leveling cam 153, are elevated by a first elevating switch cam 156 when the latter cam is in operative position, depending upon the lengths of the butts 111 on the corresponding needles N.

Referring to the left-hand portion of Figure 19, as the needles move from left to right, any needles whose butts 111 are disposed on a level between the leveling cams 152, 153 may be lowered by the left-hand widening pick feed cam 155 and any needles whose butts are disposed on said mean horizontal level may be elevated by a second needle elevating switch cam 157 when the latter is in operative position and depending upon the length of the butts of the corresponding needles. At times when the right-hand widening pick feed cam 154 is in operative position and during counterclockwise movement of the needle cylinder, this will direct the butts of certain of the needles downwardly to a set or pair of second right-hand widening picks 163, 164, respectively.

Upon the left-hand widening pick feed cam 155 being moved to operative position and during clockwise movement of the needle cylinder, cam 155 will direct the butts of certain needles downwardly to engage a set or pair of first and second left-hand widening picks 165, 166, respectively. The right-hand and left-hand widening picks each have a capacity for engaging and lowering two needles when the widening picks are positioned for reception of the butts of the leading needles directed downwardly by the respective widening pick feed cams 154, 155. The widening picks 163 to 166, inclusive, are constructed and supported in substantially the same manner as the widening picks shown in said last-named copending application, as will be later described. How ever, novel means peculiar to the present invention are provided for positioning the widening picks 163 to 166, inclusive, in operative or non-operative position either individually or in their entirety, this being one of the important features of the present invention. The mounting and controls for the widening picks will be later described.

Disposed to the left of and below the level of the right-hand widening picks 163, 164 in Figure 19 is a first needle lowering switch cam 170 which is normally disposed out of the path of travel of the butts of all the
needles in the needle circle, but is adapted to engage the butts of alternate needles which are directed thereto by the corresponding jacks J in knitting the elastic top of a stocking whereby the butts of all the needles are in lowered position so they engage and ride up the right-hand hardened cam 142 to direct the butts of the needles through the stitch cams. Spaced above the right-hand hardened cam 142 and to the right of the right-hand stitch cam 148 is a third elevating switch cam 171 above which a portion of a second lowering switch cam 172 is disposed.

Disposed to the left and above the stitch cam 147 is an auxiliary needle leveling cam 173, this being a stationery cam. All of the cams described and shown in Figure 19 may be mounted in identically the same manner as that disclosed in said last-named coping application and, therefore, only so much of certain of these cams will be described in detail as is necessary to a clear understanding of the present invention. It might be stated that the right-hand widening pick feed cam 154 is controlled as to radial inward and outward movement relative to the needle cylinder by suitable cams on a lower auxiliary pattern drum 175; the first elevating switch cam 156 (Figure 19) is controlled by the lower auxiliary pattern drum 175 and by suitable cams on a top auxiliary pattern drum 176 (Figures 1, 2 and 5); the second elevating switch cam 157 (Figures 6 and 19) is controlled by suitable cams on the top auxiliary pattern drum 176; the first needle lowering cam 170 is controlled by suitable cams on the lower auxiliary pattern drum 175; and the third elevating switch cam 171 and the second lowering switch cam 172 are each controlled by suitable cams on the top auxiliary pattern drum 176; all in identically the same manner as that disclosed in said last-named coping application and, therefore, the intervening connections between the needle control cams 154, 156, 157, 170, 171, 172 and the corresponding auxiliary pattern drums will not be described. The top and lower auxiliary pattern drums 176, 175 are also mounted and are pattern controlled for intermittent rotation in identically the manner disclosed in said last-named coping application and a further description of these pattern drums is also deemed unnecessary.

In order that the advantages of the improved controls for the widening picks 163 to 166, inclusive, may be fully realized, the present machine is equipped with means for shogging the needle cylinder, which means is broadly designated at 200 in Figure 2. The shogging means 200 in the present application is identical to the shogging means disclosed in said last-named coping application Serial No. 192,935 and the butts of the needles in the needle circle may also be arranged in substantially the same manner as that described in said last-named coping application. Since the shogging means 200 is fully disclosed in said last-named coping application, only a brief description thereof will now be given.

The shogging means 200 generally comprises a shogging disk 201 which is fixed on the end of the shaft 108 on which the cylinder-driving gear 107 is loosely mounted and which shogging disk 201 carries a pivoted latch or locking finger 202 (Figure 2) adapted to selectively engage, one at a time, a plurality of notches n formed in the periphery of a locking disk 203 fixed on the outer surface of the cylinder-driving gear 107. The position of the locking finger or latch 202 is determined by the shogging crank arm 204 pivoted on a vertical shaft 205 (Figures 2 and 5) depending from the circular bed plate 116.

It is thus seen that, when the latch or locking finger 202 is in engagement with any one of the notches n in the locking disk 203, rotational movement of the shaft 108 is transmitted to the cylinder-driving gear 107 to, in turn, impart corresponding movement to the needle cylinder 110. Thus, the means for shogging the needle cylinder causes a certain group, representing a portion of the needles in the needle circle, to move equidistant past the knitting station in knitting a first portion of a stocking during reciprocatory knitting, for example. When the needle cylinder is shogged, the pattern controlled arm 204 releases the latch or locking finger 202 from engagement with its corresponding notch n in the locking disk 203 so the shaft 108 then causes the shogging disk 201 to rotate relative to the gear 107. The shogging operation is further carried out by the arm 204 subsequently causing the latch or locking finger 202 to move into another notch n in the periphery of the locking disk 203 whereupon movement is again imparted to the needle cylinder 110.

The shogging of the needle cylinder causes either a group of needles opposite the first-named group to move equidistant past the knitting station during reciprocatory knitting or to cause another group of needles, including some of the needles in the first group along with additional needles from the second group, to move equidistant past the knitting station in order to produce triangular or recinelline areas in knitted fabric wherein the junctures of adjacent areas, generally referred to as the suture, may extend at an angle relative to the wales and courses being knitted.

Variable-capacity narrowing picks

As heretofore stated, the narrowing picks 150, 151 are preferably of the type disclosed in said last-named coping application. Due to the fact that each of the four widening picks 163 to 166, inclusive, when in operative position, engages the butts of two needles, depending upon the direction of rotation of the needle cylinder. Now, at times, it is necessary that a single needle be picked up by one of the narrowing picks during each movement of the needle cylinder in either direction and, at other times, it is necessary that one or both of the narrowing picks 150, 151 pick up two needles during movement of the needle cylinder in either direction and, at still other times, it is necessary that neither of the narrowing picks 150, 151 picks up any needles during each movement of the needle cylinder in either direction.

Since the means for varying the capacity of the narrowing picks 150, 151 shown in the present drawings is identical to that described in said last-named coping application, only a sufficient description thereof will be given to provide a clear understanding of the present invention. A more detailed description will be later given of the means for moving the narrowing picks to inoperative position so they will not raise any needles. The capacity of the narrowing picks 150, 151 is varied so these picks may pick up either one or two needles by means under control of a conventional main pattern drum 210 (Figure 2) and, at certain times, the right-hand narrowing pick 151 is elevated to inoperative position to thus move the pick 150 to operative position by means under control of suitable cams on the top auxiliary pattern drum 176, although the right-hand narrowing pick 151 may have been moved to inoperative position by any of the butts of the needles moving from right to left in Figure 19 having engaged the same.

For example, during the shogging operations of the needle cylinder, all the needles in the needle circle assume an elevated position so the butts thereof pass above the stitch cams and, upon going to a recinelline area following a shogging operation, two needles are moved downwardly to pass through the stitch cams as the needle cylinder moves in a counterclockwise direction in Figure 6. It is apparent that, upon these two needles being moved downwardly, if the right-hand narrowing pick 151 is then in operative position, these two needles would engage and be elevated to inoperative position by the right-hand narrowing pick 151. It is essential that these two first needles remain in a lowered position and pass through the stitch cams and, therefore, the right-hand narrowing pick 151 is elevated to inoperative posi-
tion by suitable cams on the top auxiliary pattern drum or first needle cam control pattern drum 176.

Generally, the narrowing picks 150, 151 are each uni-
versally mounted on a base 211 suitably secured to the rear portion of the circular bed plate 116 (Figures 6 and 15). Each narrowing pick 150, 151 is provided with a notch 112 in the inner free end of the con-
necting link 214 of the corresponding narrowing pick 150, 151 adjacent to the needle cylinder. The brackets 215 engaging the lower surfaces of the corresponding narrowing picks 150, 151 are pivoted to the top auxiliary or first needle cam control pattern drum 176 and are adapted to be successively engaged by suitable circularly spaced cams, not shown, on the drum 176, as is clearly illustrated and described in said last-named con-
necting application. The present invention also includes a novel left-hand narrowing pick lifter lever 223 (Figures 6 and 15) which is pivotally connected to the narrowing picks 150, 151 inoperative at certain times. One end of the lever 223 has a foot portion integral therewith which engages the lower surface of the left-hand narrowing pick 150 and, will, at times, raise the pick 150 to a position above the level of the left-hand stitch cam 147 so that any needles N which are raised by the stitch cam 147 will pass therebeneath. The pick 150 is raised high enough for the buttons 111 on the needles N to pass therebeneath, but is not raised high enough to engage the buttons 111 on the needles N which pass above the cam 173 (Figure 19).

An adjustable stop in the form of a screw 223a is posi-
tioned beneath the lever 223 (Figure 15) and is engaged 223a to the plate 117 and the reading end of the lever 223 oscillately mounted (Figure 15).

In order to widen two needles in each course during reciprocatory knitting it has been necessary to lower two needles with each widening pick, into knitting position, and raise two of the lowered needles with the corresponding narrowing pick so that only two additional needles would pass through the stitch cam 110 with each movement of the needle cylinder. Now, in order to increase the number of need-

The lever 223 is oscillately secured intermediate its ends, as at 224 (Figures 6 and 15), on a standard 225, 226 the lower end of which is fixed on the bed plate 116. The outer end of the lever 223 has one end of a Bowden wire 226 secured thereto, and the other end of the Bowden wire 226 is secured to the plate 117 and the reading end of the lever 223 is resil-
ently urged against the periphery of the drum 176 by a
tension spring 228b, at times, and at other times is urged against cams 229 fixed on the drum 176 and spaced therearound according to the desired pattern. The inner end of the spring 228b is fixed on the lever 228 and the other end thereof is fixed to a spring perch 228c fixed to the plate 117.

Improved controls for widening picks

As disclosed in said copending application Serial No. 192,935, in addition to the right-hand widening pick feed cam 154 being individually controlled by the lower auxiliary pattern drum or second needle cam control pattern drum 176, the right-hand widening pick 154 also operates in alternation with the left-hand widening pick 155 during widening operations. Of course, the widening pick feed cams 154, 155 are normally biased outwardly and they may be alternately moved into operative position during widening operations by means identical to that shown in said last-named copending application. However, a more efficient, more easily constructed and maintained means for this purpose is shown in the present drawings which will now be described in detail.

As disclosed in said last-named copending application, the top auxiliary pattern drum or first needle cam control pattern drum 176 is intermittently rotated in a step-by-step manner by a ratchet mechanism controlled by a continuously driven rotary cam driven stepping cylinder 231 (Figures 1, 3 and 4), this stepping cylinder 231 being journaled on a shaft 232 which is, in part, supported by a bracket 233 fixed to a rearwardly projecting portion 234 (Figure 3) of the auxiliary bed plate 117. Since the intervening connections between the top auxiliary pattern drum 176 and stepping cylinder 231 for driving the drum 176 in a step-by-step manner are clearly shown and described in the said last-named copending application, a detailed illustration and description thereof is deemed unnecessary.

As a matter of fact, the stepping cylinder 231 is only described in the present application because it is instrumental in controlling the movement of the widening pick feed cams 154, 155 during widening operations.

As is the case in said last-named copending application, the outer portions of the stems of the right-hand and left-hand widening pick feed cams 154, 155 each have a protrusion 236 thereon which is in the form of an angle clip (Figure 6). The angle clips 236 are each adapted to be resiliently engaged by one of a pair of substantially L-shaped dogs 237 oscillatingly mounted on opposite ends of a laterally movable V-shaped feed actuating arm 238.

The inner ends of the L-shaped dogs 237 are normally urged inwardly by respective tension springs 239. The central portion of the V-shaped cam actuating arm 238 is fixed on the upper end of a post 240 journaled in a bracket 241 suitably secured to the front surface of the circular bed plate 116 (Figures 1, 2, 5 and 6). The post 240 loosely penetrates the bracket 241, is suitably restrained from vertical movement therein and has one end of a crank arm 242 fixed thereto and extending rearwardly therefrom. One end of a link 243 is pivotally connected to the rear end of arm 242. Link 243 extends to the right in Figures 1 and 5 and is pivotally connected, as at 244 (Figures 1 and 3), to the front end of a lever 245. The lever 245 is pivotally supported intermediate its ends on a stud or post 246 suitably secured to and extending upwardly from the auxiliary bed plate 117 (Figure 3).

It will be observed in Figures 1 and 3 that lever 245 extends rearwardly and has an outwardly and downwardly projecting portion 250 on its rear end (Figures 1 and 4) on which one end of a pivot follower support 251 is pivotally mounted, as at 252. It will be observed in Figure 4 that the pivot follower support 251 projects into the hollow steed cylinder 231 and has an upwardly projecting follower 253 thereon which is adapted to, at times, engage the inner edges of a pair of circularly spaced cams 254 suitably secured to the inner surface of the stepping cylinder 231.

It will be observed in Figures 3 and 4 that the medial portion of the follower support 251 rests upon and is controlled by a lever 256 which is pivotally mounted intermediate its ends on the bracket 233 heretofore described. The rear end of lever 256 has one end of a Bowden wire 257 connected thereto, the upper end of the housing of which is clampingly or otherwise secured to the rear end of an arm 260 whose front end is suitably secured to the outer surface of bracket 233. Referring to Figures 2 and 3, the Bowden wire 257 extends downwardly from lever 256, beneath the base plate 101 and then upwardly on the other side thereof to the housing of Bowden wire 257 is clampingly or otherwise secured, as at 262, to a bracket 263 (Figure 2) carried by the frame 100. The Bowden wire 257 then extends upwardly and out of its housing where it is pivotally connected to the outer end of a cam follower lever 264. The cam follower lever 264 extends rearwardly and is pivoted on a rod 265 projecting from the uprising frame member 103a and the other end of the lever 264 is alternately engaged by the periphery of the lower auxiliary pattern drum 175 and suitable circularly spaced cams 265a thereon (Figure 2).

The rear end of the cam follower lever 264 is resiliently urged toward the lower auxiliary pattern drum 175 by a spring 266 one end of which is secured to the lever 264 and the other end of which is fixed to the bed plate 116 (Figure 2). It is thus seen that, when the rear end of the follower lever 264 is in engagement with the periphery of the lower auxiliary pattern drum 175, the follower support 251 (Figure 4) occupies a substantially horizontal or operative position so the irregular inner edges of the cams 254 will impart reciprocatory movement to follower 253 inwardly and outwardly as they move in engagement with the cam follower 253. In so doing, the intervening links of the follower support 251 and the post 240 (Figures 1 and 5) impart rocking movement to the feed cam actuating arm 238 to thereby impart corresponding inward and outward movement to the widening pick feed cams 154, 155 (Figures 6 and 11). It is apparent that, when a cam 265a engages follower lever 264, lever 256 is moved counterclockwise in Figure 3 to permit follower 253 to move downwardly, by gravity (Figure 4), out of engagement with cams 254.

Now, in said last-named copending application, either set of widening picks was moved into operative position by the left set of widening picks into an operative position as effected by said other set or at least one of the widening picks in said other set being engaged and lowered by engagement with the butts of corresponding needles as the needle cylinder rotated in the corresponding direction. However, in the present instance, each set of widening picks is moved inwardly and, at times, into operative position, through oscillation of the feed cam actuating arm 238, as imparted thereto by the means heretofore described.

To this end, the feed cam actuating arm 238 has the front ends of a pair of rearwardly diverging widening pick actuating arms 270, 271 fixed thereto whose hooked free rear ends alternately engage respective abutments 271, 271' which are in the form of the vertical legs of angle clips in Figures 6, 7, 8, 10 and 11. The substantially horizontal legs of the angle clips 271, 271' extend outwardly and are fixed to the upper bifurcated ends of respective vertically disposed shafts 272, 272' which serve as parts of universal mountings for the respective inner right-hand and left-hand widening picks 163, 165.

Since both the right-hand and left-hand sets of widening picks 163, 164 and 165, 166 are mounted and controlled in an identical manner, except being opposite hand, only a detailed description will be given as to the manner in which the set of right-hand widening picks
163, 164 (Figures 6, 10 and 11) are mounted and the same reference characters shall apply to like parts associated with the set of left-hand widening picks 165, 166.

It will be observed in Figures 6, 10 and 11 that the shank or medial portion of the widening pick 164 is oscillatably mounted for movement about a substantially horizontal axis in the slotted or bifurcated upper end of the vertically disposed shaft 272 and the shank or medial portion of the outer right-hand widening pick 164 is mounted for pivotal movement about a substantially horizontal axis in the bifurcated lower end of a substantially vertically disposed shaft 273. Referring to Figure 11, it will be noted that each of the vertically disposed shafts 272, 273 has a reduced lower portion 274 oscillatably mounted in vertically spaced outwardly projecting ears 275, 276 integral with a block 277 suitably secured to the upper surface of the circular bed plate 116.

The universal mounting for each of the widening picks 163, 164 also includes a suitable spring anchor 280 projecting radially from the lower portion 274 of the corresponding vertically disposed shaft, between the projections or ears 275, 276. The lower end of the tension spring 281 is connected to the spring anchor 280, in each instance, and the upper end of the spring 281 is connected intermediate the ends of the shank or stem of the corresponding widening picks 163, 164 at a point between the outer ends thereof and the universal mounting therefor.

It will be observed in Figures 6, 10 and 11 that the inner widening pick 163 has an angularly projecting tail portion 283 thereon in which one end of an adjustment screw 284 is adjustably secured. The other end of the adjustment screw serves as an abutment for engaging the shank of the outer right-hand widening pick 164. It is thus seen that, each time the feed cam actuating arm 238 moves in a clockwise direction in Figure 6 the pick activating arm 270 engages the angle clip 271 to impart counterclockwise movement to the inner or first right-hand widening pick 163 which will, in turn, impart corresponding movement to the outer or second right-hand widening pick 164 by means of the adjustment screw 284.

Movement of the inner or first right-hand widening pick 163 in a counterclockwise direction is limited by engagement of the angle clip 271 with an abutment 285 inclusive, move as they are swung outwardly with respect to the longitudinal center thereof. To this end, it will be observed in Figures 10, 11, 7, 8 and 9 that the outer portions of the respective sets of right-hand and left-hand widening picks 163, 164 and 165, 166 resiliently bear against the upper surfaces of right-hand and left-hand widening pick cam plates 290, 290', whose upper edges are generally flat and extend in a substantially horizontal plane and have respective pairs of spaced projections or abutments 291, 292 and 291', 292' thereon for limiting the inward movement of the corresponding sets of widening picks 163, 164 and 165, 166 toward the longitudinal axis of the needle cylinder 110 which will hereinafter be termed as the longitudinal center of the machine.

It will be noted that the surfaces of the projections or abutments 291, 292 and 291', 292' which are adaptively to be engaged by the outer end portions of the shanks of the respective widening picks 163 to 166, inclusive, define the outer walls of respective notches 293, 294. The inclined inner walls of notches 291, 292, 291', 292' serve as cam surfaces downwardly against which the outer portions, of the corresponding widening picks 163 to 166, are adapted to move as they are swung outwardly with respect to the longitudinal center of the machine by the corresponding...
activating arms 270, 270'. Thus, the operating or needle engaging ends of the widening picks are moved upwardly in the course of such outward movement of the outer portions or shanks thereof to occupy operating-level positions. It is apparent that, when any of the widening picks 163 to 166, inclusive, are subsequently swung outwardly at their needle engaging ends relative to the center of the machine, the outer portions or tails thereof ride up the inclined cam surfaces formed by the notches 293 to 294', inclusive, so that the movement of the buttons of any needles thereagainst causes the readin or needle engaging ends of the widening picks to move downwardly to lower the corresponding needles to where those needles whose butts are not subsequently engaged by a corresponding narrowing pick and elevated thereby will pass through the stitch cams to form stitches therewith. It will be observed in Figures 8, 9 and 11 that the right-hand and left-hand widening pick control guide cams or cam plates 290, 290' are formed integral with respective guide blocks 295, 295' suitably secured to the respective widening pick pivot shaft supporting blocks 277, 277'. It will also be noted that the widening pick control cams 290, 290' define the inner walls of respective grooves 296, 296' formed in the upper edges of the guide blocks 295, 295'. The outer walls of the respective grooves 296, 296' are disposed on a substantially lower level than the upper edges of the respective widening pick control cams 290, 290'. Widening pick selector cams or guide restrictor plates 297, 297' are mounted for longitudinal movement in the respective grooves 296, 296' and it will be noted that the upper edges of selector picks 297, 297' (Figures 10 and 7, respectively) are disposed on substantially the same level as the flat upper edges of the respective widening pick guide plate cams 290, 290'. The upper edges of the selector cams or plates 297, 297' have respective notches 300, 300' in the central portions thereof which are of substantially the same configuration as and are adapted to, at times, register with the respective notches 294, 294' in the upper edges of the respective guide plates 290, 290'. The outer ends of the selector cams or plates 297, 297' have respective inclined cam surfaces 301, 301' thereon which are adapted to, at times, register with the inclined inner walls of the notches 295, 295' in the respective widening pick cam plates 290, 290'. It will be noted that with partial movement of the selector cam 297', for example, from left to right in Figure 7 to the intermediate position shown in Figure 13 the cam surface 301' registers with the inclined surface of the both 283 and, with partial movement of the selector cam 297 from right to left in Figure 10, the cam surface 301 registers with the inclined surface of the notch 293. With the selector cams or plates 297, 297' occupying the latter positions, it is apparent that the inner ends of the first right-hand and left-hand widening picks 163, 165 will remain in lowered or inoperative position throughout oscillatory movement thereof as imparted thereto by the respective activating arms 270, 270' in one direction and as is imparted to the outer or second right-hand and left-hand widening picks 164, 166 by the butts of a needle directed thereto with movement of the needle cylinder in the corresponding directions. When the widening pick selector cams or plates 297, 297' occupy the positions shown in Figures 10 and 7, respectively, it is apparent that, with oscillation of the widening picks 163 to 166, inclusive, in either direction about their respective vertical axes, all of the widening picks 163 to 166, inclusive, will remain inactive. As a matter of fact, immediately following the movement of either or both of the selector cams 297, 297' to the positions shown in Figures 10 and 7, respectively, as imparted thereto by the activating arms 270, 270', the operating types of the widening picks in each set will remain in an inward position relative to the longitudinal center of the machine, although the butts of certain needles may be lowered to the operating level of the corresponding widening sets of widening picks, and the widening picks will then be disposed below said operating level or on an inoperative level. When both of the widening picks 163, 164 and 165, 166 in each set is to be active in lowering needles with corresponding movements of the needle cylinder, it is apparent that the selector plates 297, 297' are then moved inwardly to where the notches 300, 300' register with the respective notches 294, 294' to thereby open both the notches 293, 294 and 293', 294' in the respective cam plates 290, 290' as shown in Figure 14. Now, the position of the selector plates 297, 297' is individually pattern controlled so the selector cam 297' for example, may occupy fully operational position; with its notch 300 in register with the notch 294 in the cam plate 290 and the selector cam 297' may still occupy the position shown in Figure 7. In other words, each of the selector cams or plates 297, 297' may be caused to occupy any one of the three positions heretofore described and shown in Figures 7, 13 and 14 independently of the other of said selector plates according to a predetermined pattern. It will be observed in Figures 10 and 7 that the selector plates or cam 297, 297' are normally urged outwardly toward fully operative position, to register the respective sets of widening picks 163, 164 and 165, 166 inoperative, by means of respective tension springs 303, 303' whose outer ends, with respect to the longitudinal center of the machine, are suitably anchored, as at 304, 304', to the respective guide blocks 295, 295' and whose inner ends are suitably anchored to the selector plates 297, 297'. In this instance, the inner end of the tension spring 303 is anchored to the outer end of a pivot shaft 305 (Figure 10) and the inner end of the tension spring 303' is anchored to an abutment, pin or projection 305' (Figures 7, 13 and 14) projecting forwardly from the selector cam 297'. The pivot pin or shaft 305 has one end of a link 306 pivotally connected thereto and extending inwardly therefrom, toward the center of the machine, and whose inner end is pivotally connected to the substantially vertical arm of a bell crank 307. The bell crank 307 is oscillately mounted, as at 310, on a bracket 311 suitably secured to a fixed part of the machine, such as the cam block 287. The other, substantially horizontal, leg of the bell crank 307 has the upper end of a link 312 pivotally connected thereto whose lower end is pivotally connected to the front end of one of the follower levers 177 (Figure 2) heretofore described. The follower lever 177 is urged upwardly against the periphery of the lower auxiliary pattern drum 175 or against the stepped surfaces of corresponding circularly spaced cams 314, fixed to the periphery of the lower auxiliary pattern drum 175, by means of the tension spring 303 (Figure 10). Referring to Figures 7, 8, 13 and 14 it will be observed that the spring 303' urges the pin or abutment 305' against the upper portion of a control lever 307' oscillately mounted, as at 310', on a fixed part of the machine, such as the base block 277'. The front end of a link 312' is pivotally connected to the corresponding lever 307'. Link 312' curves rearwardly (Figures 2 and 6) and loosely penetrates the lower end of the substantially vertical arm of a bell crank 315 and has an abutment or collar 316 fixed on its rear end which is normally urged against said arm of the bell crank 315 by the spring 303' and an adaptive leg of said bell crank 315 against the upper surface of an offset substantially horizontal portion 321 of a thrust rod 322 (Figures 2 and 6) guided
in an upper thrust rod guide 327, in which many of the other thrust rods, not described in the present application but clearly shown and described in said last-named pending application, are guided for vertical movement. The guide 327 is suitably supported by the circular bed plate 116.

The thrust rod 322 extends downwardly and is guided adjacent its lower end in a conventional lower thrust rod guide 329 (Figure 2) and its lower end either bears against the periphery of the main pattern drum 210 or it is engaged and elevated by the stepped surfaces of the circularly spaced cams 330 (Figure 2) suitably secured to the periphery of the main cam drum 210.

It is thus seen that, when the cam follower arm 177 to which the link 312 is connected and the lower end of the thrust rod 322 are engaged by the lower auxiliary pattern drum 175 and the main pattern drum 210, respectively, which may be termed as the lowermost cam surfaces, the widening pick selector cams 297, 297' occupy the positions shown in Figures 10 and 7, respectively, so the inner ends of all the widening picks remain below operating level and remain inoperative. When the cam follower arm 177 connected to link 312 and the thrust rod 322 are engaged by the intermediate cam surfaces on any one of the respective cams 314 and 330, it is apparent that the respective selector cams 297, 297' are moved inwardly toward the center of the machine, to interlace with the corresponding outer widening picks 164, 166. So the inner ends of each corresponding outer widening picks or second widening picks 164, 166 will be elevated to operative position, each time they swing inwardly to the center of the machine, as such movement is imparted thereto by outward movement of the corresponding widening pick activating arms 270, 270'.

On the other hand, the inner or first right-hand and left-hand widening picks 163, 165 will remain on an inoperative level each time they are moved inwardly toward the center of the machine in the manner described. Thus, as the butts of needles are directed downwardly by the widening pick feed cams 154, 155 in respective counterclockwise and clockwise movements of the needle cylinder in Figure 6, it is apparent that the leading two needles will be engaged by the respective outer widening picks 164, 166 and lowered thereby. Of course, when only two needles are lowered by the widening picks with movement of the needle cylinder in one direction or the other, or both, the corresponding narrowing pick or picks 150, 151 may then be restricted by the corresponding restrictor bars 216 so they will only pick up one needle and move the same to inoperative position or the narrowing picks 150, 151 may both be moved to inoperative position, in the manner previously described so that they do not pick up either of the needles lowered by the widening picks 164, 166.

It is apparent that, upon the follower arm 177, to which link 312 is connected, and the thrust rod 322 being engaged by the high surfaces of any one of the corresponding cams 314 or 330, the corresponding selector cams or plates 297, 297' will be moved inwardly to fully inoperative position as shown in Figure 14 to thereby render both of the widening picks operative in the corresponding set. It is apparent that the stepped cams 314, 330 on the drum 175, 210 and the surfaces thereof may be arranged in any desired order so the positions of the widening pick selector cams 297, 297' are independently controlled and the stepped cams 314 and 330 may also be divided between the lower and upper levels thereof to form separate low and high cams.

It is thus seen that the cams for controlling the capacity of the cams 229 for controlling operation of the narrowing picks and the cams 314, 330 for controlling the widening picks may be arranged so that one or two additional needles may pass through the stitch cams during a widening operation with movement of the needle cylinder in one direction regardless of the number of additional needles which pass through the stitch cams with intervening movements of the needle cylinder in the other direction.

Narrowing and widening variations

The conditions of the narrowing picks 150, 151 and the widening picks 163 to 166, inclusive, for effecting different forms of widening and narrowing operations are itemized as follows:

I. This condition of the narrowing and widening picks is used when it is desired to knit a pattern area in which each succeeding course is shortened by one needle end thereof and is referred to as a narrowing operation. In this instance, both of the right-hand widening picks 163, 164 and both of the left-hand widening picks 165, 166 are inactive and the narrowing pick restrictors 216 are both in their innermost or operative positions so that the narrowing picks 150, 151 each has a capacity for raising one needle to inoperative position during respective clockwise and counterclockwise movements of the needle cylinder 110. In order to move both the right-hand and left-hand sets of widening picks to inactive position, the widening pick selector cams 297, 297' will be moved to the positions shown in Figure 7, respectively. Thus, with each counterclockwise movement of the needle cylinder 110, the leading needle of the then active or lowered group of needles engages the right-hand narrowing pick 151 and is raised upwardly thereby to move said needle to inoperative position above the top center stitch cam 146 and to thus decrease the number of needles passing through the stitch cam by one with each counterclockwise movement of the needle cylinder. Upon the intervening clockwise movements of the needle cylinder 110, the leading needle of the group of lowered or operative needles engages the left-hand narrowing pick 150 and is raised upwardly thereby above the top center stitch cam 146 to move said needle over the stitch cams and decrease the number of needles passing through the stitch cams by one needle with each clockwise movement of the needle cylinder.

II. This condition of the narrowing and widening picks is used when it is desired to knit a pattern area in which the length of each succeeding course is decreased by two stitches at one end thereof in a narrowing operation to form a symmetrically narrowed patch. In this instance, both of the right-hand widening picks 163, 164 and both of the left-hand widening picks 165, 166 are inactive and the narrowing pick restrictors 216 are both inoperative or in withdrawn position so that both of the narrowing picks 150, 151 have a capacity for raising two needles to inoperative position during respective clockwise and counterclockwise movements of the needle cylinder 110. Both the right-hand and left-hand sets of widening picks are maintained on the inoperative level by the selector cams 297, 297' occupying the positions shown in Figures 10 and 7.

Thus, with each counterclockwise movement of the needle cylinder 110 the leading two needles of the then active or lowered group of needles engages the right-hand narrowing pick 151 and is raised upwardly thereby to raise the latter two needles to inoperative position above the top center stitch cam 146 and to decrease the number of needles passing through the stitch cam by two with each counterclockwise movement of the needle cylinder. With intervening clockwise movements of the needle cylinder 110 the leading two needles of the group of lowered or active needles engages the left-hand narrowing pick 150 and are raised upwardly thereby so they pass above the stitch cams and decrease the number of needles passing through the stitch cams by two needles with each clockwise movement of the needle cylinder.
widened patch and is referred to as a widening operation. In this instance, the right-hand widening pick 164 and the left-hand widening pick 166 are active or in needle registers 151 and 156, respectively, so that the actuator pick restrictors 142 are either both in their innermost or operative position so that each of the narrowing picks 150, 151 has a capacity for raising one needle to inoperative position during each corresponding movement of the needle cylinder 110. In order to condition the right-hand and left-hand widening picks 164, 166 so they may be moved to active level, the pick actuator arms 270, 270', the selector cams 297, 297' will both be moved to the position in which selector cam 297' is shown in Figure 13.

Thus, with each counterclockwise movement of the needle cylinder 110 the leading needles of the then inactive or raised group of needles will be engaged by the right-hand widening pick feed cam 154 and lowered so the leading two of said group of needles may engage the right-hand widening pick 164 to be lowered further thereby so they may pass through the stitch cams. However, the leading needle of the then lowered needles engages the right-hand narrowing pick 151 and is raised upwardly thereby to pass above the top center stitch cam 146. The combined action of the widening pick 164 lowering two needles to operative position and the right-hand narrowing pick 151 raising one needle to inoperative position results in the number of needles passing through the stitch cams being increased by two with each movement of the needle cylinder 110.

Upon intervening clockwise movements of the needle cylinder 110, the leading needles of the then inoperative or raised group of needles are lowered by the left-hand widening pick feed cam 166, the leading two of which are further lowered by the left-hand widening pick 166. The leading needle of the lowered or operative needles is then engaged by the left-hand narrowing pick 150 and raised to inoperative position to pass above the top center stitch cam 146. Thus, with the left-hand widening pick 166 lowering two additional needles to operative position and the left-hand narrowing pick 150 raising one needle out of operation, the number of needles passing through the stitch cams is decreased by one with each clockwise movement of the needle cylinder.

IV. This condition of the narrowing and widening picks is used when it is desired to knit a pattern area or patch in which the length of successive courses is not affected, but wherein each succeeding course is stepped over one stitch to form a diagonal pattern area or patch, where in the number of active needles is increased by one with each clockwise movement of the needle cylinder and the number of needles in action is decreased by one needle with each counterclockwise movement of the needle cylinder. In this instance, the right-hand widening picks 163, 164 and the left-hand widening pick 165 are rendered inactive and only the left-hand widening pick 166 is rendered active. Also, the narrowing pick restrictors 216 both occupy operative or inoperative position so that each of the narrowing picks 150, 151 has a capacity for raising a single needle to inoperative position during corresponding movements of the needle cylinder 110.

In order to render both of the right-hand widening picks 163, 164 inactive the selector cam or plate 297 occupies the fully operative position as shown in Figure 10. In order to render the outer left-hand widening pick 166 active and to render the inner left-hand widening pick 165 inactive, the selector cam or plate 297 occupies the intermediate position shown in Figure 13. Thus, with each counterclockwise movement of the needle cylinder 110 the leading needle of the active or lowered group of needles engages the right-hand narrowing pick 151 and is raised thereby to pass above the top center stitch cam 146 and to thereby decrease the number of needles passing through the stitch cams by one with each clockwise movement of the needle cylinder.

Upon each intervening clockwise movement of the needle cylinder 110; the leading two needles of the group of needles lowered by the widening pick feed cam 154 are further lowered by the left-hand widening pick 166 to operative position and the leading needle of the then lowered group of needles will be engaged by the left-hand narrowing pick 150 and raised thereby to pass above the top center stitch cam 146 to thus increase the number of active needles passing through the stitch cams by one needle with each clockwise movement of the needle cylinder.

VI. This condition of the narrowing and widening picks is the reverse of condition V and is used when it is desired to knit a pattern area in which the number of needles in action from course to course remains constant, but where in each successive course is stepped over one needle to
form a diagonal patch which extends at an angle somewhat with respect to an area knit according to the arrangement in condition V. In this instance, the right-hand widening pick 164 is active, the left-hand widening picks 165, 166 and the right-hand widening pick 163 are inactive and the narrowing pick 162 are both in their innermost or operative positions so that each of the narrowing picks 150, 151 has a capacity for raising one needle to inoperative position.

In order to render the left-hand widening picks 165, 166 inactive, the selector cam 297 occupies the position shown in Figure 13. Thus, with each counterclockwise movement of the needle cylinder 110, the leading two needles of the group of needles lowered by the widening pick feed cam 154 are further lowered to operative position by widening pick 164 and the narrowing pick 151 engages the leading needle of the then lowered needles and is raised thereby to cause said last-named leading needle to pass above the top center stitch cam 146 to increase the number of active needles passing through the stitch cams by one with each counterclockwise movement of the needle cylinder. Upon intervening clockwise movements of the needle cylinder 110, the leading needle of the group of lowered or active needles engages the left-hand narrowing pick 150 and is raised thereby to pass above the top center stitch cam 146 to thus decrease the number of needles in action by one needle with each clockwise movement of the needle cylinder.

VIII. This condition of the narrowing and widening picks is the reverse of condition VII. In this instance, only the right-hand widening pick 164 is rendered inactive, the left-hand widening picks 165, 166 and the right-hand widening pick 163 are rendered active, the narrowing pick restrictor 216 on the left-hand narrowing pick 150 occupies its outermost or inoperative position, so the narrowing pick 151 has a capacity for raising two needles to inoperative position, and the pick restrictor 216 on the right-hand narrowing pick 151 occupies its innermost or operative position so the narrowing pick 151 has a capacity for raising one needle to inoperative position.

In order to render the right-hand widening pick 164 active and the right-hand widening pick 163 inactive, the selector plate 297 occupies intermediate position (see selector plate 297 in Figure 13) and in order to render both of the left-hand widening picks 165, 166 active the selector cam or plate 297 occupies the fully inoperative position shown in Figure 14. Thus, with each counterclockwise movement of the needle cylinder 110 the leading two needles of the group of needles lowered by the widening pick feed cam 154 are further lowered to operative position by the right-hand widening pick 164 and the leading needle of the then lowered or operative needles will be engaged and raised upwardly by the right-hand narrowing pick 151 to pass above the top center stitch cam 146 to increase the number of active needles by one with each counterclockwise movement of the needle cylinder.

Upon intervening clockwise movements of the needle cylinder 110, the leading four needles of the group of needles lowered by the left-hand widening pick feed cam 155 engage the left-hand widening picks 165, 166 and are further lowered to operative position. The then leading two needles subsequently engage the left-hand narrowing pick 150 and are raised upwardly thereby to pass above the top center stitch cam 146 thereby increasing the number of active needles by two with each clockwise movement of the needle cylinder.

IX. This condition of the narrowing and widening picks is used when it is desired to knit a pattern area in which each succeeding course remains the same length, but wherein each succeeding course is stepped over two stitches in one direction relative to the stitches of the preceding course to form a diagonal patch or pattern area of the same width extending in angular relationship to a given wale. In this instance, both of the right-hand widening picks 163, 164 are rendered inactive and both of the narrowing pick restrictors 216 occupy their outermost or inoperative positions so the narrowing picks 150, 151 each has a capacity for raising two needles to inoperative position during knitting of alternate courses.

In order to render both of the right-hand widening picks 163, 164 operative, the selector plate 297 occupies inoperative position, such as that in which the selector plate 297 is shown in Figure 14. In order to render the left-hand widening pick 166 active while rendering pick 165 inactive, the selector plate 297 occupies the position shown in Figure 13. Thus, with each counterclockwise movement of the needle cylinder 110 the leading four needles of the group of needles lowered by the widening pick feed cam 154 are further lowered by the right-hand widening picks 163, 164 and the leading two needles of the then lowered group of needles are raised by the right-hand narrowing pick 151 to pass above the top center stitch cam 146 thereby increasing the number of active needles by two with each counterclockwise movement of the needle cylinder.

Upon intervening clockwise movements of the needle cylinder 110, the leading two needles of the group of
then lowered needles engage the left-hand narrowing pick 150 and are raised thereby to pass above the top center stitch cam 146 to decrease the number of active needles by two needles with each clockwise movement of the needle cylinder.

X. This condition is the reverse of condition IX. In this instance, both of the right-hand widening picks 163, 164 are rendered inactive, both of the left-hand widening picks 153, 154 are again rendered active and the narrowing picks 165, 166, the pick restrictor 216 on the left-hand widening picks 165, 166 active, the selector cam 297 occupies the position shown in Figure 14. To render both right-hand widening picks 163, 164 inactive, the selector cam 297 occupies the position shown in Figure 10 and to render both of the left-hand widening picks 165, 166 active, the selector cam 297 occupies the position shown in Figure 14.

Thus, with each counterclockwise movement of the needle cylinder 110, the leading two needles of the then inactive or lowered group of needles engage the right-hand narrowing pick 151 and are raised thereby to pass above the top center stitch cam 146 and to thus decrease the number of active needles by two with each counterclockwise movement of the needle cylinder. Upon intervening clockwise movements of the needle cylinder 110, the leading four needles of the group of needles lowered by the left-hand widening pick feed cam 155 and are rendered inactive by the left-hand widening picks 165, 166 and the leading two needles of the then lowered group of needles engage the left-hand narrowing pick 150 and are raised thereby to pass above the top center stitch cam 146 thereby increasing the number of active needles by two needles with each clockwise movement of the needle cylinder.

XI. This condition of the narrowing and widening picks is used when it is desired to knit a patterned area in which each successive course is shortened at one end thereof by one stitch with movement of cylinder 110 in one direction and shortened by two stitches when knitting in the opposite direction to form a narrow patch whose inwardly converging sides extend at different angles. In this instance, both of the right-hand widening picks 163, 164 and both of the left-hand widening picks 165, 166 are rendered inactive and the restrictor 216 on the right-hand narrowing pick 151 occupies its innermost or inactive position so the narrowing pick 151 has a capacity for raising one needle to inactive position during each counterclockwise movement of the needle cylinder 110. The pick restrictor 216 on the left-hand narrowing pick 150 then occupies its innermost or inactive position so the narrowing pick 150 has a capacity for raising one needle to inactive position during each clockwise movement of the needle cylinder 110.

In order to render both the right-hand and left-hand sets of widening picks inactive the selector cams 297, 297' occupy the positions shown in Figures 10 and 7, respectively. Thus, with each counterclockwise movement of the needle cylinder 110 the leading two needles of the then active or lowered group of needles engage the right-hand narrowing pick 151 and are raised thereby to pass above the top center stitch cam 146 to decrease the number of active needles by two with each counterclockwise movement of the needle cylinder 110. Upon intervening clockwise movements of the needle cylinder 110, the leading needle of the group of lowered or operative needles engages the left-hand narrowing pick 150 and is raised thereby to pass above the stitch cams thereby decreasing the number of active needles by one needle with each clockwise movement of the needle cylinder.

XII. This condition is the reverse of condition XI. In this instance, both of the right-hand widening picks 163, 164 and both of the left-hand widening picks 165, 166 are again rendered inactive as in condition XI, the pick restrictor 216 on the right-hand narrowing pick 151 occupies its innermost or operative position so the narrowing pick 151 has a capacity for raising one needle to inoperative position during each counterclockwise movement of the needle cylinder 110 and the pick restrictor 216 on the left-hand narrowing pick 150 occupies its outermost or inoperative position so the left-hand narrowing pick 150 has a capacity for raising two needles to inoperative position during each clockwise movement of cylinder 110.

Thus, when right-hand counterclockwise movement of the needle cylinder 110, the leading one of the then lowered or active group of needles engages the right-hand narrowing pick 151 and is raised to inoperative position to pass above the top center stitch cam 146 and to thus decrease the number of active needles by one with each counterclockwise movement of the needle cylinder. Upon intervening clockwise movements of the needle cylinder 110, the leading two needles of the group of lowered or operative needles engage the left-hand narrowing pick 150 and are raised thereby to pass above the stitch cams thereby decreasing the number of active needles by two needles with each clockwise movement of the needle cylinder.

**Description of hose**

Referring to Figures 16, 17, 18 and 20 there are shown two of many different types of patterns which may be produced by application of the various conditions of the widening and narrowing picks heretofore described. Figures 16 and 17 each show portions of a man's lower leg hose and Figures 18 and 20 show the pattern areas of the hose shown in the respective Figures 16 and 17 as though the hose were cut along a line up the front of the hose and spread out flat. The hose in Figure 16 is generally indicated at 335 and includes the usual top 336, a pattern or design area 337, a heel pocket 337, and a foot 338, the usual toe pocket being omitted.

After the top 336 is knit by circular knitting, the needle cylinder 110 is shogged one-fourth revolution, whereupon the pattern area or leg is knit by first knitting a V-shaped gusset 340 by narrowing with the widening and widening picks operating as described in condition I. The needle cylinder 110 is then shogged one-half revolution and a similar V-shaped gusset 341 is then knit in the same manner as gusset 340. It is apparent that a yarn change may be effected at the start of knitting any one of the areas forming the hose, if desired, by means fully disclosed in my last-named copending application. Each of the gussets 340, 341 is formed by starting knitting with approximately half the needles in the needle cylinder 110 in a lowered position and the narrowing operations are carried out according to condition I until all the needles have been raised to inoperative position.

The needle cylinder 110 is then shogged one-fourth revolution and a diamond-shaped area 342 is then knit at the front of the hose 335 by starting with, say, two needles and widening operations are then carried out according to the manner described in condition III until approximately one-half of the needles in the needle cylinder are lowered to pass through the stitch cams. Narrowing operation then takes place in accordance with condition I until all of the lowered needles have been raised to inoperative position.

A relatively needle-dense pattern area 343 is then knit at the rear of the hose 335 with widening being carried out in the manner described in condition III until approximately one-fourth of the needles in the needle cylinder are lowered to pass through the stitch cams. Thereafter, narrowing is again effected according to condition I until all of the needles have again been raised to inoperative position to obtain pattern area 343. The needle cylinder 110 is then shogged one-eighth revolution and an angularly disposed parallelogram or diagonal patch 344 is then formed by knitting and widening in the manner described in condition III down to the dotted line indicated at 344a or until approximately
one-fourth of the needles in the needle cylinder pass through the stitch cams. Knitting is then continued by alternately narrowing and widening in the manner described in condition V until the area 344 is knit down to a dotted line 345a (Figures 16 and 18) or until approximately one-fourth of the needles in the needle cylinder pass through the stitch cams. Knitting by alternately widening and narrowing is then carried out in the manner described in condition VI down to a dotted line 345b whereupon knitting by narrowing, according to the manner described in condition I, is carried out until all of the needles are raised to inoperative position.

The needle cylinder 110 is then shogged one-fourth revolution and another angularly disposed parallelogram area 346 is knit by first widening in the manner described in condition III down to a dotted line 346a (Figures 16 and 18) or until approximately one half of the needles are in action in the first course. Narrowing of the fabric, in which one needle is raised out of action in each successive course, is then carried out in the manner described in condition I until all of the needles have again been raised out of action.

The needle cylinder 110 is then shogged one-fourth revolution, whereupon a diamond-shaped area 346 is knit, starting with approximately two needles in action in the first course and progressively widening by bringing two additional needles into action as each alternate course is knit and by bringing one additional needle into action as each intervening course is knit, this procedure being followed down to a dotted line 356a (Figures 17 and 20). This widening is effected in the manner described in condition VII. Thereafter, the fabric is widened on one side of a given wale in alternate courses and on the other side of the wale in intervening courses, by a single stitch, in which knitting is carried out in the manner described in condition V, down to a dotted line 356b.

The fabric is then narrowed, in which two needles are raised out of action in knitting each alternate course and one needle is raised out of action in knitting each intervening course, in the manner described in condition XI, until approximately one half of the needles have been raised out of action. The needle cylinder is then shogged one-half revolution, whereupon another diagonal area 357, similar to area 356, is knit, starting with approximately two needles in action in the first course and again progressively widening, by bringing two additional needles into action in knitting each alternate course and by bringing one additional needle into action in knitting each intervening course, according to condition VIII heretofore described.

It should be noted that increasing the number of needles in action by two, in knitting the upper portion of diagonal area 357, occurs with movement of the needle cylinder in the opposite direction from that in which it moves in likewise increasing the number of needles in action in knitting the upper portion of area 356. Widening continues until one needle in condition VII is knit to a dotted line 357a (Figure 20), after which the fabric is narrowed according to condition VI. In condition VI, the number of needles in action is increased by one in each alternate course and the number of needles in action is decreased by one in each intervening course.

Widening and narrowing is carried out in the manner last described down to a dotted line 357b, after which the fabric is narrowed according to condition XII, until substantially all of the needles have been raised out of action, to complete the knitting of the diagonal area 357. It should be noted that the widening and narrowing operations in the central portion of diagonal area 357 occur in opposite relation to the widening and narrowing operations in the central portion of diagonal area 356.

After diagonal area 357 is knit, the needle cylinder 110 is shogged one-fourth revolution for knitting a relatively large inverted V-shaped area or gusset 358 between the diagonal areas 356, 357. Starting with approximately two needles in action, gusset 358 is knit by widening according to condition III, until approximately one-half of the needles are returned to action. The stitches are retained on the latter needles as the needle cylinder is again shogged one-half revolution for knitting another relatively small inverted V-shaped area or gusset 359 at the back of the hose. Again starting with approximately two needles, gusset 359 is knit by widening, according to condition IV, until approximately one-half of the needles have again been lowered into action, thus com-
pleting the knitting of the pattern area. The remainder of the hose 350 is then knit in a conventional manner.

It is apparent that the terminal needles used in forming said herein to point out the fact therefore described retain the stitches thereon until adjacent courses are formed to thereby form sutures at the junctures of adjacent areas, as disclosed in said last-named copending application.

Although the action of the narrowing picks 150, 151 and the widening picks 163 to 166, inclusive, has been described herein to point out the fact therefore described or patches may be knit by selectively increasing or decreasing the number of needles in action either side of a given wale or given needle by either one or two needles, it is contemplated that the capacity of each of the widening picks and/or the narrowing picks may be varied to operate upon substantially more than two needles, without departing from the spirit of the invention, since a mere duplication of parts would be required in order to increase the capacity of the narrowing picks and/or the widening picks.

It is thus seen that I have provided novel means for selectively controlling the widening picks and narrowing picks of a circular knitting machine wherein the number of active needles may be increased or decreased by one or more during reciprocatory knitting with movement of the needle cylinder in either direction, regardless of whether one, or more than one, needle is picked down into or picked up out of action with immediately preceding and/or succeeding movements of the needle cylinder in the opposite direction.

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

I claim:

1. In a circular knitting machine; the combination with a needle cylinder having vertically movable needles and means for feeding yarns to the needles, of means to shog the needle cylinder, means to reciprocate said cylinder so as to knit a portion of a tubular fabric having a plurality of independently knit yarns in a single course, means for varying the number of needles knitting by one or more during reciprocatory knitting with movement of the needle cylinder in one direction, and means for increasing the number of needles knitting by one or more during successive movements of the needle cylinder in the other direction in the knitting of a single article.

2. In a circular knitting machine; the combination with a needle cylinder having vertically movable needles and means for feeding yarns to the needles, of means to shog the needle cylinder, means to reciprocate said cylinder so as to knit a portion of a tubular fabric having a plurality of independently knit yarns in a single course, means for varying the number of needles knitting by one or more during reciprocatory knitting with movement of the needle cylinder in one direction, and means for increasing the number of needles knitting by one or more during successive movements of the needle cylinder in the other direction in the knitting of a single article.

3. In a circular knitting machine; the combination with a needle cylinder having vertically movable needles and means for feeding yarns to the needles, of means to shog the needle cylinder, means to reciprocate said cylinder so as to knit a portion of a tubular fabric having a plurality of independently knit yarns in a single course, means for varying the number of needles knitting by one or more during reciprocatory knitting with movement of the needle cylinder in one direction, and means for increasing the number of needles knitting by one or more during successive movements of the needle cylinder in the other direction in the knitting of a single article.

4. In a circular knitting machine; the combination with a needle cylinder having vertically movable needles and means for feeding yarns to the needles, of means to shog the needle cylinder, means to reciprocate said cylinder so as to knit a portion of a tubular fabric having a plurality of independently knit yarns in a single course, means for decreasing the number of needles knitting by one or more during reciprocatory knitting with movement of the needle cylinder in one direction, and means for increasing the number of needles knitting by one or more during successive movements of the needle cylinder in the other direction in the knitting of a single article.

5. In a circular knitting machine; the combination with a needle cylinder having vertically movable needles and means for feeding yarns to the needles, of means to shog the needle cylinder, means to reciprocate said cylinder so as to knit a portion of a tubular fabric having a plurality of independently knit yarns in a single course, means for decreasing the number of needles knitting by more than one needle upon each of a plurality of movements of the needle cylinder in one direction, and means for increasing the number of needles knitting by more than one needle upon each of a plurality of movements of the needle cylinder in the other direction in the knitting of a single article.

6. In a circular knitting machine; the combination with a needle cylinder having vertically movable needles and means for feeding yarns to the needles, of means to shog the needle cylinder, means to reciprocate said cylinder so as to knit a portion of a tubular fabric having a plurality of independently knit yarns in a single course, means for decreasing the number of needles knitting by more than one needle upon each of a plurality of movements of the needle cylinder in one direction, and means for increasing the number of needles knitting by more than one needle upon each of a plurality of movements of the needle cylinder in the other direction in the knitting of a single article.

7. In a circular knitting machine having a needle cylinder provided with vertically movable needles, stitch cams defining a knitting station, pattern controlled means for effecting rotary and reciprocatory movement of said cylinder and means to shog said cylinder to cause the centers of selected groups of needles to move equi-distant past the knitting station during reciprocatory knitting; the combination of second pattern controlled means to effect the lowering of at least two additional needles to pass through the stitch cams during each of a plurality of movements of the cylinder in one direction to effect a widening operation and pattern controlled means to cause at least two additional needles to pass through the stitch cams during each of a plurality of movements of the cylinder in the other direction.

8. In a circular knitting machine having a needle cylinder provided with vertically movable needles, stitch cams defining a knitting station, pattern controlled means for effecting rotary and reciprocatory movement of said cylinder and means to shog said cylinder to cause the centers of selected groups of needles to move equi-distant past the knitting station during reciprocatory knitting; the combination of pattern controlled means to cause at least two additional needles to pass through the stitch cams during each of a plurality of movements of the cylinder in one direction to effect a widening operation and pattern controlled means to cause at least two additional needles to pass through the stitch cams during each of a plurality of movements of the cylinder in the other direction.

9. In a circular knitting machine having a needle cylinder provided with vertically movable needles, stitch cams defining a knitting station, pattern controlled means for effecting rotary and reciprocatory movement of said cylinder and means to shog said cylinder to cause the centers
of selected groups of needles to move equi-distant past the knitting station during reciprocatory knitting; the combination of pattern controlled means to effect the lowering of at least two additional needles to pass through the stitch cams during each of a plurality of first movements of the cylinder in one direction to effect a widening of the operation, and pattern controlled means to effect the lowering of a single needle to pass through the stitch cams during each movement of the cylinder in the other direction intervening between immediately successive first movements in the knitting of a single article.

10. In a circular knitting machine having a needle cylinder provided with vertically movable needles, stitch cams defining a knitting station, pattern controlled means for effecting rotary and reciprocatory movement of said cylinder and means to shog said cylinder to cause the centers of selected groups of needles to move equi-distant past the knitting station during reciprocatory knitting; the combination of pattern controlled means to cause at least one additional needle to pass through the stitch cams during each of a plurality of movements of the cylinder in one direction to effect a widening of the operation, and pattern controlled means to cause a lesser number of needles to pass through the stitch cams during each of a plurality of intervening movements of the cylinder in the opposite direction.

11. In a circular independent needle knitting machine having means for effecting rotary and reciprocatory movement of the needle cylinder, a set of stitch cams and a pair of narrowing picks; the combination of two sets of widening picks each including at least two widening picks, a widening pick in one set being operable to lower two needles upon movement of the needle cylinder in one direction and a widening pick in the other set being operable to lower two needles with movement of the needle cylinder in the opposite direction whereby one lowered needle will subsequently be picked up out of action by the corresponding narrowing pick as the remaining lowered needles pass through the stitch cams, and pattern controlled means for rendering either of said sets of widening picks inactive independently of the other of said sets of widening picks.

12. In a circular independent needle knitting machine having means for effecting rotary and reciprocatory movement of the needle cylinder, a set of stitch cams and a pair of narrowing picks each having a capacity for raising at least one needle out of action; the combination of two sets of widening picks each including at least two widening picks, each widening pick in one set being operable to lower two needles upon movement of the needle cylinder in one direction and the widening picks in the other set each being operable to lower two needles with movement of the needle cylinder in the opposite direction whereby one needle lowered will subsequently be picked up out of action by the corresponding narrowing pick as the remaining lowered needles pass through the stitch cams, and pattern controlled means for selectively rendering either of said sets of widening picks inactive independently of the other of said sets of widening picks.

13. A structure according to claim 12 including pattern controlled means to render said narrowing picks inactive at predetermined intervals during reciprocatory knitting.

14. A structure according to claim 13 wherein said pattern controlled means also includes means to selectively render one of said widening picks inactive independently of the other of the widening picks.

15. A structure according to claim 12 wherein said pattern controlled means includes means to selectively render both of said widening picks inactive at predetermined intervals during reciprocatory knitting.

16. In a circular independent needle knitting machine having a needle cylinder, means to alternately rotate and reciprocate the cylinder and a set of stitch cams, the combination of two sets of widening picks disposed astraddle the stitch cams, each set including at least two widening picks, a pair of narrowing picks disposed...
and a first narrowing pick and a second narrowing pick; the combination of means for selectively varying the capacity of each of said narrowing picks to cause either narrowing pick to, at times, pick up one needle out of action and, at other times, to pick up more than one needle, means to selectively render either narrowing pick inactive, first and second sets of widening picks, each set including a pair of widening picks, each widening pick having a capacity for receiving the butts of and lowering two needles, means for alternately shifting the first and second sets of widening picks inwardly toward the center of the machine, pattern controlled means operable to cause one of the widening picks in either of said sets to be elevated to operating level while causing the remaining widening picks to remain on a lower inactive level with each inward swinging movement thereof, and said pattern controlled means also being operable to cause both of the widening picks in either set to remain on said lower inactive level while the remaining widening picks are elevated to active level with each inward movement of the corresponding sets of widening picks.

23. In a circular independent needle knitting machine having means for effecting rotary and reciprocatory movement of the needle cylinder and a set of stitch cams; the combination of two sets of widening picks each including at least two picks, each pick in one set being operable to lower at least one needle upon movement of the needle cylinder in one direction, the widening picks in the other set each being operable to lower at least one needle with movement of the needle cylinder in the opposite direction, and pattern controlled means for selectively rendering at least one of the widening picks in either set inactive independently of the other widening picks.

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