FIG. 8.

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BY

ATTORNEYS
MULTI-FEED CIRCULAR KNITTING MACHINE

FIG. 9.
MULTI-FEED CIRCULAR KNITTING MACHINE

Fig. 15.

Fig. 13.

Fig. 14.

Fig. 16.

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Filed April 2, 1952

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MULTI-FEED CIRCULAR KNITTING MACHINE

FIG. 36.

FIG. 37.

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FIG. 41.

BROWN, SMITH & HARDY
ATTORNEYS
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<th>Number of Links</th>
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**FIG. 50.**

ROBERT H. LAWSON

BY [Signature]

ATTORNEYS
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**FIG. 55.**

- Start of heel
- Widening of heel
- Foot, pattern drum starts
- Idle move
- Rotation; End of pattern

**FIG. 56.**
MULTI-FEED CIRCULAR KNITTING MACHINE

Robert H. Lawson, Laconia, N.H., assignor to Scott & Williams, Incorporated, Laconia, N.H., a corporation of Massachusetts

Filed Apr. 2, 1952, Ser. No. 280,057

36 Claims. (Cl. 66—43)

This invention relates to knitting methods and machines and has particular reference to methods and machines for the formation of solid color patterned areas joined by interlocking loops, as exemplified by diamonds in the leg portions of hosiery.

Since fabric of the type described requires reciprocatory knitting, if floats are to be avoided, production of a patterned portion of a stocking or the like is relatively slow. However, in accordance with the present invention four feeds are used for pattern formation, a single feed being used for each color area, and, these feeds being available, heels, toes, ring toes and loopers rounds may be knit two-feed and the field (and ring toes, if desired) of a stocking may be knit four-feed thereby speeding up production. Multiple feed knitting of a top may also be accomplished.

In accordance with the invention, during patterning yarn feeding fingers are continuously in action throughout the formation of groups of courses until yarn changes are required, as, for example, between diamonds. The patterning is accordingly accomplished solely by needle selection under the control of jacks. The invention includes provision for jack selection and control in novel fashion and incorporates, further, retiming mechanism so that proper identical patterns will be produced automatically in successive knitted articles. Consistent provisions are made in accordance with the invention to form complete stockings and, in particular, to carry out the formation of multiple-feed knit portions for the speeding up of production.

In accordance with the invention provision is made for knitting elastic tops for hosiery consistent with the other aspects of the invention.

Provision is made for proper control of the yarns being fed to the needles to insure the desired knitting during reciprocation irrespective of which of a number of yarn fingers are used. In accordance with this aspect of the invention, the yarn feeding fingers are provided with movable ends which may take proper positions to insure the desired approach of the yarns to the needles.

Certain matters disclosed herein are claimed in the application of Stanley R. Shelmire, Serial Number 280,050, filed of even date herewith.

The objects of the invention relate to the attainment of the foregoing ends and to details of construction and operation whereby these ends are secured. The objects of the invention will be better understood after consideration of the following description read in conjunction with the accompanying drawings, in which:

FIGURE 1 is an elevation of the left hand side of a machine constructed in accordance with the invention, various parts, particularly the yarn feeding devices being omitted;

FIGURE 2A is a vertical section through the upper portion of the machine taken on a plane parallel to the front of the machine, the position of this plane being indicated by the traces 2A—2A in the cam development constituting FIGURE 44;

FIGURE 2B is a vertical section continuing FIGURE 2A for a lower portion of the machine;

FIGURE 3 is an elevation of a portion of the front of the machine showing particularly drive and control elements;

FIGURE 4 is an elevation, with parts broken away and sectioned, of the drive and control elements shown in FIGURE 3;

FIGURE 5 is a fragmentary vertical sectional view taken on the broken surface indicated at 5—5 in FIGURE 6;

FIGURE 6 is a fragmentary vertical section taken on the plane indicated at 6—6 in FIGURE 12;

FIGURE 7 is a perspective view, partly in section, showing particularly various auxiliary drum controls;

FIGURE 8 is a plan view of the machine looking from the plane 8—8 in FIGURE 2A;

FIGURE 9 is a horizontal section taken on the plane indicated at 9—9 in FIGURE 2A;

FIGURE 10 is a horizontal section taken on the plane indicated at 10—10 in FIGURE 2A;

FIGURE 11 is a horizontal section taken on the plane indicated at 11—11 in FIGURE 2A, there being diagrammatically indicated in the center of this figure various needle cams to indicate their angular relationships to the elements particularly shown in the section;

FIGURE 12 is a horizontal section taken on the plane indicated at 12—12 in FIGURE 2A;

FIGURE 13 is a vertical section taken on the plane indicated at 13—13 in FIGURE 12;

FIGURE 14 is a fragmentary elevation looking at the right-hand side of FIGURE 13 and showing, in particular, an auxiliary driving chain and its followers;

FIGURE 15 is a vertical section taken on the plane indicated at 15—15 in FIGURE 12;

FIGURE 16 is a vertical section taken on the plane indicated at 16—16 in FIGURE 12;

FIGURE 17 is a fragmentary perspective view showing a raising picker and its control in inactive position;

FIGURE 18 is a view similar to FIGURE 17 but showing the same elements when the picker is in position to pick single needles;

FIGURE 19 is a perspective view of various elements particularly associated with a dropping picker;

FIGURE 20 is a plan view showing the yarn and rubber feeding and controlling devices at one of the feeds hereinafter referred to as the fourth feed;

FIGURE 21 is an outside elevation of the same;

FIGURE 22 is an elevation looking at the left-hand sides of FIGURES 20 and 21, with the latch ring shown in section;

FIGURE 23 is a perspective view showing a tensioning and take-up device for control of a yarn;

FIGURE 24 is a fragmentary elevation showing a tension adjustment and looking at the right-hand side of FIGURES 20 and 21;

FIGURE 25 is a vertical section taken on the broken surface generally indicated at 25—25 in FIGURE 21;

FIGURE 26 is a vertical section through a trick wheel for control of feeding fingers;

FIGURE 27 is an elevation looking radially inwardly at a yarn clamp and cutter assembly;

FIGURE 28 is a perspective view looking at the right-hand side of the clamp and cutter assembly;

FIGURE 29 is a perspective view looking at the left-hand side of the clamp and cutter assembly;

FIGURE 30 is a horizontal section taken at the level indicated at 30—30 in FIGURES 2A and 31;

FIGURE 31 is a fragmentary elevation of the parts shown particularly in FIGURE 30;

FIGURE 32 is a fragmentary elevation looking from the plane indicated at 32—32 in FIGURE 30;

FIGURE 33 is a plan view of an assembly containing cams for control of jacks, the needle cylinder being shown in horizontal section;

FIGURE 34 is an elevation of the same, certain parts of the machine being shown in section;

FIGURE 35 is an outside elevation of the same;
FIGURE 36 is a horizontal section taken on the plane indicated at 36-36 in FIGURE 34; FIGURE 37 is a horizontal section taken on the plane indicated at 37-37 in FIGURE 34; FIGURE 38 is a horizontal section taken on the broken surface indicated at 38-38 in FIGURE 40; FIGURE 39 is a section taken on the plane indicated at 39-39 in FIGURE 34, looking upwardly; FIGURE 40 is a vertical section taken on the radial plane extending centrally through the assembly of FIGURES 33 to 38; FIGURE 41 is an exploded plan view showing certain stacked cams illustrated in FIGURES 33 to 40; FIGURE 42 is a perspective view showing a yoking control arrangement; FIGURE 43 is a diagrammatic layout of cams carried by the main cam drum of the machine; FIGURE 44 is an inside development showing cams for acting upon needles, pattern jacks and intermediate jacks and yarn and rubber feeding fingers, there being indicated at the right of the figure the heads, an intermediate jack and a pattern jack of the various types used and at the bottom of the figure the positions assumed by long and short butt needles at the beginning of clockwise and counterclockwise strokes of the needle cylinder; FIGURE 45 is a diagram showing the layout of pattern jack butts for a typical operation of the machine, the machine being as it would appear from the inside of the cylinder looking outwardly; FIGURES 46 to 49 are diagrams showing butt arrangements on the feeding finger-controlling trip wheels at respective feeds one to four; FIGURE 50 is a chart showing a sequence of main pattern chain links, main pattern drum moves and trip wheel moves for a typical operation of the machine; FIGURE 51 is a diagrammatic representation of a stocking produced by the machine consistently with the butt layouts of FIGURES 45 to 49, the main cam drum layout of FIGURE 43 and the chart of FIGURE 50; FIGURE 52 is a diagram of the type of stitch formation involved in the production of the diamonds of FIGURE 51, the diagram showing the fabric as viewed from the inside, the progress of the knitting being upwardly and the diamonds being of less extent than those of the actual stocking, the figure being particularly illustrative of the connecting loop arrangements between diamonds and the yarn change structure insuring against production of open holes; FIGURE 53 is a diagram similar to FIGURE 43 but showing the layout of cams on the main cam drum for producing a stocking having an alternative arrangement of colored areas; FIGURE 54 is a diagrammatic representation of the last mentioned stocking; FIGURE 55 is a portion of a chart which substitutes for a portion of FIGURE 59 in the matter of production of the last mentioned stocking; and FIGURE 56 is a butt diagram of a trick wheel to be substituted for FIGURE 49 in the matter of production of the last mentioned stocking.

Referring first particularly to FIGURE 2A and 44, the machine comprises latch needles 2 arranged in two series with long butts and short butts respectively designated at the bottom of FIGURE 44 as 2a and 2b. As will appear hereafter the needles provided with long butts knit heels and toes while the short butt needles knit the insteps of stockings. These needles are mounted in usual fashion in the slots of a needle cylinder 4 and cooperating with the needles are the usual sinker 6 mounted in a sinker dial and controlled by cams. Below the needles in the cylinder slots are intermediate jacks 8 provided with butts 9, all of the same length. Below these intermediate jacks there are located in the cylinder slots tiltable pattern jacks 10 each of which is of the construction particularly illustrated at the right of FIGURE 44. Each jack is provided with a fullcrum point 12. Above this fulcrum point there are butts at various levels, the lowermost of these butts being indicated at 14 while above this butt 14 there are in order butts 16a, 16b, 16c and 16d. A sixth butt may be provided but is not used in the present machine. At the upper end of the jack there is a butt 18 which at its underside is provided with an angular notch indicated at 19. The edge 21 of the jack below butt 18 is parallel to the back of the jack below fulcrum 12. Engagement of the edge 21 by the face of a cam raising butt 18 prevents rocking outwardly of the lower end of the jack as it is thus raised.

Below the fulcrum point 12 there are a number of butts which include various groups. The lowermost butt 20 is provided to furnish a differentiation of the needles during make up. Above this butt are four butts 20a, 20b, 20c and 20d. As will appear hereafter butts at these levels have functions generally corresponding to those of the butts at the levels 16a to 16d inclusive.

Above the lower butts just mentioned are butts 22 which are provided for selection of jacks by cooperation with readingcams hereafter described. Any desired number of such butts 22 may be provided to secure the desired patterns.

Below the butt 20 there is a butt 24 the lower edge of which is provided with an angular notch 26 adapted to ride over certain cams. At its lowermost end the jack is provided with a tail portion 117. The outside edge of notch 26 defines with the outer edge of butt 24 a point 25 which, as will appear, establishes a definite jack level for selection.

In the jack illustrated in FIGURE 44 all of the butts mentioned are shown. It will be understood, however, that various butts of the groups 16a to 16d inclusive, 20a, 20b to 20d inclusive and 22 are removed to provide differentiation of jacks for patterning and other purposes. The arrangements of these butts to secure various results will be later described in detail.

The present machine is provided with four yarn feeding stations which are defined essentially by the respective throats 28, 30, 32 and 34 in the latch ring of the machine. These respective throats will be hereafter referred to as defining feed number 1, feed number 2, feed number 3 and feed number 4. At these various feeding stations there are provided yarn feeding fingers indicated in FIGURE 44 at 36, there being additionally provided at feed number 4 a finger 38 arranged to feed elastic yarn to the needles, this elastic yarn being, generally, covered rubber yarn.

The various cams acting upon the needle butts may now be described. At feed number 1 the forward and reverse stitch cams are indicated at 40 and 42 respectively, there being provided between them a cam point 43 which acts similarly to the conventional center cam. A needle raising cam 44 which is withdrawable radially is provided beneath the stitch cam 42. At feed number 2 there are provided the respective forward and reverse stitch cams 46 and 48 along with the cams 46 and 48, similar to 43, there being also provided the needle raising cam 50 which like cam 44 is adapted to be radially withdrawn from action. At feed number 3 there are provided the forward stitch cam 52, the reverse stitch cam 54 and the radially withdrawable needle raising cam 56. At feed number 4 there are provided the forward stitch cam 58 and the reverse stitch cam 60. Between these is a fixed cam 61 having a special function hereafter described. Radially moveable and pivotable cams 62 and 64 are provided for purposes hereafter described. Above the cam 62 there is provided the radially movable cam 66 which is adapted to lower needles at the completion of heels and toes. A radially movable cam 67 is positioned above cam 64. Raising pickers are provided at 68 and 70 and will be de-
scribed in further detail hereafter. Lowering pickers are provided at 72 and 74. To summarize the conditions or adjustments of the needlecams it may be noted that cams 55, 61, 40, 42, 46, 48, 52 and 54 are fixed and engage both long and short needle butts, cams 60, 67, 44, 59, 66 and 56 are radially movable and cams 64 and 62 are both radially movable and pivotable.

The butts 9 of the intermediate jacks 8 are arranged to be actuated upon by various cams which will now be described. Among these are cams 76, 78, 80 and 82 which are arranged to be pivotally held in the full line positions shown in FIGURE 44. Cams 76 and 78 are adapted to raise intermediate jacks 8, the butts of which are at their level, when these jacks move from left to right during a clockwise reciprocation, but yield to permit the butts of these intermediate jacks to pass during counterclockwise reciprocations. In similar fashion the cams 80 and 82 are adapted to raise intermediate jacks 8 during counterclockwise reciprocations but to yield to permit passage of their butts 9 during clockwise reciprocations. Cams 84 and 86 are provided to raise intermediate jacks under certain conditions during both clockwise and counterclockwise reciprocations. Cams 88, 90, 92 and 94 adjacent to these cams 84 and 86 are arranged to lower the intermediate jacks by engagement with their butts 9. Cams 96, 98, 100 and 102 are also adapted to act upon the butts 9 of the intermediate jacks to lower these jacks. All of the cams acting on the intermediate jacks are fixed except the pivotal cams 76, 78, 80 and 82.

Various cams are also provided to act upon the jacks 10. A cam 104 between feed number 1 and feed number 2 is arranged with a wedge-shaped upper edge to engage within the slot 19 below a butt 18 of a pattern jack to raise 18 in both directions of reciprocation whenever the jacket reaches it with its upper end in an outer position, lowering of the jack after its rise being effected by cams 106 or 108. Raising cam 110 and lowering cams 112 and 114 have similar functions between feed number 3 and feed number 4. The blocking providing these cams 106, 105, 112 and 114 are sufficiently far out radially to permit butts 9 of intermediate jacks 8 to pass them without engagement though they will engage the upper ends of pattern jacks 10 which project radially outwardly to a considerable extent whenever engagement should occur.

Cooperating with the point 26' at the outer end of the lower key, the upper key of the cam 116, 118, 120 and 122 which serve to position the jack 25 at proper level for tilting selection. These jacks are provided with bevelled upper edges tangent to the arc of tilting so as to define the lowered positions of the jacks but not to interfere with their tilting, the points 36' riding on these upper edges.

Cams 124 and 126 are provided respectively between feed number 4 and feed number 1 and between feed number 2 and feed number 3 to engage within the notches 26 of jacks the lower ends of which are projected outwardly. For this purpose the cams 124 and 126 have sharp upper edges for engagement with the notches 26. If, however, the jacks are rocked inwardly these cams are passed by the butts 24 without action thereon. All of cams 116, 118, 120, 122, 124 and 126 are fixed.

Reading jacks which are moved upwardly and downwardly in unison step by step are also engaged with the jacks 10. These are provided to engage buttons of the group 22. Of these cams 130, 134, 138 and 142 are adapted to engage buttons during counterclockwise reciprocations of the needle cylinder while cams 128, 132, 136 and 140 engage butts during clockwise reciprocations. The arrangements for controlling these cams 130 and 134, 138 and 142 are the same as for the feeding stations to act upon the buttons 18 of the pattern jacks to rock their upper ends inwardly and their lower ends outwardly. Cams 152, 154, 156 and 158, which will be hereinafter referred to as upper key jacks, are provided at the various feeds for selective actions upon the butts at the levels 16a, 16b, 16c and 16d respectively. A cam 159 at the same level as cam 158 is provided for special action on butts at the level 16d while going on the head, as described hereafter. Cams 160, 162, 164 and 166, all at the same level, are arranged to act upon butts at the level 14 and will be hereinafter referred to as blanking jacks.

Lower key jacks 168, 170, 172 and 174 are provided at the several feeds to act respectively upon butts at the levels 26a, 26b, 26c and 26d, respectively, and are provided at the location of feed number 1 for acting upon butts at the level 20. As will hereafter appear this cam acts during counterclockwise rotation of the needle cylinder to provide selection of needles during makeup and the elastic top. Lower blanking jacks are provided at 178, 180, 182 and 184 to act upon the buttons of the jacks at 24. The various key cams and blanking jacks which have been mentioned are radially movable in relationship to the various reading cams as will be hereafter described in detail. Cams 159 and 176 are controlled for radial movements from the main cam drum of the machine.

Of the key and blanking jacks 152, 154, 156, 166, 170, 174, 178 and 182 operate during counterclockwise reciprocations of the needle cylinder. The remainder of these jacks act on jacks during clockwise reciprocations. Cams 159 and 176 are active during counterclockwise movements of the needle cylinder.

The sinker cam arrangement is particularly illustrated in FIGURE 9. The cam ring 186 carries the sinker withdrawing cams 188, 194, 208 and 206 at the respective feeds. These are flanked by the sinker projecting cams 190, 192, 196, 198, 202, 204, 208 and 210. The sinker cam ring is arranged to oscillate to controlled extents as will be hereafter described.

Reference may now be made to the reading cam assemblies indicated generally by the numeral 212. One of these is provided in association with each of the feeds and their construction will become clear from consideration of FIGURES 30 to 41, inclusive, which specifically illustrate the assembly located at feed number 4.

Each of these assemblies is the same except for the position of the key cams and the additional cams 159 and 176 and consequently a detailed description of one will suffice for the others.

A frame 214 provides support for the various parts. A carrier 216 embraces a long pinion 218 which is vertically mounted in the frame and the carrier 216 also embraces a vertically mounted screw 229 which at its lower end carries a pinion 224 meshing with the teeth 226 of an annular gear 228 which is mounted for rotation in the circular slot 231 in plate 232 of the machine frame. Studs 234 projecting upwardly from the top of the gear 228 are arranged to be actuated upon by paws as hereafter described.

A pair of members 236 and 238 is pivoted at 240 to the carrier 216 and have partial threads to provide a split nut arrangement embracing the screw 230 under the action of a spring 242. Fixed conical points 244 and 246 are provided as shown most clearly in FIGURE 40 which are arranged to be engaged by, and to spread, the split nut members 236 and 238 if the carriage 216 exceeds uppermost and lowermost limits of its travel. The purpose of these is to aid in engaging the screw from the split nut members against the action of spring 242 thus preventing accidental over-run of the carrier 216 which might result in damage.

A vertical shaft 248 mounted in suitable bearings is secured to at 250 a collar which is slotted to receive an ear 254 carried by a second collar 252 which is provided for free angular adjustment on the shaft. Adjustable screws 256 threaded in the collar 250 and engaging the ear 254 serve to set the angular position of the collar 252 relative to the shaft. A collar 258 is fixed to the shaft.
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3,046,733 7 248 and is provided with a cam follower extension 262 which is arranged to be acted upon by a cam 266. The collar 252 is provided with a cam follower extension 269 arranged to be operated on by the cam 266. The two collar follower extensions 260 and 262 are thus relatively adjustable but, once adjusted, are effectively rigidly connected to shaft 248 and by cooperation with cams 264 and 266, respectively, serve to provide positive rocking movements of the shaft in both directions. The cams 264 and 266 together with an additional cam 296 which will be mentioned hereafter are carried by a block 267 mounted on a ring 268 which is arranged for annular movement in a slot in the lower bed plate 230.

Cams 265 and 267 provide the initial moves of respective followers 260 and 262 and when block 267 is in its mid position, serve to hold key cams 156 and 158, as well as reading cams 140 and 142, in an inactive position.

Pinned to the shaft 248 is a collar 270 which is slotted for the reception of an ear 271 formed on a collar 272 which is mounted for adjustment relative to the shaft. Adjustment is afforded by screws 276 threaded into the collar 270 and bearing against the ear of the collar 273. The collar 272 is provided with a gear segment 274 which meshes with an idle 278 which in turn meshes with a pinion 280 secured to the shaft of the elongated pinion 218. The arrangement is such that the rocking of the shaft 248 effected by the cams 265, 264, 267 and 266 results in the imparting of a rocking motion to the elongated pinion 218 thus to effect alternately the reading cams which are mounted to slide in carrier 216 and are provided with teeth 252 meshing with pinion 218. In the particular reading cam assembly illustrated in the figures now under consideration the reading cams are 140 and 142.

At its upper end the shaft 248 carries an arm 284 which is provided with a downwardly extending pin 286 engaging in an opening in the outer end of the upper key cam 156 which, along with other key and blanking cams, is slidable in the frame structure 214. Due to this arrangement the key cam 156 is moved into and out of action concurrently with the reading cam 142 on the corresponding side. It may be noted here that while the various reading, key and blanking cam assemblies are similar in construction, pairs of them have right-hand and left-hand configurations, i.e., at the first and third feeds it will be noted that the three key cams 154 and 158 are on the outer side as compared with the key cams 156 and 152 at the fourth and second feeds. Similar right-hand and left-hand arrangements occur in the case of other elements as will be apparent from FIGURE 44 but these need not be specifically referred to in the present general description of the reading cam assembly.

The cam follower extension 262 is provided with a downwardly extending pin 288 engaging in an opening in the outer end of the slide of key cam 168. This arrangement is such that the key cam 168 is movable into and out of its active position concurrently with the corresponding reading cam 140.

A sleeve 290 is journaled on the shaft 248. Clamped to its lower end is an arm 292 supporting a downwardly extending pin 294 which is arranged to be acted upon by cam 296 which is secured to the assembly including cams 264 and 266. An arm 290 is secured to the upper end of the sleeve 290 and is provided with an upwardly extending pin 300 which engages an opening in the outer end of the slide constituting blanking cam 166. The arm 298 is urged outwardly by the arrangement of the plungers 302 and 304, outward movement being limited by the stop hook 306 which is in position to be engaged by the pin 304.

A lever 308 is pivoted on a stud 310 and is provided with a cam follower portion 312. It is also provided with an extension 314 entering an opening in the outer end of the slide constituting blanking cam 184. Lever 308 is pulled by spring 316 to engage a cam 318 which is mounted to be circumferentially slidable with respect to the ring 268. The nature of this mounting arrangement will be evident from FIGURE 38 in which it will be noted that a stud 319 has been provided in the lower portion of the block which carries cams 264, 266 and 296 and in this space the cam 318 is movable between limits defined by an end wall 326 and an undercut end wall 328. These end walls are provided to secure the block to the ring 268. A spring 324 attached to the stud 318 at one end is retained in the lower portion of this cam 318. As the block 267 moves inwardly, the cam 318 is urged outwardly by the action of the cam 267 on the flange 322 which carries cam 318 and serves to prevent the cam from moving radially inwardly and is engageable by lever 321 to effect at desired times a sliding movement of the cam against the action of spring 324 when the ring 268, during rotary knitting or at the ends of reciprocating strokes while patterning, occupies a mid or neutral position.

The cam 159 is mounted adjustably in the upper end of the reading cam assembly, being urged outwardly by a spring 330 against an adjustable step screw 332. Cam 159 is normally fixed during operation of the machine.

On a stud 334 carried by the plate 230 there is mounted a lever 336 to which is pivotally secured a pawl 340. This pawl 340 is shown in FIGURE 32. A spring 342 urges this pawl 340 inwardly in position to engage the stud 334 on the ring 228. A rod 338 is operated as hereafter described on the inner side of the arm 336 about pivot 334 and in the assembly illustrated in FIGURE 30 produces on each stroke a clockwise movement of the ring 228.

The pawl 340, however, may be rendered inoperative by an arm 348 of a bell crank movable beneath the pawl 340 to raise the same to clear studs 334. For this purpose the bell crank is mounted on post 346 below a fixed collar 347 and has movements imparted to it from a link 350 connected to the other arm 353 of the bell crank. Movement of the bell crank is limited by a stop screw 351 carried by collar 347 and extending within a slot in a block 349 secured to the bell crank.

The arrangement just described of pawl 340 is duplicated on the other side of the machine as illustrated in FIGURE 12, there being provided the pawl 352 actuated through the link 354 and controlled by the bell crank 356 connected to the link 360, arm 353 and stop 358. The oscillation of pawl 352 effects counterclockwise steps of the ring 228. As will appear hereafter these pawls 340 and 352 are alternately operable and provide first upward and then downward movements of the various reading cams in unison.

The raising pickers 68 and 70 are similar though, of course, designed to operate in opposite directions. The details and control of the picker 68 are illustrated particularly in FIGURES 17 and 18 and it will be understood that the construction and control of the picker 70 are similar. The picker 68 is provided with lower and upper steps 362 and 364 respectively, the active end of the picker being carried by a lever 366 pivoted to the cam block and normally urged in a clockwise direction as viewed in FIGURE 18 by a spring 368. As will be evident hereafter the pickers occupy three different positions during different phases of operation of the machine. One of these positions is an uppermost position corresponding to extreme counterclockwise position of the picker 68 as viewed in FIGURE 17. In this position the picker 68 overlies needle butts as they pass over cam 40 and consequently butts are not engaged to be raised by the picker. In an intermediate position, illustrated in FIGURE 18, the picker is so positioned as to engage only a single butt which reaches the picker at a level just above the step 362 but at a level insufficient to pass over the step 364. The step 362 is narrow and as the movement of the needle cylinder proceeds after the butt passes over the step 362 this butt only is raised, the picker moving to a height under the action of this butt such that the next butt moves thereunder. In its lowermost position the picker is at a level such that the leading butt engages
above the step 364 and serves to move the picker upwardly and in the direction of needle travel. The arrangement is such that when this occurs the step 362 engages the next following needle butt with the result that two needles are picked upwardly, the butts of succeeding needles then passing under the picker.

To achieve these three positions of the picker there is provided the cam 370, urged in a right-hand direction by a spring 376 and pulled in a left-hand direction by a Bowden wire 378, all as viewed in FIGURES 17 and 18. The portion 374 of cam 376 when the cam is in its counterclockwise or left-hand position causes the picker to assume its uppermost position to be missed by the butts reaching it. If, however, the cam 370 is in an intermediate position as illustrated in FIGURE 18 the picker lever 366 rests on the portion 372 of cam 370 so that the picker is in a position to raise only single needles at each stroke in the direction in which the picker is active. The third position involves extreme clockwise position of the cam 370 so that the picker lever drops off the cam ledge 372. In this condition the picker is at its lowermost position to engage two needles during each stroke. The Bowden wires 378 for the two cam controls are actuated from the main cam drum by the pulsing mechanism.

The lowering pickers 72 and 74 are similar in their construction and operation, except for reversal of hand, and the description of the details with respect to picker 72 will suffice for picker 74. The details with respect to picker 72 are illustrated in FIGURE 19. The picker 72 is in the form of a lever pivoted about a horizontal axis which in turn is carried by the usual swivel 380 pivoted on a vertical axis in the bracket 382. A spring 384 pulling downwardly is located at the outer end of the picker lever normally urging its operating end into a recess in the cam 386. A second cam 386 is provided in the usual fashion to serve when the picker is engaged by a cam butt to lower the picker as it swings in a direction which is toward the left in FIGURE 19. After the picker is released by the needle it is free, after the segment of butts have cleared its upper surface, to move back to its original position under the action of spring 384. For indication of its operation the picker is shown in FIGURE 19 in the position which it would assume after engagement by a needle butt.

Underlying the outer end of the picker lever is a pin 388 vertically guided in the bracket 382. This pin is provided with a slot 389 through which extends a slide provided with a cam surface 390, the slide being urged toward the right in FIGURE 19 by spring 392 and being operable toward the left as viewed in that figure by a pull wire 394 controlled from an auxiliary cam drum of the machine, hereafter described, and provided with a pair of collars 396 engaging an upstanding arm 398, through which the pull wire passes, carried by the shaft of the switch cam 64 which shaft is arranged to oscillate about its axis and also to be moved inwardly against the action of a spring 402 (FIGURE 11). The outer end of the shaft of switch cam 64 is pointed and is indicated at 400. This is arranged to be actuated upon by a cam 404 pivoted at 406 and actuated by a Bowden wire 408 from the main cam drum of the machine against the action of a spring 426. A slide 410 is guided in a suitable fixed bracket and enters a slot in the pin 388, being provided with a cam surface indicated at 411. A spring 412 normally urges this slide toward the left in FIGURE 19 and the slide is provided with an adjustable screw 414 arranged to be acted upon by the cam 404. The described arrangements will have their functions set forth more fully hereafter but at the present time it will suffice to say that the picker 72 may be rendered inactive by the movement of the cam surface 411 to the right as viewed in FIGURE 19. The movement of cam 390 to the left is effected by pull wire 394 and is concurrent with the rocking of the cam 64 to an upper inactive position, i.e. clockwise as viewed in FIGURE 44. The action of cam 411 to render picker 72 inactive is associated with positioning of cam 404 to move inwardly the cam 64, this action taking place by reason of engagement of adjustable screw 414 by cam 404. The action, however, is not concurrent, the cam 404 being so arranged as to move the cam 64 into action, at a half-way position under the action of Bowden wire 408 without rendering the picker 72 inactive. Further movement of the cam 404 to its fully displaced position under the action of Bowden wire 408 will render the picker 72 inactive while at the same time maintaining cam 64 in its inner position.

FIGURE 19 also shows the control for radial movements of the stitch cam 60. This cam is carried by a slide 416 normally urged inwardly by the action of spring 418. The slide is provided with an upstanding pin 420 engageable by the end of a lever 422 which is movable by a Bowden wire 424, through connections to the main cam drum, against the action of a spring 418.

Referring now to FIGURE 9 there are shown therein a pair of latch OPENERS 428 and 430, the former of which is arranged to open latches during makeup as the needles approach stitch cam 58, while the latter opens latches as the needles approach stitch cam 52. As shown in FIGURE 19, hereinafter the two latch openers are required since only alternate needles are selected to take rubber at feed number 4. Latch opener 428 is mounted in a carrier 432 pivoted at 434 and urged in a counterclockwise direction by a light spring 436 to a position limited by a stop screw 438. A link 440 connects the carrier 432 to a bell crank 442 which mounts the second latch opener 430. A light spring 444 also urges this latch opener in a counterclockwise direction. A Bowden wire 446 actuated from a cam on the main cam drum connects to a lever 448 provided with an arm 450, the outer end of which extends upwardly to engage the latch opener 430. A strong spring 454 urges the lever 448 in a clockwise direction so that through its arm 450 and link 449 the latch openers are normally held in outer inactive position. When, however, they are to be active, a pull is exerted on Bowden wire 446 to overcome spring 454, whereupon the springs 436 and 444 move the latch openers into engagement with the needle latches.

Referring particularly to FIGURES 9 and 10, there are shown therein the devices which control oscillatory movements of the sinker cam ring. The fixed member 441 is provided with surfaces 456 and 458 against which there may abut the adjustable stop screws 460 and 462 carried by the sinker cam ring 186. As will be evident from FIGURE 9 the clearances are such that when these surfaces are engaged by the screws the cam ring has a considerable extent of oscillatory movement. A limited oscillatory movement is provided by additional stop devices including the adjustable screws 464 and 466 which may be engaged respectively by the screws 460 and 462. The screws 464 and 466 are respectively carried by upwardly extending levers 458 and 470 which are pivoted at their lower ends at 472 and 474. A transverse pin 476 extends through openings in the levers 458 and 470 and is carried by a pin 478 slidable mounted in the frame of member 441 and is urged inwardly by a spring 480. By reason of this arrangement the levers 458 and 470 are normally positioned to bring their stop screws 464 and 466 into positions to limit the oscillatory movements of the sinker cam ring. The levers 468 and 470, however, may be withdrawn by the action of a lever 478 on the headed end of pin 478, the lever 478 being connected through a Bowden wire 484 for actuation by the main cam drum of the machine. When the levers 468 and 470 are withdrawn outwardly the stop screws 460 and 462 are arrested by the surfaces 456 and 458 thereby providing considerable oscillatory swing of the sinker cam ring.

The yarn feeding devices will now be described with particular reference to FIGURES 2A, 8, 10 and 20, inclusive. Each inelastic yarn Y passes from the supply
cone through an eye 486, thence between tension discs 488, through an opening in an arm 490 and then through eyes 494 and 496. The arm 490 is pivoted and acted upon by spring 492 to act as a takeup.

The purpose of this takeup action will become apparent hereafter. From an eye 496 the yarn passes through the eye 500 of a takeup sweep 502 pivoted at 504 and acted upon by an individual spring 506, the springs for the take-ups at each feed being anchored to a lever 508 which may be clamped in an adjusted position by a screw 510 as indicated particularly in FIGURE 24. The tensions of the takeup sweep springs may thus be adjusted. From the takeup sweep each yarn passes through eyes 496 and 512 and thence through the feeding hole 514 of a yarn feeding finger. Each of these yarn feeding fingers comprises an end portion 516 which is pivoted at 518 to a lever 520 mounted upon a transverse pin 522. The purpose of the end 516 is to provide proper location of the yarn feed in the throat of the latch ring 34 during reciprocatory knitting. As reciprocation in one direction takes place the portion 516 of the yarn feeding finger may move in the direction of run of the yarn while during reverse reciprocation it may move in the opposite direction and in either case will occupy a definite and proper position irrespective of the particular yarn finger which is active.

As will be noted from the cam development there are at each feed four inelastic yarn fingers with the exception of feed 60 where there are three yarn fingers handling inelastic yarn and there is one finger handling the rubber yarn. While the inelastic yarn fingers are thus made free to move irrespective of their positions to proper location, said yarn fingers when inactive may be closely arranged side by side and for this purpose each of the ends 516 is provided with an extension 524 provided with a wedge-shaped end so that as the yarn finger rises to inactive position the movable end 516 having a wedge-shaped lower edge will be properly located in the assembly. The yarn fingers are urged in a downward direction by individual springs 526 and are provided with pin 518 extensions 528 adjacent to the pivot pin 522, which extensions 528 are arranged to engage the lower ends of the sweep levers 502 below their pivot pin 504. As illustrated particularly in FIGURE 25 the lower end of each sweep lever is curved as indicated at 529 to prevent jamming in the event that a yarn breaks at 527, as the finger is raised to inactive position, the curved end 529, serving to cooperate with the extension 528 so that as each yarn feeding finger is rendered inactive its corresponding takeup sweep is also rendered inactive being brought to substantially a vertical position against the action of its spring 506.

The yarn feed levers 520 have projections 530 engageable by levers 532 of which there is one for each yarn lever. Each of the levers 532 is provided with a follower portion 533 engageable by butts 536 on elements 538 mounted in slots in a trick wheel 540. Secured to the trick wheel is a ratchet 542 arranged to be advanced step by step by a pawl 544 pivoted at 546 to an arm 547 and urged by a spring 548 into engagement with the ratchet. The arm 547 is urged clockwise as viewed in FIGURE 25 by a spring 550. Movements are imparted to the lever 547 by a adjustable screw 552 secured in a member 554 which is mounted on a vertical pin 556 and has a portion 560 in which is located a follower screw 570 adapted to be engaged by a cam 572 provided with three steps 574, 576 and 578 (FIGURE 10). The cam 572 is secured to a ring 580 which is arranged to be oscillated by a link 582 the operation of which will be described later. It may at this time be pointed out that the link 582 is urged by a spring in a downward direction as viewed in FIGURE 10. By reason of this spring action it may be at times impossible to move to this end the lever 580 is provided with an ear 584 which is engageable by a latch member 586 (FIGURE 10) taking the form of a lever connected by a link 588 to controlling devices hereafter described.

As has already been indicated an elastic covered rubber yarn is fed at feed number 4 which is the one particularly illustrated and now under detailed discussion. The elastic yarn passes from its supply through an eye 590 and then between the tension discs 594. From these it passes through an eye 592 and a second eye 596 to the feeding hole 598 in a lever 600 similar to the levers 520 but without a pivoted outer end. The lever 600 is mounted on the pin 592 and provided with a portion 602 engaging a lever 604 mounted on pin 534 and provided with a follower portion 605 engageable by butts 606 carried by the elements 538 mounted in the trick wheel 540. The butts 606 are all of the normal height of butts 536 with the exception of one but 606 which is of less length as indicated in FIGURE 26. The purpose of this special butt will be described hereafter in connection with the operation.

As will hereafter appear the elastic yarn is not cut during the continuous operation of the machine but trails from stock to stock. It is, however, engageable by a lever 608 provided with a hook-shaped end as indicated in FIGURE 8, which lever is mounted to swing about a vertical axis under the action of a link 612 which is connected to the lower end of a lever 614 secured to a sleeve 615 journalled on a shaft 616 and urged in a counter-clockwise direction by a spring 617. The spring 617 produces the tension necessary to maintain the elastic yarn taut, as indicated in FIGURE 18. A follower lever 620 connected to sleeve 615 is engageable by butts in the position 622 on the elements of the trick wheel 540.

Journalled on the shaft 616 for free movement about the same is a lever 624 which has a follower portion engageable by butts in the locations 626 of the elements mounted in trick wheel 540. The inner end of lever 624 is adapted to operate a yarn clamping and cutting device.

The foregoing specific description of the yarn feeding assembly is directed to the assembly at feed number 4 where an elastic yarn is fed as well as three inelastic yarns. At each of the other feeds a similar assembly is provided with the exception that at these other feeds there are four inelastic yarn feeding fingers and there is omitted the assembly of devices specially associated with the elastic yarn, i.e., there will be no special finger such as 43 for the corresponding inelastic yarn tensioning means 594 nor the elastic yarn guiding lever 608, etc.

The fourth inelastic yarn feeding finger will take the position of the finger 600 and butts on the trick wheel elements at the position corresponding to 606 will control this inelastic yarn feeding finger. Butts at position 622 will be inactive even if pressed. It will be evident that all of the yarn feeding assemblies are simultaneously operated by the stepping of their trick wheels under control of the ring 580.

Reference will now be made to the inelastic yarn clamping and cutting means with particular reference to FIGURES 27, 28 and 29. The lever 624 engages the lower end of an adjustable screw 626 carried by a lever 628 pivoted at 630 to a frame assembly supported by a central post 629, it being understood that there is a clamping and cutting assembly associated with each of the feeds. A spring 632 normally urges the lever 628 downwardly. The lever 625 is connected by a link 634 to a yarn trapping lever 636 pivoted at 640 and provided with a nose portion 642 which in particular is adapted to engage and guide a yarn. A curved edge portion 638 of the trapping lever also serves to guide a yarn. A clamping member 644 is provided with an upturned outer end and is mounted on a pin 645 being pressed downwardly by a spring 648 against a base member 646. This base member is provided with a downwardly beveled outer edge as indicated at 647 to provide with the upwardly extending portion of member 644 a month for the reception of a yarn. For the better clamping of the yarns the cooperating surfaces of
members 644 and 646 are desirably provided with inter-
engaging flutes as indicated at 649 in FIGURE 27.
Secured to the member 645 is a fixed cutting blade 650.
A movable cutting blade cooperating therewith is pro-
vided at 652 and is pivoted at 656 being urged into cut-
ting relationship with the fixed blade by a leaf spring
658. A movable blade receives the handle by the link
653 carried by the link 634 so that as the link is depressed
the movable blade overlaps the fixed blade to cut the
yarn. In order to insure better clamping action than is
provided by spring 648, the link 634 is provided with an
extension 635 which presses against the member 644 when
calibrating is to occur. To provide further controls for the
yarns, wire guides 660 and 662 are provided as illus-
trated in the figures.
The yarn changing operations including clamping and
cutting are described in detail hereafter.
Referring now particularly to FIGURES 1, 2A, 2B, 3,
4 and 12, the driving devices for the machine will be
described. The power input is through shaft 664 which is
associated with the conventional speed change pulleys
with speed control devices (not shown). A pinion 665
on shaft 664 meshes with a gear 666 connected through a
stirrup 700 to a clutch drum 698. This gear 666 is a turn
meshes with a pinion 672 which is affixed a clutch ele-
ment 674 arranged to be engaged by a movable clutch
member 676 which is splined to a shaft 682 on which the
pinion 672 is journaled. On its other side the clutch
member 676 is engageable with a clutch element 677
which is secured to a pinion 678 also journaled on shaft
682. The pinion 678 meshes with a gear segment 680
which is journaled on a shaft 708.
To the shaft 682 there is secured the bevel gear 684
which meshes with the bevel gear 686 which imparts rota-
tion or oscillation to the needle cylinder through con-
ventional connections. The needle cylinder is arranged
to be raised and lowered for stitch control through the
conventional bearing arrangement at 688 and vertically
movable sleeve 690 which is held downwardly by a spring
691 to bring a lug 693 into engagement with an adjustable
pawl member carried by a lever 695. This, provided with a group
of followers 693a, 693b and 693c actuated by cams on the
main cam drum of the machine.
The clutch member 676 is movable selectively to en-
geage the elements 674 or 677 by means of a slidable mem-
ber 694 which is provided with a pin acted upon by cams
696 on a clutch drum 698. This clutch drum is secured to
a shaft 699 which through gears 700 and 702 drives the
main cam drum 704. The cams on this drum are omitted
from FIGURES 2B and 3 for the sake of clarity but are
shown in detail in FIGURE 43 to which reference will
be made hereafter.
A link 706 connected to a crank pin on gear 678 has
its lower end connected to the gear segment 680 to im-
port oscillations thereto.
A pawl 710 pivoted on a pin carried by the gear seg-
ment is arranged to advance a ratchet 711 to which is
secured a sprocket 712 over which there is trained the
main chain 713 of the machine. The ratchet 711 and
sprocket 712 are journaled on the shaft 699. It may be
here noted that the gearing is such that the main chain
is advanced the length of one link for every four revolu-
tions of the needle cylinder during rotary knitting or for
one complete reciprocation of the needle cylinder during
reciprocatory knitting. During reciprocatory knitting the
main chain advances when the cylinder is moving clock-
wise.
The chain 713 is provided with three kinds of links:
plain links which represent idle moves, links provided
with laterally extending pins 715, and links provided with
radially extending ears 716. The pins 715 are arranged
to engage a follower 716 carried by a lever 717 pivoted to
the frame, which lever is connected to the upwardly extend-
ing link 588 referred to previously. The lugs 714 are
arranged to engage a follower 718 which is carried by a
pivoted pawl guard 719, engagement between the follower
718 and the lugs 714 being under spring action.
A pawl 720 is arranged to engage teeth of a ratchet
721 which is secured to the shaft 699. The pawl 720 is
pivoted to an arm 722 of gear segment 680 journaled on
the shaft 708 on which there is also jogged an arm 723
which connects upwardly extending arm 724 of which is
acted upon by a cam 725 secured to gear 666. To the for-
wardly extending arm of the bell crank 723 there is
pivoted an auxiliary pawl 726 which is arranged to engage
a ratchet 727 provided with only a single tooth-forming
notch 728. As will appear hereafter the purpose of the
auxiliary pawl is to provide a special step of the main
cam drum. The auxiliary pawl 726 is held in engage-
ment with ratchet 727 by a spring 729. The guard 719
when not lowered by lugs on the main chain is arranged
to lift pawl 720 out of engagement with teeth of ratchet
721 and also to lift the auxiliary pawl 726 away from
engagement with ratchet 727. The last action is effected
by its end 730 which underlies a laterally extending pin
731 which also serves as a pivot for the auxiliary pawl
726. As will appear hereafter, a low lug on the chain 713
will locate the guard 719 and its end 730 in position to
engage the auxiliary pawl 726 but permit action of pawl
720. Except for the arrangement for actuation of the
operating link 588, the various devices just described for
control of the main cam drum and for drive of the needle
cylinder are conventional. Briefly stated, the main con-
trol of the machine is by the chain 713 the links of which
are advanced without interruption as above indicated.
Under control of this chain, through the pawl 720 pri-
marily, and through the auxiliary pawl 726 for one step,
the main cam drum is advanced at proper times to secure
controlling actions which will be detailed hereafter. Ad-
ditionally, changes are controlled from rotary knitting
or reciprocatory knitting and vice versa through the clutch
control drum 698.
In the present machine additional controlling opera-
tions are required and for this purpose mechanism is
provided across the rear of the machine.
Gear 670 meshes with a pinion 726 which in turn
meshes with a gear 734 secured to a shaft 736 extending
across the rear of the machine. A cam 738 is secured
to shaft 736 and is provided with successive steps 738a,
738b and 738c and a fall 738d arranged to act upon a
follower roller 740 carried by a lever 742 which is jour-
naled upon a fixed shaft 744. The lever 742 is provided
with an upwardly extending arm 746 which, as shown in
FIGURE 1, is connected to the link 582 which controls ring 580 (FIGURE 10), the lever 746 being urged forwardly by a spring 747.
A clutch member 748 is splined to the shaft 736 and is
movable selectively to a left-hand position, a central posi-
tion or a right-hand position by a slide member 750
guided on a rod 752 and provided with a follower roller
755 arranged to be acted upon by clutch controlling cams
generally indicated at 756 in FIGURE 7, and detailed in
FIGURE 43, these cams being carried by the main
cam drum 704. In its left-hand position, as seen in FIG-
URE 12, the clutch member 748 engages an element
757 which is secured to a drum 760 which is journaled
on the shaft 736. In its right-hand position it engages
the clutch element 761 carried by a drum 758 which
carries cams 762 and 766 respectively acting upon pivoted
rollers 764 and 768 for the control of the pull wire 739
previously described in connection with Figures 64 and
the pull wire 395 corresponding to this on the other side
of the machine. The pull wire 394 is connected to the
upper end of an arm 769 which is connected to
lever 764.
To the drum 758 there is secured the member 770 pro-
vided with a notch 774. Arranged to engage in this
notch is the wedge-shaped end of a lever 776 which con-
stitutes a detent. Secured to the drum 760 is a member
773 which is provided with a notch 780 arranged to be...
engaged by the wedge-shaped end of a second detent lever 782. The detent levers 776 and 782 are journaled upon a pin 784 and are respectively urged toward engaging position by springs 786 and 782. A double end cam pin carried by the member 750 is adapted to engage follower screws carried by the detent levers 776 and 782 to remove them from action. This removal occurs to free the corresponding drum 778 or 760 for rotation when the clutch is shifted. The detent lever 782 is also removable from action through the medium of an arm 780 pivoted on pin 784 and provided with a laterally extending pin 793 engageable with the detent. A Bowden wire 794 is operated from mechanism shown in FIGURES 5 and 6 for control of the arm 792.

Referring particularly to FIGURE 16 there is a double lobed cam 796 secured to the drum 760 and arranged to act upon the follower roller 798 carried by a lever 800 which is secured to a transverse shaft 802, engagement of the follower with the cam being maintained by a spring 805. The shaft 802 is provided with arms 804 and 806 with which respectively are connected to the links 354 and 344 serving for actuation of the respective levers 352 and 350.

A double lobed cam 810 is carried by drum 760 and it is arranged to act upon the follower roller 812 of an arm 814 journaled at 818 and carrying a pawl 819 pulled into engagement with the teeth of a ratchet 822 by a spring 816, the arm 814 being held in engagement with the cam 810 by a spring 820. Inasmuch as the shaft 726 makes one revolution for each four revolutions or for each complete reciprocation of the needle cylinder, it will be evident that the ratchet 822 will be advanced on each stroke of the needle cylinder, i.e., twice during each complete reciprocation, whenever drum 760 is rotating. The ratchet 822 is secured adjutantly to a sprocket 824, over which an idle gear 826 there passes a chain 828 half the links of which carry lugs 827 on one side and half the links of which carry lugs 829 on the other side. As will be noted from FIGURE 13 the lugs 827 and 829 complement each other so that during a complete cycle of the chain the followers 830 and 832 are alternately raised, one for each half cycle. The followers 830 and 832 are carried by rock shafts 834 and 836, respectively, to which in turn are secured arms 838 and 840 respectively operating the links 360 and 359 which control the pawl guards 356 and 358. The result is that during one half cycle of the chain 828 the ring gear 822 is advanced by step in one direction and then during the other half cycle step by step in the opposite direction.

The drum 760 carries a pair of cam members 842 and 844 which define a race engageable with a pin 852 to produce oscillations of lever 846 pivoted at 848 and connected at 850 to the ring 868. The cam race is shaped to impart steps of movement to the ring as hereinafter described through the pin 852 which is mounted for vertical sliding movement in the lever 846, being urged downwardly by a spring 854. The pin 852 is movable upwardly against the action of the spring to disengage it from the cam race by a lever 856 which is controlled through a Bowden wire 858. When lever 856 is rocked to release the pin 852 from the cam race it enters a slot 855 in a fixed member 857 to lock the lever 846 in a central idle position.

In order to provide for retaining of the pattern mechanism there is provided the arrangement particularly illustrated in FIGURES 5 and 6. A horizontal lever having arms 860 and 862 is pivoted at 861 and concentrically there is provided vertical arm 864 which is connected to the arm 862 by a spring 863, the arm 864 being drawn by the spring to a position relative to arm 862 determined by an adjustable stop screw 865. A pull wire 866 connected to arm 862 and controlled from the main cam drum serves to pull arm 862 downwardly at proper times and with it, yieldingly, the arm 864 through the action of spring 863, and at the same time arm 860 rises and pulls upwardly the Bowden wires 794 and 858 heretofore referred to.

A latch 868 is pivoted at 870 to the frame and is provided with a ledge 872 underlying the arm 860. The latch 868 is urged into engaging position by a spring 874. Pivoted to the frame at 876 is a lever 878 which is urged downwardly by a spring 879. A slot 880 in the lever 878 embraces the fixed pivot pin 870 for the latch 868. The end of lever 878 is provided with a follower 882 which is engageable to be lifted by a side lug 884 carried by one link of the chain 828. The latch 868 is provided with an arm 896 in which there is slidable mounted a bar 888 carrying a laterally projecting pin 890 which extends rearwardly, as viewed in FIGURE 5, and engages within an arcuate slot 892 formed in the lever 878. The arrangement is such that as the lever 878 is rocked the action of side lug 884 of the chain the bar 888 will be moved upwardly into position to be engaged by a lug 894 carried by a clutch member 897 which is splined to shaft 736 and is arranged to be shifted by pins 896 of the arm 864 to be selectively engaged or disengaged from the clutch element 898 secured to the drum 760.

The mechanism just described has the following operation:

During operation of the drum 760 to oscillate the lever 846 the clutch 897, 898 is disengaged, there being no pull exerted on the wire 866. Under these conditions the arm 860 occupies a lower position under lever 878 and latch 872 of latch 868 which is held by it in a counterclockwise position as viewed in FIGURE 5. At this time detent lever 782 is held in its inactive position by cam 790 and Bowden wires 794 and 858 are both in released condition, the latter permitting pin 852 to engage in the cam race on drum 760. Bar 888 is, under these conditions, rocked downwardly and towards the left as viewed in FIG. 5 so that even if it is raised by engagement of lug 884 with follower 882 of lever 878 it will not be engaged by lug 894. When patterning is to end prior to disengagement of clutch 748 as shown, the drum 760, a pull is exerted from the main cam drum on wire 856, rocking lever 862 downwardly and the arm 860 upwardly and with them under the yielding action of spring 863, the arm 864. The clutch 897, 898 is engaged as soon as the notch in 898 is in position to be engaged by the tooth on 897. As arm 860 rises, bars are exerted on Bowden wires 794 and 858. The former through lever 792 and pin 793 retains the detent lever 782 in its inactive position. The latter disengaged pin 852 from the cam race. As arm 860 rises the latch shoulder 972 will move below it so that the parts assume the position illustrated in FIGURE 5. Bar 888 is thus rotated counterclockwise into position such that, when later raised, it will be engaged by lug 894. Wire 866 is then released, but because of the latching action the clutch will remain engaged and the pulls will remain on Bowden wires 794 and 858.

When this action occurs the lug 884 will not be beneath the follower 882. Rotation of drum 760 will then continue with concurrent rotation of cams 810 and 796 to continue the advance of the chain 828 and also to continue the advance of ring gear 828. The result is continued advance of the pattern shown driven through clutch 897 even though clutch 748 is disengaged. When lug 884 passes beneath follower 882 bar 888 is raised. No further action occurs however until lug 894 engages bar 888 rocking the latch 868 from beneath arm 860. When this occurs the clutch 897, 898 is disengaged and simultaneously the detent mechanism is brought into play to arrest the drum 760 in a predetermined position whereupon the cam race is directly below the pin 852. This pin is also released and drops into the race. The parts are thus brought to an initial position with the patterning mechanism brough to a retimed condition for subsequent operation.

Referring now particularly to FIGURES 12 and 42,
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there has been described the lever 321 operated by a Bowden wire 325. At the other feeds there are similar arrangements. Controlling the Bowden wire 325, controlling lever 902, Bowden wire 904 controlling lever 906 and Bowden wire 908 controlling lever 910. These Bowden wires have special controlling means illustrated in FIGURE 42 as applied to the Bowden wires 908 and 325. A follower 914 acted upon by cams on the main cam drum is connected directly to Bowden wire 908 to provide for its positive actuation but is connected only through a yielding arrangement to Bowden wire 325. For control of the latter the follower 914 is connected to a wire 916 which is secured in a block 918. A clip 920 embraces the upper edge of this block which is provided with an elongated slot 922 for the reception of a pin 924 secured in the clip. A pair of springs 926 react between the clip and the block to pull the clip downwardly relatively to the block. The Bowden wire 325 is connected to the clip 928. As will be evident the arrangement is such that a positive pull is imparted to Bowden wire 908 but only a yielding pull is applied to Bowden wire 325. A similar arrangement which is not illustrated in detail but is indicated in FIGURE 1 connects a follower 912 similar to follower 914 to Bowden wires 960 and 964, the former being positively pulled while the latter is yieldingly pulled by follower 912. Referring to FIGURE 12 a bell crank 928 acted upon by a Bowden wire 930, controlled from the main cam drum, and by a spring 932, is provided for the operation of cam 176. A lever 934 operated by Bowden wire 938 from the main cam drum and by a spring 936 controls cam 159.

Reference will now be made to FIGURE 43 which shows the cams on the main cam drum in developed condition. To facilitate understanding of this development the cams which have radial action, i.e., acting on followers such as 912 and 914 in FIGURE 1 are shown, in effect, laid on their side in the circumferential and axial positions which they occupy. Rotation is in the direction of the arrow at the top of this figure. The numerals across the top of the figure represent drum positions 1 to 16, inclusive, and consistently with the positions of the cam followers, as will be described, it may be considered that these numerals shown in FIGURE 43 are the conditions existing prior to step number 1 of the cam drum 704. The rows of cams on the cam drum may be described as follows:

The follower 693a is acted upon by a cam 940 for control of the stitch formation during the knitting of the foot of the stocking. The bend in the thread is accomplished by change of height of the needle cylinder and is generally referred to as stitch tensioning. Follower 693c is controlled by a cam 942 for adjustment of the stitch tension during the knitting of the stocking top. Cams 944 and 946 act on follower 693c for controlling stitch tension during the formation of the heel, advance toe, toe and loopers rounds.

It will be noted from FIGURE 43 that the followers 693a, 693b and 693c are shown in a position corresponding to step 9, but this is because they are on the opposite side of the cam drum from the principal followers. The position relative to their cams which is illustrated is that preceding what will be designated step number 1 of the drum.

Cam members 756 previously mentioned define a race which has the component portions 901, 902, 954 and 956 and extends the roller 755 (FIGURE 7). This roller is also somewhat displaced from the circumferential position of the lever followers. All of the lever followers such as 912 and 914 of FIGURE 1 occupy the same circumferential position which is indicated at 958 in FIGURE 43. All of the remaining cams to be described upon the main cam drum corresponds to a single step movement to the right from the position illustrated in FIGURE 43.
will be understood that these fingers carry inelastic yarn except in the case of feed number 4 where the fourth finger carries elastic yarn as already described. In the case of production of the stocking which will be detailed hereafter, the third and fourth fingers at feed number 3 are not in use. The diagrams show the setups of the buttons 604 and 626 and of the particular buttons 606 and 622 at the fourth feed. The position of the half length butt 606 is indicated in FIGURE 49. At the left-hand side of the figures there are indicated by numerals the steps of the trick wheels which are active (rather than the steps of the ratchet wheel which are engaged by the driving pawls). It will be noted that each step of the trick wheel involves three rows of butt. As will appear in a description of the yarn change sequence each step of a trick wheel involves three successive operations defined by these rows of butt.

The chart constituting FIGURE 50 shows numbers of links, types of links, main drum moves, trick wheel moves, the active yarn fingers at the various feeds put into operation by these moves, and the salient events which result. It will be understood, since only one yarn at any feed is feeding at the same time, that the entry of yarn fingers into use is immediately the removal of the yarn fingers previously in action. Plain links of the pattern chain having no lugs are indicated by O. Links which have pins 715 to initiate yarn changes are indicated by P. Links which carry lugs 714 to start the main drum are designated by L. One of the links is indicated as having a low lug and the part of this will become apparent hereafter. Rubber yarn fed from number 4 finger at feed number 4 is specially indicated by R. Drum moves are numbered to correspond with the numbers in FIGURE 43 while trick wheel moves are numbered to correspond with FIGURES 46 to 49 inclusive. The absence of a yarn finger in a position at any feed is indicated by zero.

Where the finger numbers in FIGURE 50 are enclosed in parentheses there is indicated the fact that while the fingers are in active position the yarns fed thereby are not being knitted.

FIGURE 51 indicates a stocking knit on the described machine consistently with the setups of elements previously described and the operation which follows. This stocking comprises the makeup course m, the elastic top e, the leg f, the heel h, the foot j, the ring toe r, the toe t and the loops round or waste courses w. The yarns and the relationship of the formation of the various portions of this stocking are indicated in the figure, the number of the feed being first given then the number of the finger. The dotted lead lines indicate the feeds and fingers which are used for the formation of the side diamonds on the opposite side of the stocking from that illustrated.

Before discussing the cycle of operation involved in the formation of a stocking a typical yarn changing sequence may be described as it takes place for the change of one inelastic yarn for another. For consistency of description it will be assumed that the yarn change occurs at feed number 4 corresponding to step number 7 of the trick wheel which, as will appear from FIGURE 49, involves the substitution of the yarn from finger number 1 for that previously running from finger number 2.

Referring particularly to FIGURES 1, 3, 4, 10, 12 and 20 to 29 inclusive, it may be first noted that during reciprocatory knitting the main chain 713 advances while the needle cylinder is moving in a clockwise direction. As a chain pin 715 moves under and lifts lever 717 through pin 716, rod 588 is correspondingly raised, thus held from moving inwardly substantially beyond the outermost portion of step 738c of the cam. The timing of the pattern chain advance relative to the timing of cam 738 is such that as the latch 586 is lowered to release the lug 584 the roller 740 is on the surface 738c of the cam. As the drum then revolves, and the roller 740 moves down the slope 738d of the cam, the ring 580 will move clockwise as viewed in FIGURE 10 under the action of spring 747 and link 582. Referring to FIGURES 10 and 22 it will be evident that this movement releasing follower screw 570 from the cam steps 578, 576 and 574 of cam 572 will result in retraction of pawl 544 in a clockwise direction as viewed in FIGURE 22 to bring it into position to engage a next following tooth of the ratchet 542. What has just been described takes place during a clockwise stroke of the needle cylinder. As the cam 738 continues to rotate, the needle cylinder reverses its direction so that when cam step 738a moves roller 740 to begin the yarn change the cylinder is travelling in a counterclockwise direction.

When cam surface 738a moves under roller 740, the ring 580 is moved far enough to cause surface 574 of cam 572 to pass under the follower screw 570 which in turn causes screw 552 to engage and move arm 547 and its pawl 544 a distance sufficient to disengage the trick wheel 540 through the spacing of one trick, i.e. one-third of the total step involved in effecting the complete change.

Prior to the occurrence of this step, yarn was feeding only from finger number 2, and this yarn continues to feed after this first step occurs. On the occurrence of this first step a trick butt will pass from under the follower of finger lever number 1 and through the action of a spring 526 finger number 1 will be lowered into yarn, feeding position.

Yarns from both fingers number 1 and number 2 will now be taken and knit by the needles elevated at this feed number 4, which needles during patteming may be only two alternate needles as will appear hereafter in discussion of the yarn changes occurring at the end of one diamond and the beginning of the next.

The length of the cam surface 738a determines the distance the needles travel before the yarn fed from finger number 2 is taken out of action by the raising of its finger.

When cam surface 738a further lifts roller 740, cam surface 576 will engage screw 570 to give a further advance to pawl 544 which still engages the same tooth. The trick wheel thus advances a second step and a trick butt 536 passes under the follower of lever 522 to lift finger number 2. At the same time a butt 526 passes under the follower of lever 624 which, as it rises, contacts screw 626 (FIGURE 27) and through lever 628 and link 634 opens the clamp and cutter. During the travel of the needles to which the yarn has been presented the end of the newly introduced yarn, which has been held by the clamp, is drawn free and the yarn being taken out of action passes into the open clamp and cutter. The clamping and cutting operations will be shortly described in greater detail.

The length of cam surface 738b is sufficient to permit the needles to which the old yarn is connected to travel far enough to safely draw the yarn into the open clamp and cutter and when cam surface 738c further lifts roller 740 the final move of the trick wheel is taken to move butt 526 from under the follower of lever 624 permitting the lever to drop under the action of spring 632.

At this time ring 580 has completed its cycle and has moved in a counterclockwise direction far that, as seen in FIGURE 10, screw 570 is resting on surface 578 of cam 572 and the trailing edge of lug 584 has passed beyond the latch 586 which is still lowered. As pin 715 of the chain passes from under the pin 716 of arm 717 the latch 586 will be released and moved into position to hold the lug and its ring 580 against the
action of spring 747 as cam surface 738c moves from under roller 740. The trick wheel pawl 544 will accordingly remain in its advanced position until another chain link pin 715 moves into position to release the ring 590 with the result, described above, that the pawl under the action of spring 589 may be withdrawn to engage the next tooth of the trick wheel ratchet.

Considering the clamping and cutting actions, when a yarn is out of action its end is held between clamp 644 and the base 646 by the action of spring 648. For better clamping action the clamp and base have the matching longitudinal flutes 649 and the extension 635 on the lower end of link 634 rests on the clamp as previously described.

The yarn extends from the clamp to the yarn finger, and when it is lowered into action the yarn is laid over the guide wire 660. After the needles have seized the yarn and knitted it, it is carried in a counterclockwise direction and slides on the guide wire 660 beneath the same to a point near where the guide enters the base 646, and as the needles continue to move the yarn passes under the edge 647 withdrawing the free end of the yarn approximately at a right angle to the clamp, which is desirable to prevent other inactive yarns from being swept out of the clamp.

When a yarn is taken out of action its finger is raised as is lever 628 and link 634 which, due to the linkage, swings trapper 636 upwards and opens shear blade 652. In this case the yarn extending from the needles to the finger is carried also in a counterclockwise direction but, since its finger is raised, it is guided into the clamp by surface 638 of trapper 636 and passes over the bow 647 and between shear blades 652 and 659. The abutment 652 prevents the yarn from being drawn back into the V of the shears so that scrapping off of excessive lint may be avoided.

When lever 628 is released spring 633 through link 634 causes trapper 636 to swing inwardly and hook edge 642 engages the yarn which is above the end of guide 660 and moves it safely back into the clamp. Due to the arrangement of the linkage the trapper 636 swings inwardly before the pin in link 634, due to lost motion provided by slot 654, causes shear blade 652 to cut the yarn at 641 and end of the operation extension 635 of link 643 will be again resting on clamp 644 to hold the yarns securely in the clamp.

Since leg pattern knitting takes place while the needle cylinder is reciprocating each yarn when in action must be under control of a takeup sprocket to retrieve the slack produced between reversal of the needle cylinder and beginning of knitting in each direction. The paths of the yarns have already been described. When a yarn is out of action the sweep should also be inactive since the continual pull of the spring might draw the yarn from the clamp and, therefore, when the yarn finger is raised the projection 528 engages the extension 529 of its sweep moving the sweep to, and holding it in, an upright inactive position. Under normal conditions the sweep is nearly upright when the finger rises and projection 528 moves it only slightly. However the main takeup sweep 522 does normally receive a slight movement from the finger when it rises which would cause slack in the yarn at the time when it was being guided into the clamp and cutter and might allow the yarn to get out of control. The auxiliary sweep 499, under the action of spring 492, is ready at all times to take up any small amount of slack which may develop.

The foregoing indicates the fashion in which the inelastic yarns are handled. The special handling of the rubber yarns will be described in connection with the overall operation.

The operation of the machine through the cycle of knitting a stocking will now be described. There should be borne in mind the fact that, as the chain pawl advances, the drum pawl is withdrawing. The advance of the chain pawl 719 occurs during reciprocatory knitting when the needles are travelling clockwise. The movement of the main cam drum 704 then occurs during the next counterclockwise stroke of the cylinder if the guard 719 has been lowered by a lug 718 during advance of the chain. In the present machine all movements controlled by the main drum occur while the cylinder travels in the counterclockwise direction which is the direction of its movement in rotary knitting, the only exception being in the case of movement by the auxiliary racking pawl 726 referred to hereafter.

Reference may now be made particularly to FIGURES 43 to 51 inclusive. At the start of the cycle which will be considered as the time preceding the first step of the main cam drum the following conditions exist:

- All yarn fingers are out of action, and, with exception of the elastic yarn in finger 38, their yarns have been cut and are held in their associated clamps. Since when the elastic yarn is out of action it travels down inside of the needle cylinder to the pick feeder, it leads from the finger over the guard 698 (FIGURE 20) and to permit its seizure by the needles, the guard has now been moved clockwise by the action of trick butts 622.

The cylinder is rotating.

Follower 693b is on cam 942 setting the cylinder for proper stitch control for the top.

Follower roller 755 is in its mid position so that clutch elements 761 and 796 are disengaged by the clutch member 748. Drums 758 and 760 and the parts which they carry are consequently stationary. Shaft 756, however, is rotating so that cam 736 is ready to provide a yarn change.

Follower 882 is held up by lug 334 on auxiliary chain 828. Lever 862 is released, clutch 897, 898 is disengaged, pin 852 is in the race of cams 842 and 844, and detent 782 is released. Detent 776 is also released to hold the drum 778.

The retiming of the pattern mechanism will have located the reading cams in their uppermost positions. They will at this time be inactive.

Switch cams 62 and 64 will be in inactive position and will be raised. Clearing cam 50 will be out of action. Clearing cam 44 will be in active position at this time.

Pickers 68 and 70 will be in their raised inactive position. Cam 159 is out of action. Followers 912 and 914 are both released so that the lower blanking cams are in action and cam 296 holds the upper blanking cams in action.

The sinker cam stop screws 464 and 466 are out of position to engage the screws 469 and 462.

Clearing cam 56 is out of action.

Makeup cam 176 is in action due to cam 1034 on the main cam drum.

The latch openers 428 and 430 are in their active positions under the action of cam 1036.

Stitch cam 60 is in action.

Ring 268 being in its mid position, all of the blanking cams are in active positions and it will therefore be seen that the needles pass through the cams at their lowest positions, passing below all of the stitch cams.

The main cam drum now receives its first step to make-up position and the yarn controlling trick wheels are advanced through their first steps causing fingers numbered 1 at feed numbers 1, 2 and 3 to be lowered and finger number 4 carrying the elastic yarn at feed number 4 is lowered and its book 688 returned to its position shown in FIGURES 8 and 20. As will appear while the yars at feed numbers 1 and 2 are lowered, these yarns are not taken by the needles which fail to rise at these feeds.

The first step of the main cam drum gives rise to the following conditions:

Clearing cams 50 and 44 remain out of action, as do also the pickers 68 and 70. Cam 159 remains out of action.

References to "Table ..." are not shown in the provided text.
Assuming that inelastic yarn is to be fed only at feed number 3, consistently with the assumed stocking being knitted, cam 104 will be absent and consequently blanking cam 178 will remain active, blanking cam 180 also remaining in active position but having no function. However, due to the action of cam 1014 blanking cams 182 and 184 will be out of action. Cam 176 will therefore be effective for control preceding cam 124.

Clearing cam 56 is moved into action in steps, the step 1024 causing it to move in as short butt are passing so that it will engage long butts, and it is then dropped in all the way at the end of the drum stroke while long butts are passing so that it will thereafter engage short butts.

The latch openers still remain active.

Cam 60 which was in active position is now withdrawn in steps, the first step, controlled by cam 1036, taking place at the beginning of the drum move. This withdraws cam 60 so that it will miss short butts and engage long butts. At the end of the drum move it is fully withdrawn to miss both long and short butts.

Due to the above the makeup occurs as follows:

As short butt needles are passing the positions of cams 1024 and 176, these needles riding low as a previously indicated, cam 60 is first moved out to miss short butts and immediately thereafter blanking cam 182 is removed, along with blanking cam 184, the removal of which is only for clearance. As soon as cam 182 is removed, cam 176 will also drop the needles by reason of the butt series at 20°. Those jaws which have butts 20° are pressed inwardly and pass cam 124 without raising. However, those jaws from which butts 20° are missing will engage cam 124 and will rise thereover, lifting their intermediate jacks for rise-over 84, and causing the corresponding needles to rise to a lever at which they could be engaged by cam 60. However, as just noted, cam 60 has been withdrawn to miss short butts and consequently the selected short butt needles will miss this cam, engaging cam 61 and rising to tuck height, being thereafter depressed by stitch cam 58. They will then pass cam 56 which will still but out sufficiently far to miss short butts. While the rubber finger 38 is lowered, the rise of the needles over cam 61 is not sufficient to cause them to seize the rubber.

The first long butt needle associated with a jack from which butt 20° is missing will be similarly raised by the action of cam 176 and 84 but since cam 60 is sufficiently inwardly to engage long butts this needle and the following alternate long butt needles will rise upwardly over cam 60 and will then be depressed by cam 58, the rise of the needles being sufficient to cause them to seize the rubber yarn. Complete withdrawal of cam 60 takes place only after the long butts have passed it, during the subsequent passage of short butts. When the long butt needles which have seized the rubber yarn reach cam 56 they will rise thereover along with the long butt needles which have not taken the rubber yarn, since cam 56 is at this time sufficiently far inwardly to engage long butts at miss short butts. During the passage of the long butt needles this cam moves fully inwardly so as to engage short butt needles following the long butt needles. The result is that the long butt needles take yarn at feed number 3 and draw stitches under the action of stitch cam 53.

The short butt needles following the long butt needles which have taken the rubber yarn at feed number 4 will undergo alternate selection by the action of cam 176 and those which are selected for upward movement will be raised by their intermediate jacks under the action of cam 84 but will then rise only to tuck height under the action of cam 58. The rubber yarn having been initially selected the rise to tuck height is sufficient to cause the selected needles to take the yarn in passing down cam 58. Before the long butt needles again reach the position of cam 60 this cam will have fully withdrawn so that the alternate long butt needles have the same action as just described for the short butt needles. The results of the foregoing may be summarized as follows:

Alternate long butt needles are raised over cam 60 to take the rubber yarn, while alternate short butt needles and alternate long butt needles in subsequent passages rise over cam 61 to take the rubber yarn. The latches of these needles are cleared by cam 56, over which all needles then rise to take the inelastic yarn at feed number 3, drawing stitches by passing under cam 52 whereupon they remain at low level until selection again takes place due to the action of cam 176, alternate needles being raised by reason of its actions while intermediate needles remain low until they again engage cam 56. The result is knitting by all of the needles of yarn at feed number 3 while the rubber yarn is interposed on alternate needles. This action continues throughout the formation of the top. The next two moves of the main cam drum are essentially idle ones except that in move number 2 the latch openers are removed from active position, being no longer necessary since all needles now carry yarn.

The next, fourth, move of the main cam drum effects transition to knitting of the leg. The clutch drum initiates a reciprocating phase of the machine. The following events occur in the counterclockwise movement of the cylinder preceding the first reverse stroke.

Follow cam 942 is made to provide normal leg tension. Clutch controlling roller 755 moves into race 950 which results in disengagement of detent 782 from notch 780 and engagement of clutch member 748 with the element 757 secured to drum 760, which drum accordingly starts revolving to impart movements to rings 68. Cams 50 and 44 and pickers 68 and 70 re-engage from action.

Sinker cam ring stop screws 644 and 466 are permitted to move into stopping position to limit movements of the sinker cam ring for the purpose of causing loops to be drawn in back of sinker nests rather than in front of them over the usual sinker platform. This results in positioning of the stitches along the junctions of the differently colored areas in well defined diagonal lines, avoiding pair of stitches of the same color, formed in consecutive courses, side by side. The last condition gives an irregular boundary of objectionable appearance.

The step of cam 1016 permits a partial movement of follower 914 which allows Bowden wire 908 (FIGURES 12 and 42) to move sufficiently to permit spring 911 to swing lever 910 so that through spring 324 a cam, similar to 318 (FIGURE 38) but having a reverse action, slides into active position, thereby uncoupling cam 182 into operation. While the movement of follower 914 is sufficient to permit Bowden wire 908 to cause blanking cam 182 to become active, the corresponding movement of wire 916 does not permit movement of Bowden wire 325 since the loaded tension of springs 926 is sufficient to overcome spring 319 and associated spring 324, thus preventing introduction of blanking cam 184. As the drum continues its present movement, follower 914 drops from the step 1016 which permits springs 926 to move pin 924 to the bottom of slot 922 nullifying the action of the springs, and Bowden wire 325 is permitted to move under the action of spring 319 as it swings lever 321 to allow cam 318 to slide into position (clockwise as viewed in FIGURE 38) and move blanking cam 184 into action. The reason for delaying the action of blanking cam 184 in respect to blanking cam 182 is due to the fact that butts 24 of jacks 10 are recessed in the sense of the right, as seen in FIGURE 44, and blanking cam 184 must not move in until, through the action of blanking cam 182, all jacks have been cleared from cam 124, since otherwise a jack being lowered by cam 88 would be wedged on top of cam 184. During patterning, the four cutting cams 318 are completely taken of cam 268 which will oscillate in timed relation with reciprocating strokes of the needle cylinder, reaching its mid
position prior to the end of each cylinder stroke and continuing its movement as the cylinder reverses its direction. The action of follower 914, just described, will be repeated later, as will similar actions of follower 912 to introduce blanking cans 178 and 189. At all such times the needle cylinder will be traveling in a counterclockwise direction and ring 265 will be stationery and in its mid position.

Clearing cam 56 is removed from action in steps, first being moved outwardly to miss short butts during the passage of long butts and then moving fully outwardly during the passage of short butts. The result, it may be noted, is to leave clearing of needles solely to the selection of the pattern devices, all three cams 44, 59 and 56 being now out of action. Cam 176 is moved out of action by the termination of extent of cam 1634. Stitch cam 60 is dropped into action so that it will be in position to engage needles to cause them to draw stitches during reciprocatory reverse strokes of the needle cylinder.

At the end of the last counterclockwise movement preceding the first reverse stroke, since cam 56 is out, all of the needles will be in low position. Step number 3 of the trick wheels does not affect any action at feed numbers 1, 2 and 3 but at feed number 4 actions take place to remove the rubber yarn and insert the inelastic yarn from the right side of the fabric. Stitch cam 49 that no clamping and cutting action takes place in this step. The finger is taken out in two steps, it being raised partway by the half length butt 606 in the second step of the third trick wheel movement and then all the way by the full length butt in the third step of this movement. The partial rise initially of the rubber finger is to insure that it passes beneath the plate of the clamp and cutter. The rubber guard 608 is swung outwardly by the action of the butts 622 at the beginning of trick wheel step 3 and is not restored until the beginning of trick wheel step 4 when it engages the rubber yarn to carry it inwardly, the rubber yarn passing it as it is withdrawn on the first reverse stroke and being engaged and swept inwardly by it on the next forward (counter-clockwise) stroke.

In the last counterclockwise movement before the first clockwise stroke the yarns at feed numbers 1 and 2 are not taken by the needles but are first taken during the first pattern stroke in reverse direction. Introduction of the yarn at the end of trick wheel movement number 3 from finger number 3 at feed number 4 is to prevent a stepping diamond color at the tip of the stocking. As will be evident from FIGURE 49 on the fourth step of the trick wheel this yarn is replaced by a yarn from finger number 2 at feed number 4, which last yarn knits the front upper diamond of the stocking. The yarn from the third finger at feed number 4 is the same color as the yarn carried by number 1 finger of feed number 3. The yarns at feed numbers 1 and number 2 are first taken during the reverse stroke following step number 3 of the trick wheel. These yarns are taken due to the action of the pattern mechanism in the fashion which will hereafter be described. These yarns are pulled out of their respective clamps and feeders in reverse direction. From this point on yarn changes take place in accordance with the description previously given.

The fourth trick wheel move takes place after the first complete reciprocation, and as will be clear from FIGURES 46 to 49, yarn changes are made to provide at feed numbers 2 and 4 the yarns for the formation respectively of the upper rear and front diamonds. The yarns at feed numbers 1 and 3 are already those which are proper for the formation of the uppermost side half diamonds.

Movements of the ring 265 are now imparted by the cam arrangement on the drum 760, the ring 265 occupying an extreme counterclockwise position during counterclockwise movements of the needle cylinder and an extreme clockwise position during clockwise movements, the ring being restored momentarily to its mid position at the ends of each of the needle cylinder strokes.

Stepping of ring gear 226 now takes place, first for a series of steps in one direction and then for a series of steps in the opposite direction, the directions of step movements being controlled from the auxiliary chain 238 through the pawl guards 349 and 356 which are alternately active. In the beginning of the pattern the reading cans will be in their uppermost position and will move downwardly step by step and then again upwardly, occupying the extreme upper and lower positions only during single strokes.

The patterning takes place during the drum positions attained by move 4 and idle moves 5 and 6. During the patterning the trick wheels have their moves 3 to 10 inclusive. The yarn changes will be clear from FIGURES 46 to 50 inclusive and with reference to FIGURE 51.

The formation of the solid figure patterns may now be described with particular reference to FIGURES 44 and 45. During this figure formation cans 44, 59 and 56 are withdrawn and cans 62 and 64 are inactive. The upper blanking cans 160, 162, 164 and 166 and the lower blanking cans 178, 180, 182 and 184 will be momentarily located in active position at the ends of the needle cylinder strokes but will be inactive during the operating portions of the strokes.

Cams 144, 146, 148 and 150 which act upon the upper butts 18 of the jaws are active at all times and take part in the figure formation. Cam 176 is now inactive, this being the cam which operates on the lowermost butts 28 of the jacks in the makeup operations.

Of the upper key cans, cans 152 and 156 are active during counterclockwise strokes while cans 154 and 158 are active during clockwise strokes. Of the lower key cans, cans 168 and 172 are active during clockwise strokes and cans 170 and 174 are active during counterclockwise strokes.

Of the reading cans, cans 130, 134, 138 and 142 are active during counterclockwise strokes and cans 140, 136, 132 and 128 are active during clockwise strokes.

For the purpose of specific description there may be considered first a clockwise and then a counterclockwise stroke of the jack specifically indicated at J in FIGURE 45. It will be noted that this jack has butts missing at 20a and 20b but is provided with butts 20c and 20d. It will also be noted that in the lower group of reading butts 22 the even numbered butts are present and the odd numbered butts are absent. The even numbered butts of this series of butts the even numbered butts are absent and the odd numbered butts are present. There will be first considered a clockwise stroke with the reading cans at the level numbered 6 and then a counterclockwise stroke with the reading cans at the level numbered 7.

It will also be noted that the jack J has butts missing at 16a and 16b but has butts present at 16c and 16d. At this point it may be noted that all of the jacks have butts present at 14.

Assume now that jack J starts its clockwise stroke, its starting position, as will be evident from FIGURES 44 and 45, will be to the left of cans 170 and 178 in FIGURE 44. As will appear hereafter, its lower end will initially be inward. The reading cans will be at level 6. Jack J will pass cans 170 and 178 which are inactive during a clockwise stroke and will have its upper end rocked inwardly by cam 144, and then rocked outwardly by cam 128 engaging the butt 22 present at level number 6. The upper end is again rocked inwardly by cam 158 engaging the butt present at 16d, so that butt 18 passes without engaging cam 110. Cam 156 is inactive and in any event the upper end of the jack is already in inner position so that this can will be passed without engagement. Cam 142 is inactive and while it is at the...
level of an existing butt the jack will pass it without being acted on. The top butt 18 being already in inner position it will pass the cam 150 without action. The butt of the jack at number 6 level will, however, be engaged by active cam 140 with the result that the lower end of the jack will be rocked inwardly. Key cam 168 is in active position but produces no movement of the jack because it has no key butt at 26a. Due to the inward position of the lower end of the jack it will pass without engaging cam 124.

Cams 174 and 138 are inactive and no rocking of the jack occurs since it reaches cam 146 when on the hybrid 18 to rock its upper end inwardly. The jack then passes the position of active cam 136 which engages the butt at number 6 level rocking the lower end of the jack inwardly. The jack then passes the active cam 172 without action and due to the inner position of its lower end it passes without engaging the cam 136. Key cam 170 and reading cam 130 are both inactive and hence the next action is that of the cam 144 on its butt 18 to effect inward rocking of the upper end of the jack. Cam 128 engages the butt at level number 6 to rock the upper end of the jack outwardly. However, the jack is immediately rocked in the reverse direction by active key cam 158 which engages butt 18d and the result is the rocking inwardly of the upper end of the jack to cause it to miss cam 110. The jack J ends its clockwise stroke in a position in the vicinity of cam 156.

It will be noted from the above that the jack has moved at a constant level except for its rise over cam 104 and its subsequent depression by cam 108. The corresponding intermediate jack 8 will move beneath cam 82 and will enter from the left of FIGURE 44 at a level below the cam 78 and will pass beneath cam 84. However as the jack J rises over cam 104 the associated intermediate jack will be raised, the cam 80 rocking slightly as indicated by the construction line position in FIGURE 44 to permit rise and the intermediate jack will thereafter rise over cam 76 and will be depressed to its original level by cam 100, passing outward from the right of FIGURE 44 at this last level.

The corresponding needle starts at a level corresponding to the passage of its butt below the stitch cams and the needle will remain at this level until it is raised by the rise of the intermediate jack 8 over cam 76. The rise of the needle thus effected is to clearing level and it will then engage stitch cam 48 after being slightly depressed by the cam point 41 and will take yarn and draw a stitch at the second 2 frames of the unit the yarn being fed through the throat at 30. Following full depression by the stitch cam 48 it will remain at this depressed level as it passes from the right-hand side of FIGURE 44.

At the end of the clockwise stroke there will occur a shifting of the various cams acting upon the jack. The jack as the result of which will be raised the number 7461 at which as noted above the jack J has its butt missing. At the ends of the strokes the reading cams are withdrawn so that the changes of their levels take place without engagement with butts 22. After change of level the readingcams corresponding to the next stroke move into action. Of the upper key cams, cam 152 and 156 will now become active while cams 154 and 158 become inactive. Of the lower key cams, 170 and 174 become active while 168 and 172 become inactive. Reading cams, 140, 150, 138 and 142 are now active while the other associated reading cams are inactive. There may now be described the sequence of operations involved as the same jack J moves in its counterclockwise stroke entering the right-hand side of FIGURE 44.

The jack J moves counterclockwise past the cam 110 with its upper end in inactive position and will pass the inactive key cam 158 and the inactive reading cam 128 and also the cam 144 which will be without action thereon. Cam 130 is active but since it is now in position number 7, where the jack butt is missing, it is without action on the jack. Key cam 170 is active but as has been noted the butt at level 20b corresponding to this key cam is missing from the jack with the result that the lower end of the jack remains in outer position to engage and rise over the cam 126. The result of this rise is to cause the butt 9 of the intermediate jack 8 to engage and rise over cam 86 and then to be depressed by cam 92 which also depresses the jack J to its normal level.

Cams 172 and 132 are inactive and the jack accordingly passes these cams and also cam 146 without action its upper end being in inner position. Cam 134 is active but since it is now in position number 23 its associated reading cam 223 is inactive while the other associated reading cams are inactive. There is no butt at level 16c from this key cam without being acted upon. The jack also passes the active cam 152 which would have no effect because the upper end of the jack is already in inner position but in any event this cam 152 could have no effect since the butt at level 16c is missing. The jack accordingly passes cam 104 without engagement and then passes the inactive cam 154 and 136 and also the cam 148. It then passes without engagement the cam 138 which is at the level of the missing butt but active cam 174 engages the butt 20d to rock the lower end of the jack inwardly. The result is that the key cam 170 becomes active and then passes the inactive cams 168 and 140. Cam 150 will rock its upper end to inner position. The jack then passes cam 142 which though active is without action in viewing the missing butt at level number 7. The jack then passes active cam 156 which has no effect since the upper end of the jack is in inner position and the jack then passes without engaging the cams 110 and 144.

Jack J reaches its final position only after passing cams 130, 170 and 178. As it reaches cam 130 its lower end is in outer position, and cam 130, though active, is at the level of a missing butt so no action on the jack occurs. Cam 170 is also active but as on this cam 170 and then passes cam 178, therefore, the lower end of the jack would engage cam 126 and would be lifted thereby, in turn raising its intermediate jack and needle. To avoid such occurrence the blanking cam 178 is provided which, becoming active toward the end of the stroke, rocks the lower end of the jack inwardly to miss cam 126. This action is typical of the blanking cams which prevent second selections of the jacks as they reach for a second time the feeds into which they were originally selected.

It will be noted that the path of the jack in this counterclockwise stroke has been at a constant level except for the rise over cam 126 which as already mentioned serves to produce a rise of the intermediate jack 8 over cam 86 and then its depression by cam 92. Otherwise the intermediate jack also moves at constant level.

The rise of the intermediate jack over cam 86 produced a corresponding rise of the needle, the butt of which then engaged the stitch cam 48 to rise thereover to a clearing level, the needle being then slightly depressed by the cam point 41 and then fully depressed by cam 46 to take the yarn at feed number 2 from the throat 30 to draw a stitch therefrom. After passing down to the lower end of cam 46 the needle moved at a constant low level from the left-hand side of FIGURE 44.

It will be noted that the result of the foregoing was to cause the needle associated with the jack under discus-
tion to take yarn at the same feed during strokes in both
directions and to take yarn at that feed only. Inasmuch as
the operations of jack J and its associated intermediate
jacks and needles are typical of operation of all of the
jacks and their corresponding intermediate jacks and
needles the operation may be briefly and generally sum-
marized as follows:

A jack will effect the taking of yarn by its needle in a
clockwise stroke at feed number 1 or feed numbers 2
or 3 in a counterclockwise stroke at feed number 2 or feed
number 4 when (a) the corresponding reading cam engages
a butt 22 to rock the upper end of the jack outwardly and
(b) the corresponding upper key cam fails to engage a butt
16 to move the upper end of the jack inwardly with the result
that the jack rises over cam 104 or 110.

A jack also causes its needle to take yarn in a clock-
wise stroke at feed number 1 or feed number 3 or in a
clockwise stroke at feed number 2 or feed number 4 when
(a) the corresponding reading cam fails to engage a butt
22 leaving the lower end of a jack in outward position and
(b) the corresponding lower key cam fails to engage a butt
20 to rock the lower end inwardly with the result that the
jack rises over either cam 124 or 126.

Any other existing conditions at any of the feeds will
cause a needle to fail to take yarn.

For points made above see FIGURE 45 in which as pre-
viously noted the particular jack under discussion is
indicated at J. It will be noted that, in the case of this
jack J, in the lower region of butts 22 the butts are pres-
ent at the even numbered levels and absent at the odd
numbered levels. As has been previously indicated the
even numbered levels correspond to clockwise strokes of
the needle cylinder and the odd numbered levels corre-
spond to counterclockwise strokes.

The result of what has been described is that so long
as the reading cams engage or are at the level of the lower
butts 22 of jack J the jack will cause its corre-
sponding needle to take yarn at feed number 2.

It will be noted, however, that the butts at the upper
portion of the series 22 are arranged so as to be present
in the odd numbered positions but absent at the even
numbered positions. Consequently when the reading
cams are at the levels of these upper butts a different
action of the needles occurs and as may be determined
from following out the general considerations given above
it will be found that the needle corresponding to jack J
will then take yarn at feed number 1 in both directions
of reclamation.

It will appear from FIGURE 45 there is a transition
point for the jack J. In the clockwise stroke when the
reading cams are at the level numbered 10 the needle cor-
responding to jack J will take yarn at feed number 2. In the
clockwise stroke with the reading cams at level number 11 the corresponding needle will take yarn at feed number 1. However, in the next clockwise stroke the needle corresponding to jack J will take yarn at feed number 2 due to the jack butt at level 12. In the next counterclockwise stroke with the reading cams at the level number 13 the needle corresponding to jack J will again take yarn at feed number 1. Then in the next clock-
wise stroke with the reading cams at level number 14 the
yarn will be taken by the corresponding needle at feed
number 1. Thereafter at the subsequent higher levels of
the reading cams yarn will be taken in every stroke at feed
number 1.

A result of what has just been mentioned is to pro-
duce a junction of the colored areas produced at the
various feeds in which in the finished product there will
appear, for example, a diamond of solid color bounded
by a diagonal line of stitches of the next adjacent color,
then a second diagonal line of stitches of the first color
following by a solid area of the second color.

The particular selections involved will become appar-
ent from consideration particularly of the butts at the
levels 16 and 20a, 20b, 20c, and 20d of FIGURE 45 which
butts are controlled by the key cams. As will be evi-
dent the jack may be considered divided into segments each of which has a particular arrangement of
butts at levels 16 and 20a, 20b, 20c and 20d in each seg-
ment, there being two butts of each group present and two
butts of each group absent. Each segment then corre-
sponds to the formation of stitches at two adjacent feeds
as indicated in the figure. The lower grouping of butts 22
will effect the taking of yarn at one feed of the pair and the
upper grouping of butts 22 at the other feed of the pair
with the transition conditions described above.

In view of the complete description of typical opera-
tions and the statement of the general conditions involved
it is believed unnecessary to detail the specific jack move-
ments for every possible combination exhibited in FIG-
URE 45.

So far it has been assumed that during the formation
of a single diamond corresponding to a single complete
cycle of rise and fall of the reading cams there has been
fed at each feed only a single yarn. It will be evident
however that varied effects may be produced by yarn
changes.

FIGURE 52 is a view of the inside of the patterned por-
tion of a fabric, the progress of knitting being from the
bottom toward the top of the figure, the directions of the
strokes in the formation of the various courses being
indicated by the arrows at the right of this figure. In
this figure the number of courses and wales constituting
the extent of a diamond is reduced as contrasted with the
designs produced by the setup of FIGURE 45 and the
other mechanical controls which have been described,
but the sequences of formation of loops are clearly and
typically shown. This figure shows the nature of the
junctions between the diamonds and particularly the di-
agonal lines of stitches at the junctions. It will be noted
that (except for yarn change overlaps) no stitch con-
tains more than one yarn. It will also be noted that each
yarn is knitted only once in the wale at which reversal of
knitting direction occurs, i.e. a yarn is not knitted into a
terminal wale in one stroke and then linked with itself
through formation of a loop in the same wale formed
in the next stroke.

Of particular significance is the matter of yarn change
between contiguous ends of diamonds. As previously
pointed out each yarn change is completed during a coun-
terclockwise stroke of the needle cylinder. It will be
evident, from the needle selections indicated and the
yarn changing sequence, that the present machine pro-
duces a yarn change involving the knitting of both the out-
going and ingoing yarns in the same stitches by two non-
adjacent needles as indicated at 1050 and 1052. The
result is that the yarn ends are securely engaged in the
fabric without a possibility that they will work loose
when the product is worn. This is in contrast with prior
devices in which ingoing and outgoing yarns at the
junction points of diamonds were knit in separate strokes
with the result that stretching of the fabric could easily
disengage loops and produce openings and runs unless
they are later tied to insure that they could not
slip.

The stitch 1054 intervening between stitches 1050 and
1052 belongs to one of the diamonds at the side of the
two diamonds involved in the yarn change and, as will
be evident, provides a stitch belonging to the two diagonal
groups of stitches joining the meeting diamonds.

It will be evident that variations of the junctions at the
ends of diamonds may be produced having the common
characteristic that ingoing and outgoing yarns
are together in at least one stitch to insure that their ends
are properly held, there being preferably two stitches in-
volving this knitting together of the two yarns.

The knitting of the heel is started with number 7 step
of the main cam drum and step number 11 of the trick
wheels. The trick wheel move effects changes to put in
action the fourth fingers at each of feeds number 1 and
two and puts into action feed finger number 3 at
feed number 4. No yarn change is made at feed number
3. While fingers are in active positions at feeds number
3 and 4, yarn is not taken by the needles during
heel formation at these feeds and as will be evident here-
after, when extending from these feeds wrap about
the shanks of picked needles and their take-up
acts to achieve proper control of the yarns.

The main drum move brings cam 944 into engagement
with follower 693c to position the needle cylinder for
proceeding the passage of the stitches. The cylinder height is
to be enlarged for heavier yarn in the heel or,
at any rate, even if heel stitches are drawn from the
same weight yarn as the leg, it may be desirable to raise
the cylinder to draw at least the same size stitches as in
the leg due to the fact that in formation of the heel the
stitches are not drawn over the sinker nebs as they were
during leg formation.

As will be noted by considering the portions 950 and
952 of the cam race for roller 755, this roller is moved
substantially throughout the main cam drum move to
effect disengagement of drum 760 and engagement of
drum 765. Clutch 748. Throttle 783 is released by
cam 790 but is held out for retiming as described, while
detent 776 is moved outwardly by cam 790 to disengage
notch 774 releasing drum 758. The rotation of drum 758 thus
initiated effects rotation of cams 762 and 766 which,
through levers 764 and 768, provide swinging of cans
62 and 64. Cam 399 at the same time reciprocates but
will presently appear it has no action in this phase of
the operation since pin 388 will be otherwise lifted.

At the end of move number 7 cam 960 effects move-
ment of levers 404 and 404' to move cans 64 and 62 in-
wardly to engage long butts of needles and also suffi-
ciently close upon the follower 404 the actuating
screw on the side of the machine to hold the
associated pins which have been raised by cans 390 and
399' to lower the dropping pickers 72 and 74 to in-
tactive positions.

Clearing cam 50 is put into action by release of the
follower from cam 968. This cam moves inwardly suffi-
ciently far to engage long butts only. Clearing cam 44
is also moved inwardly to engage long butts by the drop-
ning of its follower on step 980.

Pickers 68 and 70 are fully released to positions to
engage and raise two needles on each stroke.

It is noted that cam 936 is arranged to act on its
follower only during the initial portion of move number
7 of the main cam drum. Cam 159 moves into action
to cause the jacks associated with the approximating
quarter of the long butt needles to rise over cam
156 so that the intermediate jacks rise over cam 86 and
the needles rise over cam 48 to take yarn at the second
feed. It may be noted that the jacks associated with
heel needles have their butts missing at the position of
key cam 170 and that ring 268 has not reached its mid
position to operate blanking cans 178 and 180 so that
these cans do not prevent the rocking of a pattern jack
by 159 as noted. Cam 156 is inactive at this time since
the drum 760 is not dechotted until near the end of the
main cam drum move. The reason for the use of
cam 159 is to insure that the trailing long butt
needles will take yarn at number 2 feed before cam 62
goes in, the inward movement of cam 62 taking place
during rotation of cam 159. At least three of the trailing
long butt needles must knit at feed 2 since otherwise the
active yarn which would be changed to a heel yarn at the
back of the heel would trail from this point to the yarn finger,
and since on the next stroke (clockwise) of the needle
cylinder the shanks of the leading two long butt needles elevated
by the picker and be missed by some of the succeeding heel
needles. By knitting the yarn on a few needles during

the counterclockwise stroke, as described, the yarn is con-
ected to the leading stitches to which it is to be joined
and, therefore, is held down in the proper position to be
taken by the active needles. Cam 44 must go in to cause
the needles beginning with the long butt series to take
yarn at feed number 1 but this cam may be controlled
from the main cam drum in sufficient time for this to
occur. Cam 159 must go out as soon as the long butts
have passed in the same move of the main drum, being
particularly required to be out of action before the re-
verse stroke occurs because otherwise it would clash
with the actuating follower 404.

Cam 1012 acts to withdraw the sinker cap stop screws
464 and 466, freeing the sinker cans for normal oscilla-
tion so that the yarns will feed under the nebs of
the sinkers in the usual fashions as contrasted with the action
during patterning when, with the stop screws in position,
the sinker cap movements were limited to cause the yarn
be drawn over the nebs of the sinkers.

Withdrawal of clutch 748 from the drum 760 would
produce stopping of this drum except for the fact that
just prior to this withdrawal clutch 897 is engaged by the
action of cam 1042 which initiates retiming of the chain
838. Throttle 873 is withdrawn from the race provided by cans 842 and 844
while lever 845 is in its central position and the lever 846
is latched in that position while at the same time pin 793
is moved out to prevent detent 782 from engaging notch
780. As a consequence, rotation of drum 760 continues
but only for the purpose of rotating cans 796 and 810
for retiming as described.

After clutch 748 disengages the drum member 757,
roller 755 continues to move until at the end of the main
drum move it is in the race 952 and has caused the clutch
to engage member 761 of drum 758, and through cam 790
has lifted off actuator 414 and the actuating screw
which now begins to revolve and through its cans 762 and 766,
levers 764 and 768, wires 395 and 394, reciprocates switch
cams 62 and 64 in proper timing with movement of the
needle cylinder in each direction as previously described.

The various actions just described provide for narrow-
ing in the formation of the heel as follows:

In the counterclockwise move of the needle cylinder
Corresponding to move number 7 of the main cam drum
the trailing long butt needles are controlled by the action
of cam 159 to clear their stitches over cam 48, and they
then draw yarn at feed number 2. In passing down stitch
46 while all long butts needles are cleared by cam 44
and take yarn at feed number 1 knitting it at stitch cam
40. They then pass under cam 64 and under cans 60,
61 and 58, missing cam 56 which is held out during heel
and toe knitting. Some of the leading long butt needles
at the end of the stroke would pass the location of cam
62 and to prevent their being raised thereby this cam is
swung upwardly before they reach it as described previ-
ously. The short butt needles are missed by all of the
cams and ride low.

On the reverse stroke the long butt needles are raised
by cam 64 and then by cam 48, knit yarn at feed number
1 by passing down stitch cam 42 are cleared by cam 58,
and take and knit yarn at feed number 2 as they pass
down cam 48. They then pass under cam 62 and, pass-
ing under or by the other cans, pass under can 64 which
is raised as they approach. In this stroke, however, the
first two long butt needles are picked upwardly by picker
68. In needles fowing stroke the two leading long
butt needles are picked by picker 70 and thus narrowing
occurs in usual fashion.

During the continuation of narrowing, moves 12 to
16, inclusive, of the trick wheels occur but these are
essentially idle moves, there being no yarn changes ef-
fect.

Widening is begun by move 8 of the main drum. It
will be noted from FIGURE 50 that the pattern chain
link initiating this move is indicated as having a low
lugs. Referring to FIGURE 4, it will be noted that auxiliary pawl 276 has been oscillating on the circular portion of ratchet 277 having only a single tooth 728. Up to this point in time, even when the auxiliary pawl was released against the ratchet, it was without action since it could not engage the tooth. The low lug of the pattern chain lowers guard 719 and its end 730 sufficiently to permit the pawl 279 to engage its ratchet 272 but insufficiently to permit pawl 723 to engage its ratchet tooth 728 which, at the time of its drum move, would be in position for engagement by pawl 726 if the guard was fully lowered by a chain lug at normal height and, being caught in the tooth, would advance the drum on the next passage of cam 725. On this move the levers 404 and 404' are swung partially toward their inactive position by the dropping of the follower on the lower step of 962 of cam. By reason of this action cam 411 releases pin 388 and the corresponding action occurs on the other side of the machine so that the dropping pickers 72 and 74 are solely under control of the cams 398.

Pickers 68 and 70 are now raised to their positions for single needle picking by the action of cam 990. No other changes are effected by the main cam drum. Needle movements now occur as in the case of narrowing with the exception that the dropper picks 72 and 74 lower three needles on each stroke and the narrowing picks 68 and 70 raise a single needle on each stroke. Due to the action of cam 390, lowering picker 72, during a clockwise stroke, is rendered inactive until the leading group of elevated needles is passing, at which time the picker is released to ride under this group until after its passage, when the picker rises into position to engage and lower the first three needles of the elevated group following the active needles and after passage of this group the picker is again rendered inactive. During a counterclockwise stroke, cam 390' controls lowering picker 74 in a similar manner. Cams 62 and 64 vibrate for the same reason as in narrowing to avoid raising of leading long needle with as they reach these cams a second time in each stroke.

Move number 9 of the main cam drum initiates the knitting of the four-wheel foot.

At this time the tooth 728 is in position to be engaged by cam 279 which is raised by the high lug on the main chain and accordingly move number 9 of the main drum is initially imparted by the action of cam 275 moving this auxiliary pawl while the balance of the move is by the main pawl 279. As will shortly appear this early move is to insure withdrawal of blanking cams 102 and 104, and therefore the short and long needles respectively reach them in the counterclockwise stroke.

Trick wheel move number 18 provides yarn changes at the first and second feeds to finger number 1 of each. No change is effected at the third and fourth feeds but the yarn fed by the active fingers at these feeds will now be taken by the needle.

The advance of the main cam drum also involves movement of the clutch drum to provide rotation of the needle cylinder.

Cam 940 now acts on follower 693a to provide a proper setting of the needle cylinder for the desired stitches in the foot.

Roller 735 now enters portion 954 of its race to move the auxiliary clutch to neutral position to stop the oscillation of cams 62 and 64. At this time detent 776 engages notch 774 to hold drum 755 stationary. If retiming has been completed detent 782 will engage notch 780; but if retiming continues this action will not occur until retiming is completed. By the dropping of the follower from cam 962, cams 62 and 64 are withdrawn from action.

Clearing cam 50 is taken out of action by cam 970.

Cam 44 is moved fully inwardly by the dropping of the follower from step 980.

Pickers 68 and 70 are moved to their highest inactive positions by cam 992.

Blanking cams 178 and 182 are moved out of action by cams 1008 and 1018, cams 184 and 180 being concurrently moved out of action though this is merely for clearance as jack butts move downwardly.

Cam 56 moves into action as the follower leaves cam 1026.

In the knitting of the foot the long butt needles first knit at feed number 2 and the short butt needles at feed number 4. The movements of the needles for this purpose are controlled by the blanking cams 178 and 182 being out of action, and it is for this reason that it is necessary to have the drum move removing these blanking cams completed prior to the beginning of the last counterclockwise stroke. The needles during the knitting of the foot enter the right-hand side of FIGURE 44 below thecams 54, 58, are cleared by cam 56 and take yarn at feed number 3 going down cam 52. The reading cams and keycams at cam 52 are then taken out of action by cams 178 and 182, the pattern jacks will rise over cam 126 causing the intermediate jacks to rise over cam 86 lifting the needles to engage and ride over cam 48 where clearing occurs. The needles then take yarn at the second feed in passing down stitch cam 46 and are cleared by cam 44. Then they take yarn at the first feed in passing down stitch cam 40 and are selected upwardly to engage cam 60 by the action of cam 124 on the pattern jacks and cam 84 on the intermediate jacks. After clearing by cam 60 they take yarn at the fourth feed in passing down stitch cam 58.

It will thus be seen that four feed knitting takes place giving rise to very rapid production of the foot of the stocking. The active yarns at this time are desirably of the same color to avoid the appearance of stringing in the foot.

Moves 10 and 11 of the main cam drum are idle ones as are also moves 19 and 20 of the trick wheels.

The formation of the ring toe is begun by move number 12 of the main drum and move number 21 of the trick wheels. The yarn change is to finger number 4 at each of the first and second feeds with withdrawal of the fingers at the third and fourth feeds.

The main cam drum move provides restoration to action of blanking cams 152 and 184 by drop of the follower from cam 1018 and step 1020. This drop, however, occurs in two steps, there being first a drop from cam 1018 to step 1020 sufficient to move cam 182 into action, as previously described.

Cam 56 is removed from action in steps, first partway to miss short butt needles while continuing engagement with long butt needles due to step 1030 and then, due to step 1022, moving cam 56 fully outwardly to miss long butt needles. The removal of yarn at number 3 feed occurs as short butt needles fail to rise at the position of cam 56. Withdrawal of yarn at feed number 4 takes place after needles fail to clear over cam 60 due to the action of blanking cam 182. It will be evident that the result of the foregoing is two feed knitting at the first and second feeds only, this being preparatory to the knitting of the toe at these feeds.

Move 13 of the main cam drum initiates narrowing of the toe. As will be evident from FIGURE 43 this move results in positions of the machine elements corresponding to those involved in the narrowing of the heel with the additional introduction of blanking cams 178 and 180 by the movement of follower 912 and cam 1008 and step 1010 as described similarly for cams 182 and 184 and consequently the narrowing of the toe need not be described in detail.

The widening of the toe proceeds upon step number 14 of the main drum. An idle advance of the trick wheels, move number 23, occurs. The move of the main drum results in the same conditions as existed for
the widening of the heel, and the widening of the toe need therefore not be described in detail.

The formation of the looper's rounds is initiated by move 15 of the main cam drum, there being no attendant yarn change. This move effects somewhat different conditions of those involved in the heel, since the looper's rounds are to be knit only at the first and second feeds. The clutch drum produces rotation of the needle cylinder. The auxiliary clutch moves to neutral position to stop the action of cams 762 and 766, detents 782 and 776 engaging respective notches 780 and 778. Cams 689 and 753, the pins of cams 689 and 753 are moved out of action by the dropping of the follower from cam 966. Cam 50 is withdrawn by the action of cam 968. Cam 44 which was already in position to engage long butts only is now released by cam 966 for movement to engage short butts, the cam dropping in during the passage of long butts.

Pickers 68 and 70 are moved to their inactive positions by cam 988. Blanking cams 178 and 180 are withdrawn.

It will be noted that cam 56 is already out of action while cam 162 is already in action.

The result of the foregoing rotary knitting at the first and second feeds, the needles being caused to rise by reason of the withdrawal of cam 178, through the actions of cams 126 and 86 so that they clear over cam 48 and take yarn at the second feed, being then cleared by cam 44 and taking yarn at the first feed. By reason of the condition of cam 162 they remain low at the fourth feed and by reason of withdrawal of cam 56 they also move low at the third feed.

The rotary knitting thus continues with the toe yarns and with the toe tension adjustment.

The next event is move number 24 of the trick wheels. This move removes from action the yarns at the first and second feeds with the resulting occurrence of a press-off, leaving the needles bare.

Move 16 of the main cam drum then takes place resulting in the stepwise removal of cam 44 by cams 972 and 974, and a restoration to action of blanking cams 178 and 180 which as will be evident prevents any clearing of needles and results in their moving at low welt level. In this same move cam 176 is put into action in preparation for the following makeup and the latch openers are also put into active position. The cycle then automatically repeats.

It is sometimes desirable to carry the leg pattern into the instep to the extent, for example, of the formation of an instep diamond. A stockinette in which this occurs is illustrated in FIGURE 54 which, in comparison with that shown in FIGURE 51 involves the formation of a colored diamond after completion of the heel. The formation of such a diamond is carried out by reciprocal knitting as in the formation of the leg. Such knitting requires the formation of side half diamonds $d_1$ which are in effect continuations of the half side diamonds above the heel, a back diamond $d_2$ and concurrently with the second halves of the diamonds $d_1$ and $d_2$, half side diamonds $d_3$. As ordinarily desired, the diamond portions $d_1$, $d_2$, and $d_3$ would be formed of the same color yarn as the side half diamonds preceding the heel and the foot. Except upon close examination, revealing the diamond junctions, the portion of the stocking beyond the heel will then be uniform in color with the foot except for the front diamond $d$.

Various changes are involved in the mechanism for the formation of the stocking of FIGURE 54. FIGURE 53 shows the changes of cans on the main cam drum, and may be compared with FIGURE 43 already described. The trick wheels at the first, second, and third feeds may be the same as before, but at the fourth feed the trick wheel set-up is as illustrated in FIGURE 56 which may be compared with FIGURE 49. The various moves are the same as illustrated in FIGURE 50 to move number 7 of the main drum. Moves 7 to 11 are then different, while thereafter the moves 12 to 16, inclusive, are the same as before. The moves which are different are indicated in FIGURE 55 which may be considered as representing substitutions for the corresponding portions of FIGURE 50.

Referring back to FIGURE 53 and comparing it with FIGURE 43, it will be noted that cam 940 is substituted for cam 940 to give a delay of one step in action upon the follower 693a.

The cam race acting on follower 755 is the same as in FIGURE 43 with the exception of the race portion 954, and the race portion 954 is that race portion 954". As will appear the race at 954 is provided for the purpose of pattern control during the formation of the diamond $d$ and its associated diamonds.

Previous cam 980 is changed to include the addition of an elevated step 983 and a trailing ledge 985.

Cam 1008 is shortened to the extent indicated at 1008 in FIGURE 53.

The single cam 1012 is replaced by cam 1012 and 1013.

Cam 1018 is replaced by a shorter cam 1018.

Cam 1028 is extended and terminates in a step 1029.

The cam 1042 which controls the pattern at the sides placed in a later position at 1042, since retiming cannot begin until after the completion of the instep diamond.

Comparing FIGURE 56 with FIGURE 49 it will be noted that the controls for the first and fourth fingers at number 4 feed are the same as before. In the case of the third finger at this feed the control is the same up to step number 11, and then remains different through step number 19. In the case of the second finger at this feed there is a difference beginning with step number 11 and continuing through step number 20. Butts at 626 are added in step number 20. It may be pointed out that the general result is to cause yarn from the second finger at number 4 feed to knit the instep diamond $d$ as contrasted with the feeding of yarn from the third finger of feed number 4 during the knitting of the foot of the stocking of FIGURE 51.

Referring now particularly to FIGURES 55 and 50, it will be noted that the main drum moves numbers 7 and 8 correspond in the two figures with the sole exception that at feed number 4 at the start of the heel the yarn from the third finger is lowered into active position as compared with the yarn from the second finger at this feed. However, as already noted, while yarn at number 4 feed is thus placed in position in preparation for later knitting, it is not taken during heel formation.

Upon the occurrence of main cam drum move number 9, change of the needle cylinder operation to rotation does not occur, but rather reciprocation continues. The pattern drum starts due to the formation of the raceway 954, and then reciprocatory diamond pattern formation occurs as previously described with concurrent events corresponding to those involved in the formation of the leg. Move number 10 of the main cam drum is an idle one.

Move number 11 of the main cam drum, indicated as idle in FIGURE 50, now effects the resumption of rotation and the termination of the pattern with substitution of yarn from the third finger at number 4 feed for the yarn from the second finger at this feed. The subsequent moves are then the same as before.

As will be evident from the brief description just given, there will be produced the stocking of FIGURE 54 and it is unnecessary to describe the actions of the various parts of the machine in detail since they are the same as already fully described.

It will be clear from the foregoing descriptions that stockings of various pattern formations either in the leg sections or continuing forward from the leg into the foot portions of the stockings may be produced, the machine not being limited to the formation of diamonds but being equally adaptable to the formation of other figures depending solely upon the set-ups of the various pattern controlling elements. Yarn changes involving stripe formations or the
like may also be provided, and it will be evident that, if desired, larger numbers of fingers than those described may be provided at the various feeds.

What is claimed is:

1. A knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause only one feeding station during a single reciprocatory stroke, with a selected group of needles taking yarn at each of a plurality of said feeding stations during said reciprocatory stroke; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

2. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause any needle to take yarn at only one feeding station during a single reciprocatory stroke, with a selected group of needles taking yarn at each of a plurality of said feeding stations during said reciprocatory stroke; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

3. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause any needle to take yarn at only one feeding station during a single reciprocatory stroke, with a selected group of needles taking yarn at each of a plurality of said feeding stations during said reciprocatory stroke; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

4. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause any needle to take yarn at only one feeding station during a single reciprocatory stroke, with a selected group of needles taking yarn at each of a plurality of said feeding stations during said reciprocatory stroke; means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

5. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause needles of each of selected groups to take yarn at a corresponding feeding station to provide areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

6. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause needles of each of selected groups to take yarn at a corresponding feeding station to provide areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric; and means for controlling needles during another period of rotary knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

7. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause needles of each of selected groups to take yarn at a corresponding feeding station to provide areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

8. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause needles of each of selected groups to take yarn at a corresponding feeding station to provide areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

9. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause needles of each of selected groups to take yarn at a corresponding feeding station to provide areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of rotary knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

10. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause needles of each of selected groups to take yarn at a corresponding feeding station to provide areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause needles of each of selected groups to take yarn at a corresponding feeding station to provide areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric; and means for controlling needles during another period of rotary knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.
provide areas each of which is knit primarily from a single yarn, with all of said needles taking yarn during each stroke of reciprocation; means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric; and means for controlling needles during another period of rotary knitting to cause all of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

11. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause needles of each of said groups to take yarn at a corresponding feeding station to provide joined areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

12. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to take yarn at a plurality of feeding stations; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

13. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to take yarn at said four feeding stations; means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric; and means for controlling needles during another period of rotary knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

14. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during another period of reciprocatory knitting to cause selected needles to take yarn at said four feeding stations; means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric; and means for controlling needles during another period of rotary knitting to cause at least some of said needles to take and knit yarn at a plurality of feeding stations to produce multifeed fabric.

16. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to take yarn at said four feeding stations to produce areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

17. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to take yarn at said four feeding stations to produce joined areas each of which is knit primarily from a single yarn; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take yarn at a plurality of feeding stations to produce multifeed fabric.

18. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling certain needles to take yarn at one feeding station during a single stroke of reciprocatory knitting; and means for controlling certain needles to take yarn at a plurality of feeding stations during a single stroke of reciprocatory knitting.

19. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles to take yarn at all four feeding stations during a single stroke of reciprocatory knitting, with at least some of said needles taking yarn at only one feeding station during such stroke; and means for controlling certain needles to take yarn at a plurality of feeding stations during a single stroke of reciprocatory knitting.

20. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles to take yarns at all four feeding stations during the formation of a single course, with at least some of said needles taking yarn at only one feeding station during the formation of such course; and means for controlling certain needles to take yarn at a plurality of feeding stations during a single stroke of reciprocatory knitting.

21. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles to take yarns at all four feeding stations during the formation of a single course, with at least some of said needles taking yarn at only one feeding station during the formation of such course; and means for controlling certain needles to take yarn at a plurality of feeding stations during the formation of a single course.

22. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four feeding stations, and
means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles to take yarns at all four feeding stations during a single stroke of reciprocatory knitting, with at least some of said needles taking yarn at only one feeding station during such stroke; and means for controlling certain needles to take yarn at a plurality of feeding stations during the formation of a single course.

23. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles so that different groups of needles take yarn at each feed during successive reciprocatory strokes to produce at least one diagonal junction between areas knit primarily from yarns fed at different feeding stations, with said junction comprising, in a single course, a pair of loops formed of yarn fed at one feeding station separated by a loop formed of yarn fed at another feeding station.

24. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles so that different groups of needles take yarn at each feed during successive reciprocatory strokes to produce diamond-shaped areas knit primarily from yarns at different feeds with diagonal junctions between such areas, with each of said junctions comprising, in a single course, a pair of loops formed of yarn fed at one feeding station separated by a loop formed of yarn fed at another feeding station.

25. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of a plurality of yarn feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles to cause yarn to be taken and knit at each of said feeding stations for a predetermined group of needles during a single reciprocatory stroke, and to cause a yarn to be taken and knit at each of said feeding stations for a predetermined group of needles during a succeeding reciprocatory stroke, to provide four simultaneously formed and suture-joined areas each of which is knit primarily from a single yarn.

26. In a circular knitting machine comprising a needle cylinder, independent needles carried by said cylinder, yarn feeding means at each of at least four spaced feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause a yarn to be taken and knit at each of said feeding stations by a predetermined group of needles during a single reciprocatory stroke, and to cause a yarn to be taken and knit at each of said feeding stations by a different predetermined group of needles during the next reciprocatory stroke.

27. In a circular knitting machine comprising a needle cylinder, independent needles carried by said cylinder, yarn feeding means at each of at least four spaced feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to knit a plurality of suture-joined contiguous partial courses, each of a separate yarn, at said stations to form a composite circular course during each of single strokes of reciprocatory knitting, said needle controlling means varying the selected needles in successive strokes to produce at least one suture deviating from straight walewise extent.

28. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least four spaced feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles to cause every needle to take and knit when at at least one feeding station during each reciprocatory stroke, to cause a yarn to be taken and knit at each of said feeding stations by a predetermined group of needles during a single reciprocatory stroke, and to cause a yarn to be taken and knit at each of said feeding stations by a different predetermined group of needles during the next reciprocatory stroke.

29. In a circular knitting machine comprising a needle cylinder, independent needles carried by said cylinder, yarn feeding means at each of at least four spaced feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to knit at least four suture-joined contiguous partial courses, each of a separate yarn, at said stations to form a composite circular course during each of single strokes of reciprocatory knitting, said needle controlling means varying the selected needles in successive strokes to cause at least one suture of a series of successive composite circular courses to extend at an angle to the wales.

30. In a circular knitting machine comprising a needle cylinder, independent needles carried by said cylinder, yarn feeding means at each of at least four spaced feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to knit at least three suture-joined contiguous partial courses, each of a separate yarn, at said stations to form a composite circular course during each of single strokes of reciprocatory knitting, said needle controlling means varying the selected needles in successive strokes to cause
at least one suture of a series of successive composite circular courses to extend at an angle to the wales.

33. In a circular knitting machine comprising a needle cylinder, independent needles carried by said cylinder, yarn feeding means at each of at least three spaced feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to knit a plurality of suture-joined contiguous partial courses, each of a separate yarn, at said stations to form a composite circular course during each of single strokes of reciprocatory knitting, said needle controlling means varying the selected needles in successive strokes to produce at least one suture deviating from straight walewise extent.

34. In a circular knitting machine comprising a needle cylinder, independent needles carried by said cylinder, yarn feeding means at each of at least three spaced feeding stations, and means for producing relative reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to knit at least three suture-joined contiguous partial courses, each of a separate yarn, at said stations to form a composite circular course during each of single strokes of reciprocatory knitting, said needle controlling means varying the selected needles in successive strokes to produce at least one suture deviating from straight walewise extent.

35. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least three feeding stations, and means for producing relative rotary and reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to take and knit yarn at a plurality of feeding stations to produce multifeed fabric.

36. In a circular knitting machine comprising a needle cylinder, needles carried by said cylinder, yarn feeding means at each of at least three feeding stations, and means for producing relative rotary and reciprocatory movements between said cylinder and said yarn feeding means; means for controlling needles during one period of reciprocatory knitting to cause selected needles to take and knit yarn at said three feeding stations; and means for controlling needles during another period of reciprocatory knitting to cause at least some of said needles to take and knit yarn at a plurality of feeding stations to produce multifeed fabric.

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