March 14, 1961 R. H. LAWSON 2,974,506

KNITTING METHOD AND MACHINE

Filed June 3, 1957 5 Sheets-Sheet 1

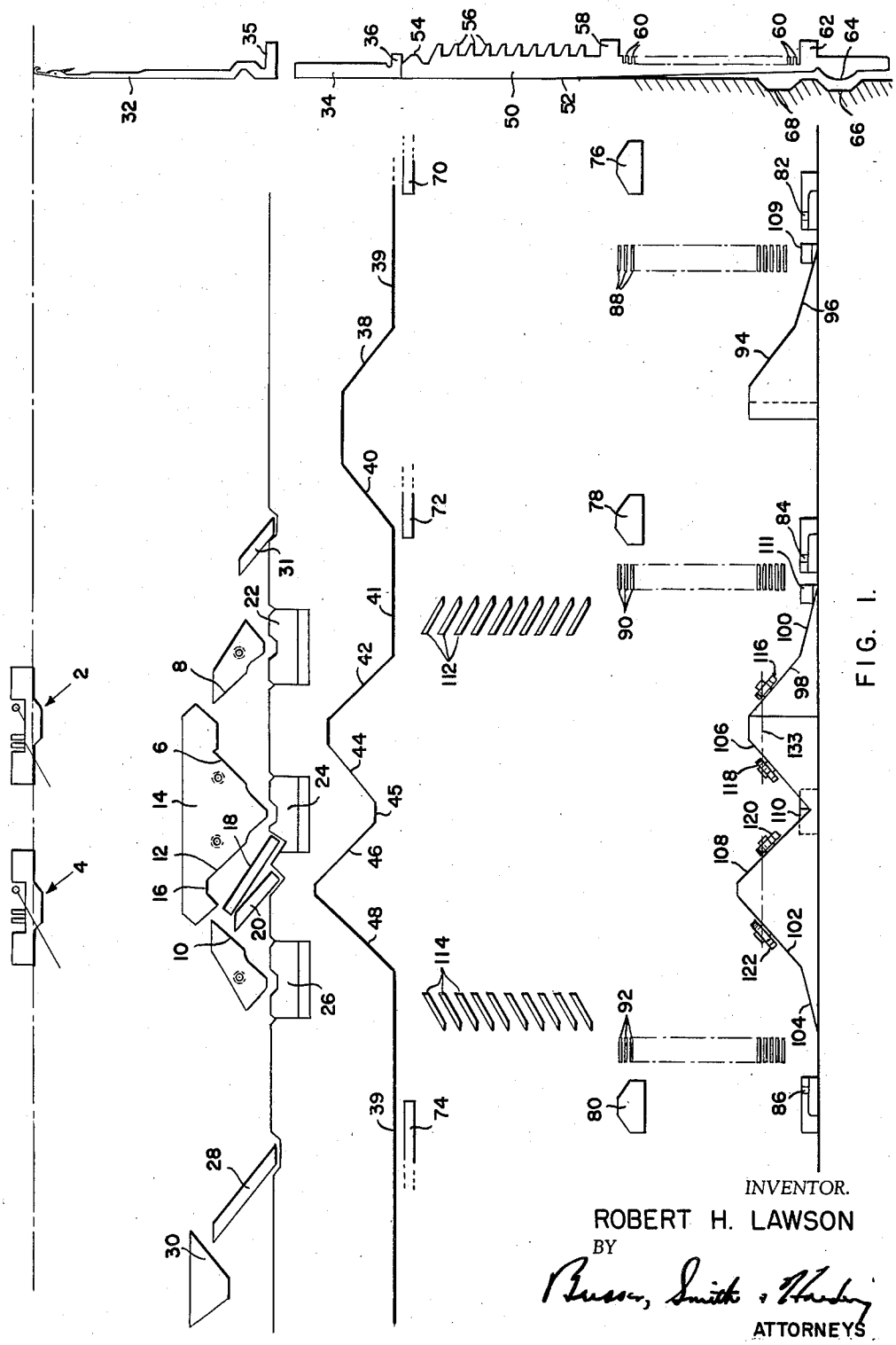


FIG. 1.

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KNITTING METHOD AND MACHINE

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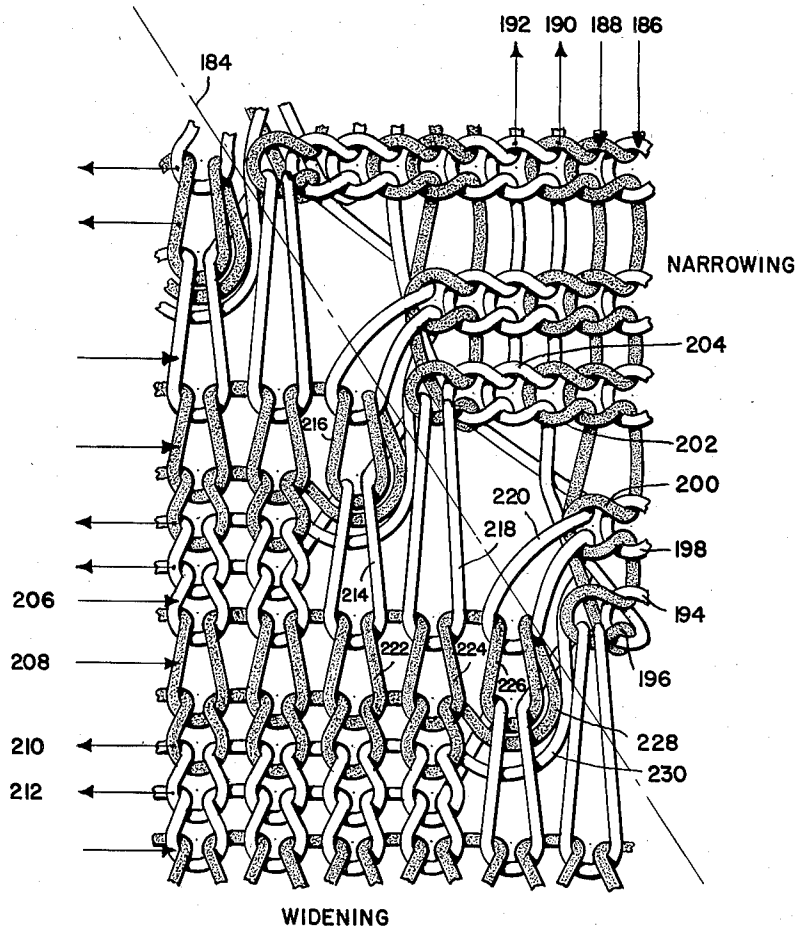


FIG. 9.

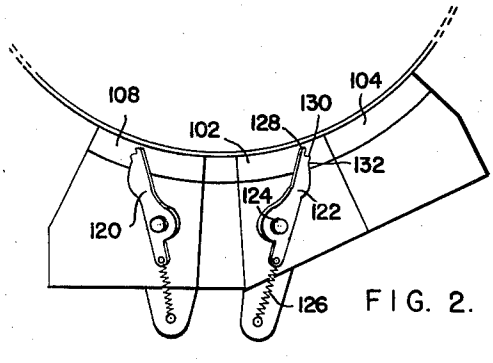


FIG. 2.

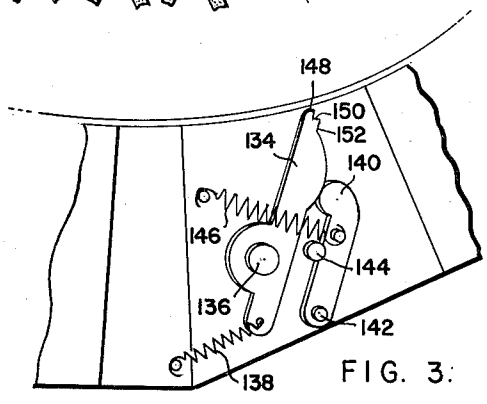


FIG. 3.

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March 14, 1961 R. H. LAWSON 2,974,506

KNITTING METHOD AND MACHINE

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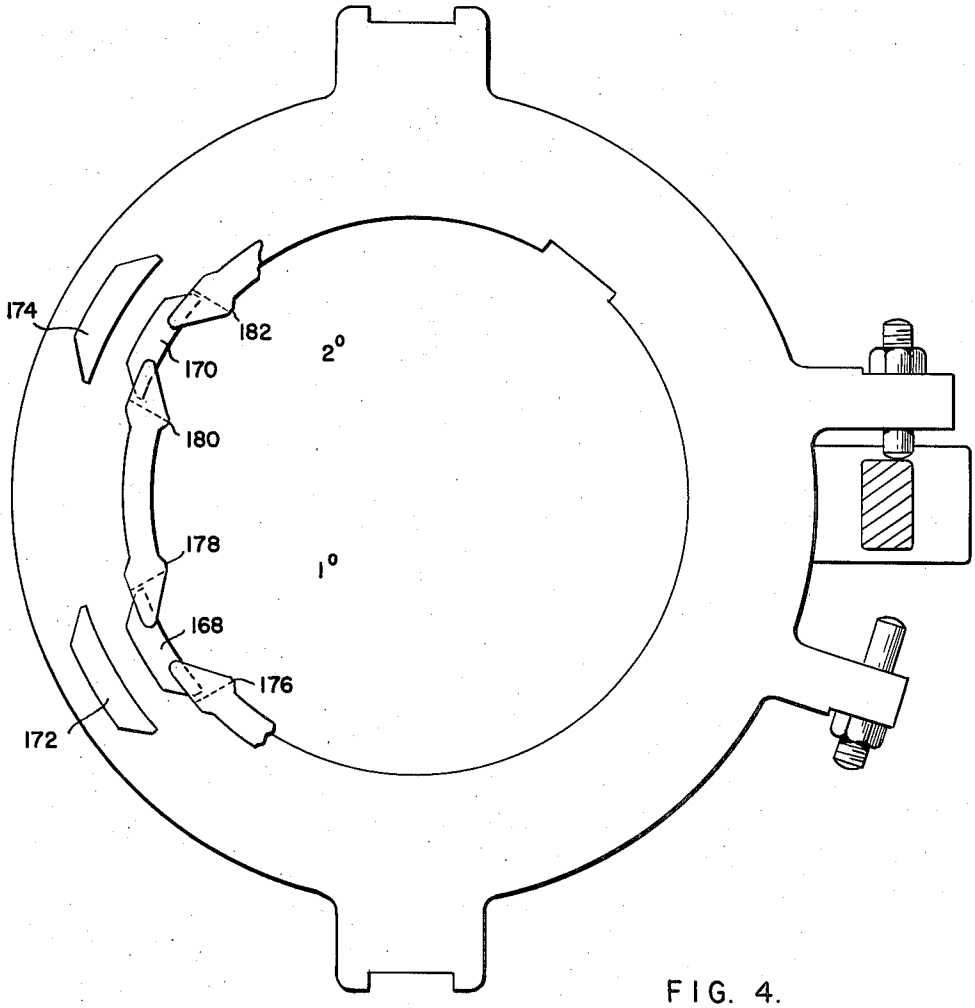


FIG. 4.

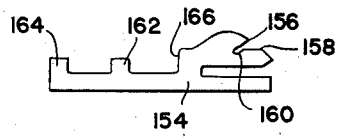


FIG. 5.

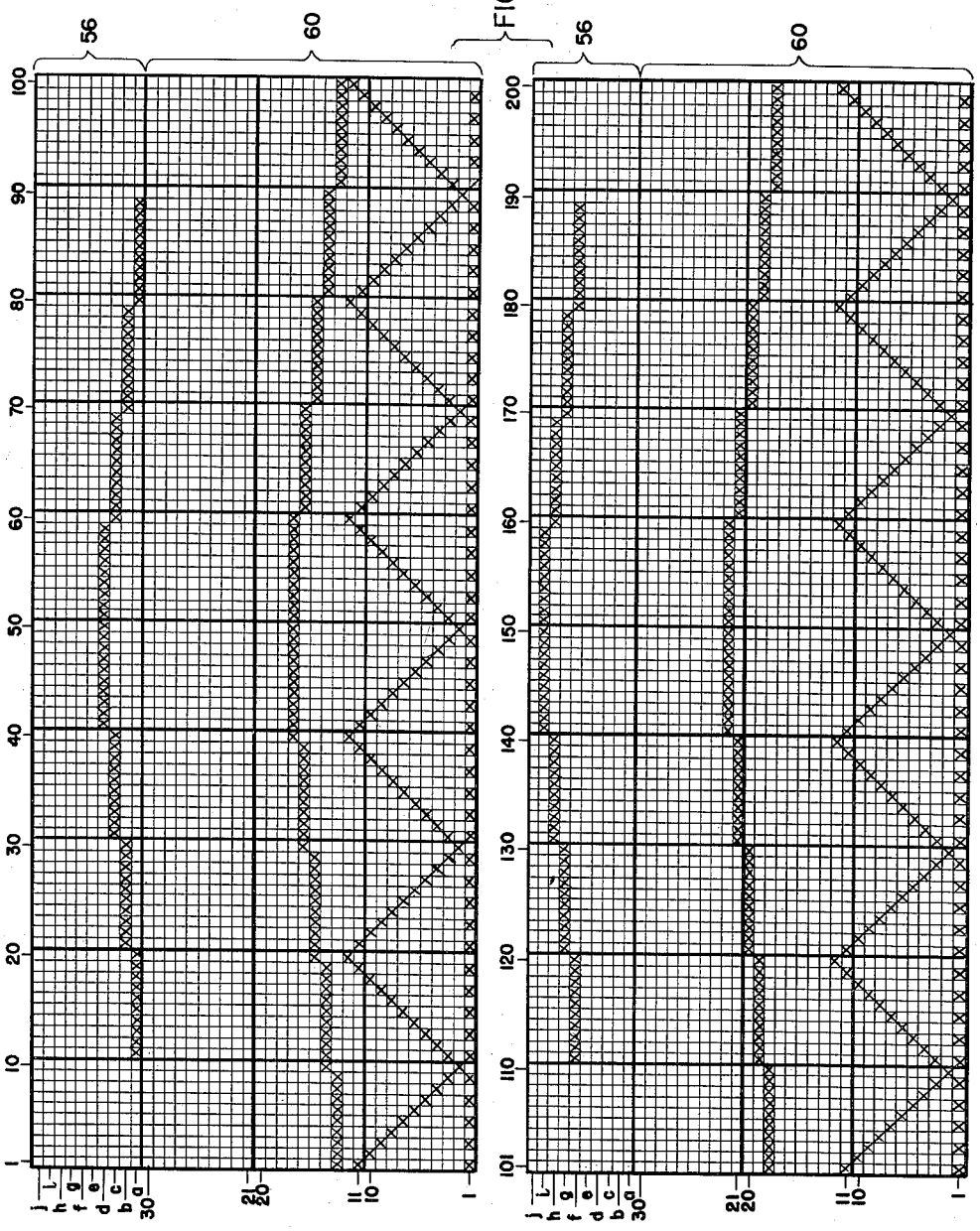
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KNITTING METHOD AND MACHINE

Filed June 3, 1957 5 Sheets-Sheet 4

FIG. 6.



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KNITTING METHOD AND MACHINE

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NARROWING

STROKE	CAMS IN ACTION			TUCK	KNIT
1	2	13 - 18	g,h,i	189	188 - 111
2	2 - 3			112	113 - 188
3	2 - 4			187	186 - 113
4	2 - 5			114	115 - 186
5	2 - 6			185	184 - 115
6	2 - 7			116	117 - 184
7	2 - 8			183	182 - 117
8	2 - 9			118	119 - 182
9	2 - 10			181	180 - 119
10	2 - 11			120	121 - 180
11	2 - 12			179	178 - 121
12	12 - 11	13 - 19	h, i	122	123 - 178
13	12 - 10			177	176 - 123
14	12 - 9			124	125 - 176
15	12 - 8			175	174 - 125
16	12 - 7			126	127 - 174
17	12 - 6			173	172 - 127
18	12 - 5			128	129 - 172
19	12 - 4			171	170 - 129
20	12 - 3			130	131 - 170
21	12 - 2			169	168 - 131
22	2 - 3	13 - 20	i	132	133 - 168
23	2 - 4			167	166 - 133
24	2 - 5			134	135 - 166
25	2 - 6			165	164 - 135
26	2 - 7			136	137 - 164
27	2 - 8			163	162 - 137

FIG. 7.

WIDENING

STROKE	CAMS IN ACTION			TUCK	KNIT
28	2 - 9 2 - 6	13 - 20	i	138	139 - 165
29	2 - 6 2 - 7			165	164 - 136
30	2 - 7 2 - 4			136	137 - 167
31	2 - 4 2 - 5			167	166 - 134
32	2 - 5 12 - 2	13 - 19		134	135 - 169
33	12 - 2 2 - 3	13 - 19 13 - 20	h, i i	169	168 - 132
34	2 - 3 12 - 4	13 - 20 13 - 19	i h, i	132	133 - 171
35	12 - 4 12 - 3			171	170 - 130
36	12 - 3 12 - 6			130	131 - 173
37	12 - 6 12 - 5			173	172 - 128
38	12 - 5 12 - 8			128	129 - 175
39	12 - 8 12 - 7			175	174 - 126
40	12 - 7 12 - 10			126	127 - 177
41	12 - 10 12 - 9			177	176 - 124
42	12 - 9 2 - 12	13 - 18	g,h,i	124	125 - 179
43	2 - 12 12 - 11	13 - 18 13 - 19	g,h,i h, i	179	178 - 122
44	12 - 11 2 - 10	13 - 19 13 - 18	h, i g,h,i	122	123 - 181
45	2 - 10 2 - 11			181	180 - 120
46	2 - 11 2 - 8			120	121 - 183
47	2 - 8 2 - 9			183	182 - 118
48	2 - 9 2 - 6			118	119 - 185
49	2 - 6 2 - 7			185	184 - 116
50	2 - 7 2 - 4			116	117 - 187
51	2 - 4 2 - 5			187	186 - 114
52	2 - 5 2			114	115 - 189
53	2 2, 3			189	188 - 112
54	2, 3			112	113 →

FIG. 8.

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United States Patent Office 2,974,506 Patented Mar. 14, 1961

2,974,506

KNITTING METHOD AND MACHINE

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Filed June 3, 1957, Ser. No. 663,052

24 Claims. (Cl. 66—51)

This invention relates to knitting methods and machines and has particular reference to the knitting of two feed heels and toes in the knitting of hosiery wherein, in general, rotary knitting is carried out in two feed fashion through at least the major portions of the hosiery.

Circular knitting machines involving the use of two feeds throughout the major knitting of stocking parts have heretofore involved the carrying of inactive needles at a high level during the making of heels and toes, as normally is done in single feed machines. One major advantage of doing this is that the yarn during a reversal of motion winds around the front of the needle which last knit before the reversal and which has been moved to a high inactive level. This results in closing the eyelet which would occur if the yarn passed in back of this inactive needle, which would be the normal occurrence if needles were carried at a low inactive level.

The machine provided in accordance with the present invention has two feeds which may be, and preferably are, in action from the start of the stocking which normally is at the top, but can instead be at the toe. During the making of the heel and toe, both feeds are in action substantially as described in my Patent 2,440,280, dated April 27, 1948, but in the machine of the present invention the idle needles during heel and toe knitting move at a low level instead of at a high level as shown in said patent. In accordance with the present invention, eyelets which would normally result because of the needles at low level are closed by tucking certain or all needles that are put out of action during both narrowing and widening.

Heretofore, it has been necessary to group the stitch cams of the two feeds close together when making two feed heels and toes and this arrangement of the knitting cams is shown in said patent. One important reason for this close grouping of the stitch cams has been to enable the yarns to be moved from under to over the nebs of the sinkers at the first idle needle for both feeds, the reason for this being so that the yarn may be easily retrieved upon reversal of knitting and also to avoid cutting of the yarn between the throats of the sinkers and the shanks of the idle needles. In knitting two feed during reciprocation, the yarn from the feed first knitting will come out above the nebs of the sinkers at the first or approximately at the first idle needle in the normal manner at the next feed, though this yarn tends to drop down when the sinkers are withdrawn for knitting and, due to the very flat angle of the yarn from the last needle to knit to the yarn finger, its tendency is to wedge itself below the sinker nebs. No such difficulty is encountered if the needles are left in a low idling position, which means that the knitting stations may be separated as much as desired, which is a very helpful feature in certain machines where yarn changes are made by horizontal movement of yarn fingers, for example, as in many superposed cylinder machines.

Close grouping of the knitting cams does, however, reduce the amount of the reciprocatory stroke necessary

to knit all desired needles at two or more feeds. Accordingly, in the preferred embodiment of the invention, the closely grouped cams are used, but this is not as necessary to proper operation of the machine as is the case when the needles are idled at high level. Another feature of the present invention provides that, if due to size or necessary spreading apart of the feeding stations, for example, to accommodate yarn changes by horizontal movements of yarn fingers, it is found that during the knitting of reciprocatory courses the needles must pass the knitting cams a second time, then it is much easier to keep them out of the knitting wave during such second passage.

Still another feature of the machine provided in accordance with the invention is that it is possible to make heel and toe sutures of a type not possible when the needles are idled at high level.

The major objects of the present invention relate to the attainment of operations such as have been briefly indicated. These and other objects of the invention, relating particularly to details of construction and operation, will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

Figure 1 is a developed view of the knitting cams of a preferred embodiment of the invention as viewed looking outwardly from the needle cylinder, there being indicated at the right in Figure 1 a typical arrangement of a latch needle with its intermediate jack and pattern jack;

Figure 2 is a plan view of one of the jack raising cams and its support showing also picks operating on the jacks;

Figure 3 is a plan view similar to Figure 2 but showing a different type of control for a pick;

Figure 4 is an inverted plan view of a sinker cap adapted to be used in accordance with the invention;

Figure 5 is an elevation of a sinker used in accordance with the invention;

Figure 6 is a chart showing a typical arrangement of selecting butts on needle pattern jacks;

Figures 7 and 8 are charts respectively showing cam settings and needle actions involved in the narrowing and the widening of a heel in accordance with the invention; and

Figure 9 is a diagrammatic view showing the stitches of a suture resulting from operation of needles in accordance with the other figures.

It will be understood that the invention involves only certain changes of a conventional Scottt & Williams hosiery machine and the drawings and description herein will refer particularly only to such changes, it being understood that the machine is otherwise essentially conventional. Various references will be made hereafter to conventional aspects of the machine as disclosed in issued patents.

As has been indicated, the invention is applicable to various types of machines including superposed cylinder machines, but for purposes of disclosure the invention will be described with reference to a machine having a single rotary needle cylinder, though it is applicable to machines of stationary needle cylinder-rotary cam type.

Two feeding stations are indicated at 2 and 4, the former of which may be arbitrarily referred to as the main or first feeding station and the latter as the auxiliary or second feeding station. At each of these yarns may be interchangeably fed to the needles from a plurality of conventional yarn feeding fingers. Needle movements during rotation are counterclockwise, that is from right to left through the cams as illustrated in Figure 1. The forward stitch cam at the main feed during rotary knitting is indicated at 6 and the reverse stitch cam at this feed is indicated at 8, the cam 8 being radially movable. The forward stitch cam at the auxiliary feed

is indicated at 10, the reverse stitch cam being indicated at 12. The cams 6 and 12 are provided on a single cam element 14 consistent with the location of the two feeding stations close together, though it will be understood that so far as the present invention is concerned these stations may be substantially spaced subject to practical limitations on the desirable throw of the needle cylinder during reciprocatory knitting. A clearance notch 16 is provided in the cam element 14 for purposes which will hereafter become apparent.

A movable clearing cam 18 and a movable cam 20 for raising needles to tuck level are provided in association with the stitch cams at the auxiliary feeding station. Cams 22, 24 and 26 are provided below the lower ends of the stitch cams and serve to limit downward movements of the needles and act to impart slight rises thereto. A radially movable clearing cam 28 is provided, and following it in the direction of needle rotation there is a fixed cam 30 for lowering needles to tuck level. A radially movable cam 31 is provided for raising needles to tuck level as hereafter explained.

A typical latch needle used in the machine is indicated at 32, this being provided with a butt 35. In the present machine all of the needle butts may be of the same length.

Below the needles in the slots in the needle cylinder are intermediate jacks 34 provided with butts 36. These are arranged to be acted upon by cams 38, 40, 42, 44, 46 and 48, there being also provided the level cams 39 and 41 arranged to hold the intermediate jacks in definite lowered positions. A cam surface 45 between cams 44 and 46 is at a level above 39 and 41.

Also associated with each needle is a pattern jack 50 which is of rocking type, having a fulcrum for rocking at the location 52. Each pattern jack is provided with an upper butt 54, a series of saw tooth selecting butts 56, a central butt 58, a series of selection butts 60, and a lower butt 62. Butts 56 and 60 are selectively removed in accordance with the patterning to be accomplished. Additionally, each pattern jack is provided with a heel 64 which is arranged to cooperate with grooves 66 and 68 which are turned in the needle cylinder prior to the insertion of the usual inserted walls which define the slots for the needles and jacks. These grooves, as illustrated, are provided with sloping upper and lower cam edges which provide camming actions on the pattern jacks as described hereafter. Groove 66 is at a level to receive heels 64 of pattern jacks at their selection level; groove 68 is at a level to receive heels 64 of pattern jacks which are at a level at which, through the intermediate jacks, their needles are positioned at tuck height.

Cams 70, 72 and 74 are arranged to engage the upper butts 54 to press them inwardly so as to rock outwardly the lower ends of the pattern jacks. Cams 76, 78 and 80 are arranged to act upon butts 58 to insure proper leveling of the pattern jacks for selection.

Cams 82, 84 and 86 are arranged to press inwardly to a slight and predetermined extent the butts 62 to provide uniformity of positions of these butts.

There are three selection stations involved in the present machine with which are associated the usual cam levers 88, 90 and 92 arranged to selectively engage the pattern butts of the group 60. The cams 88 and 90 are arranged to perform their selecting actions during rotations or forward reciprocations of the needle cylinder, whereas the cams 92 perform their selecting actions during reverse reciprocations of the needle cylinder. The cams 88, 90 and 92 are selectively controlled by conventional trick wheels which are stepped about and timed up during operation of the machine in the usual fashion. Since this is conventional, the trick wheels and their driving connections are not illustrated.

It will be understood that, as usual, the levers which carry the cams 88, 90 and 92 may be, in groups, selectively rendered active or inactive, so that the trick wheels may carry, through the same portions of their circumferences, trick butt setups for different purposes involved in the formation of different parts of the stocking. In view of the use of the pattern jacks in the formation of heels and toes, it is desirable that the trick wheels should have more than the usual number of butt levels so that the patterning possibilities for other portions of the stocking will not be reduced. What has been said of the controls for the cams 88, 90 and 92 applies also to the matter of controls of other selecting cams 112 and 114 which will be hereafter more fully described.

Following the cams 88 in the direction of cylinder rotation there is a pattern jack raising cam 94 preceded by an extension of gradual slope 96. The cam 94 is arranged to raise the pattern jacks, the intermediate jacks 34 and the needles to clearing height. The height to which raising is effected is, preferably, somewhat higher than that involved in the passage of the needles over stitch cam 8 so that this stitch cam may be moved into or out of action at will when all needles are raised by their jacks passing over selecting cam 94.

In similar fashion, the selecting cams 90 are followed by a pattern jack raising cam 98 preceded by an extension 100 of gradual slope, the cam 98 raising the needles to clearing height.

Selecting cams 92 are followed, in the direction of reverse reciprocation, by a pattern jack raising cam 102 which is preceded by an extension of gradual slope 104. The extensions of gradual slope at 96, 100 and 104 are provided to insure that the pattern jacks are rising relatively slowly so that, if their heels 64 are not completely out of the groove 66, a camming action of the upper portion of this groove may be effected gradually, with the steeper cams 94, 98 and 102 acting on the butts 62 only after the heels 64 have been cammed fully outwardly. It will be noted that the cam 102 is substantially higher than the cam 98 so as to effect rise of the needles to an especially high clearing position accommodated by the notch 16 in the cam member 14.

A cam surface 106 is arranged to raise pattern jacks at the first or main feed during reverse reciprocations, while a similar cam surface 108 is provided to raise pattern jacks during forward reciprocations or during rotation at the second or auxiliary feed. Between the cam surfaces 106 and 108 there is located a cam 110 which restricts downward movements of the pattern jacks under the actions of the cams 44 and 46 on the intermediate jacks 34. It will be noted that the cam surface 45 between surfaces 44 and 46 is higher than the cam surfaces 39 and 41 to provide a lesser downward movement of an intermediate jack. The cam 110 fills in the space at the lower portions of the cam surfaces 106 and 108 so as to prevent any outward movement of the lower end of a pattern jack at this point if the pattern jack has been unselected and is moving at the selection level. Movable cams 109 and 111, respectively preceding the cam slopes 96 and 100 are arranged to be usually in inner position when the corresponding cams 70 and 72 are withdrawn, and in inactive position when the cams 70 and 72 are active. However, both cams 72 and 111 are simultaneously inactive in the preferred procedure involving selective tucking at the second feed as described hereafter. Cams 109 and 111 are to insure that the lower ends of the pattern jacks are in inner positions with their heels 64 in groove 66 so that the butts 62 will not engage the cam slopes 96 and 100.

Cams 112 and 114 are arranged to act upon the saw tooth butts 56 of the pattern jacks, the former cams acting during movements of the cylinder in a forward direction and the latter during movements in the reverse direction. These cams, in effect, serve to negative selection by the respective cams 90 and 92, in that, even if a cam 90 or 92 would select a pattern jack so that it would not be raised, nevertheless a cam 112 or 114 may produce a rise. The particular actions of cams 112 and 114 will

be described later. It may be here remarked that their slopes are such as to produce rises of pattern jacks at a higher rate than the respective cam slopes **100** and **104**.

Picks **116**, **118**, **120** and **122** are associated with the cams **98**, **106**, **108** and **102**, respectively. These picks are identical in operation, and reference may be made particularly to Figure 2 which shows their construction, mounting and operation, pick **122** being specifically detailed. As shown, the pick **122** is pivoted on the face of cam **102** at **124** and a tension spring **126** is provided to hold it normally in the position illustrated while permitting, however, rocking movements in both directions from this position. The pick has, at its end adjacent to the cylinder, a finger **128** projecting beyond a shoulder **130** having a limited extent and terminating at an edge **132**. The other picks **116**, **118** and **120** are similarly constructed and mounted with, of course, reversal of positions of the picks **116** and **120** as compared with picks **118** and **122**. In the particular showing in Figure 2, the shoulder **130** is of a width so as to engage and effect picking of a single needle. However, this shoulder may be wider so as to engage and pick two or even more needles, and the several picks may differ in the numbers of needles picked depending upon the type of suture which is to be produced. In brief, the action of a pick may be described by referring to pick **122** associated with cam **102**. Assuming that a group of pattern jacks are rising up cam **102** following a group which have missed this cam, the butt **62** of the leading jack of the rising group will engage the finger **128** causing the pick to rock so that the butt **62** is engaged by the shoulder **130** to be rocked inwardly as the pick rotates. Assuming that the shoulder is of single butt width, the butts **62** of pattern jacks following the first will not engage the shoulder **130**, but the butt of the second of the jacks will engage the edge **132** to continue the movement imparted to the pick. The arrangement is such that the butt **62** of the leading jack of the rising group will be pushed off the cam **102** at a level indicated by the chain line **133** in Figure 1, which represents the path of the lower edge of the butt **62** which corresponds to a rise of the associated needle, through the intermediate jack, to a tuck level. The subsequent rising jacks are not pushed off the cam **102** but rise to the top thereof, raising their needles to a cleared level. The actions of the picks other than **122** are the same, the picks acting to raise one or more leading needles of a rising group to tuck level while subsequent needles rise to cleared levels determined by the cams **98**, **106** or **108**.

A somewhat better pick arrangement is illustrated in Figure 3, the construction being such that the pick is more accurately positioned than is the case shown in Figure 2 wherein the position is determined merely by the minimum tension position of a spring such as **126**. Referring to Figure 3, there is shown a pick **134** which is the same as the pick **128** already described. This pick is mounted at **136** and is urged downwardly, or clockwise as viewed in Figure 3, by a spring **138** which, it will be noted, would tend to locate the pick beyond the position illustrated if it were not for the fact that the pick engages a yielding detent lever **140**, pivoted to the cam at **142** and urged against a stop **144** by a relatively strong spring **146** capable of overcoming the effective action of the spring **138**. By this arrangement, the pick, and its finger **148**, shoulder **150** and edge **152** are quite definitely positioned, a situation which is particularly desirable if more than one needle is to be picked in a single operation. The pick **134** is nevertheless free to rock downwardly through the action of descending butts **62** by forcing the detent **140** to yield against the action of spring **146**. The pick arrangement illustrated in Figure 3 may be used in association with any or all of the cams **98**, **106**, **108** and **102**.

In a machine of the type herein described in which the idle needles during reciprocatory knitting travel beneath the stitch cams, the stitches on the idle needles are subject to strain unless special provision is made to prevent this. Accordingly, there are used special sinkers illustrated in Figure 5 in conjunction with special camming illustrated in Figure 4. The sinker **154** shown in Figure 5 has a conventional neb **156** overlying the sinker ledge **158**. However, instead of the usual throat, there is a notch **160** at the back of the throat which notch is provided with a sloping edge meeting the ledge **158**. The sinker is provided with butts at positions **162** and **164**, and as hereafter described, these butts may be of different lengths to differentiate groups of sinkers. The sinker has a back **166** extending vertically which is arranged to be acted upon by cams to impart inward movements to the sinkers, the butts **162** and **164** being used for the imparting of outward movements.

Referring to Figure 4, the sinker cap is shown therein in inverted plan view and there are illustrated therein the cams which act upon the sinkers. These comprise, at the position of the first feed, the cams **168** and **172** for acting respectively on butts **162** and **164** and cams **170** and **174** at the second feed position respectively arranged to act upon the butts **162** and **164**. Cams **176**, **178**, **180** and **182** are arranged to project the sinkers inwardly by engagement with the sinker backs **166**.

The cams **168**, **170**, **172** and **174** are arranged to be selectively moved vertically so as to cooperate selectively with sinker butts of different heights. For this purpose they may be mounted on individual leaf spring which normally withdraw them upwardly away from butt-engaging positions, with provision of plungers operated from the main cam drum of the machine to move them downwardly against the spring actions to active positions. The arrangement for accomplishing this need not be described herein since it may be identical with what is illustrated in Page et al. Patent 1,977,590, dated October 16, 1934.

The arrangement of butts on the sinkers and the sinker operations will be described hereafter in conjunction with a detailed description of heel and toe formation.

As was pointed out previously, the invention is quite broadly applicable to various types of knitting machines, but for purposes of illustration it will be particularly described as applied to a hosiery machine equipped with conventional inturned welt mechanism. As the description proceeds, applications to other machines will be referred to.

Starting with the operation at the time when the toe has been completed and the looper's waste courses are being made, the stitch cam **8** and clearing cam **18** may be in their innermost positions close to the cylinder, with cams **28** and **31** out of action away from the cylinder. The first selection station will now be in action, which means that the cam **70** will be active to project the butts **62** of the pattern jacks outwardly while the safety cam **109** will be in its outer position to allow the pattern jacks which are not selectively pushed in by cams **88** to ride over the cam **94**. At this time the other two selecting stations will be inactive, with cams **72** and **74** withdrawn from the cylinder and with the safety cam **111** in its innermost position to insure that the pattern jacks pass behind the cams **100** and **98**. At this time all of the pattern jacks will rise over cams **96** and **94**. Operation will then proceed as follows:

Needle butts **35** will enter the right of Figure 1 at the welt level determined by their previous depression by stitch cam **10** and their slight rise over cam **26**. The intermediate jacks will be located in the position determined by engagement of the level cam portion **39** with their butts **36**. The pattern jacks should be at selection level and at any rate will be levelled by the cam **76** acting on their butts **58**. Cam **70** will project their lower ends outwardly and cam **82** will press the butts **62** slightly inwardly to secure a definite position of the

jacks with the heels 64 slightly inside the groove 66. In the particular operation now being described, none of the pattern jacks will be acted upon by any of the cams 88, and consequently they will be raised first slowly by cam 96 and then more rapidly by cam 94. In the rise over cam 96, the heels 64 will be cammed outwardly by the upper sloping surface of the groove 66. As rise of the pattern jacks occurs, the intermediate jacks will be raised and ultimately will engage the needles 32 raising them from the low level to a cleared level determined by the top of cam 94. Since stitch cam 8 is in its active position, the needles will ride thereover and pass to the stitch cam 6 thereby being moved downwardly to draw yarn presented at the first feed. The needles will then rise over clearing cam 18 and pass to stitch cam 10 whereby they will be lowered to take yarn at the second feed, thereafter passing from the lower end of stitch cam 10, from which they will pass at welt level until again raised through the action of cam 94.

After the pattern jacks pass the upper end of cam 94, they will be lowered by the action of cam 40 on the intermediate jacks. Cam 72 is out of action, but the butts 62 will be in projected position until they engage first the cam 84 by which they are moved slightly inwardly and then the safety cam 111 by which they are moved fully inwardly with their heels 64 in groove 66. In this position they will pass the cams 98, 110 and 108 at selection level, to reenter the right of Figure 1 where their lower ends will again be rocked outwardly by cam 70. Thus, two feed knitting of the waste courses takes place. The operation just described is typical of two feed plain knitting such as may later occur during the knitting of the leg and possibly the foot of a stocking.

If the machine is equipped with inturned welt mechanism and stockings are to be started on bare needles, the next move of the main cam drum of the machine will remove the yarn fingers at both feeds thus dropping the stocking off the needles. During the next few revolutions while the needles are running through the stitch cams without taking yarn, their latches may be opened by one of the well-known methods such as the use of a yielding point where the needles are rising under the action of cam 94. This latch opening may be carried out as disclosed in Scott Patent 1,574,703, dated February 23, 1926.

For makeup, every other pattern jack is provided with a butt 60 at the lowermost level, these butts being missing from the intermediate pattern jacks. On the next drum move, the lowest selector cam 88 is moved into a position close to the cylinder to push inwardly every jack provided with a butt 60 at the lowermost position, with the result that only alternate jacks will ride over cam 94 to cause alternate needles to be raised to clearing level and thereby pass over stitch cam 8 to take yarn at the first feed. The intermediate needles will follow the low path, passing across the cam 31 which is out of action and below stitch cam 8. The pattern jacks which have had their lower ends rocked inwardly will continue to move at low level past the cams 96 and 94 and thereafter the other cams in the fashion previously mentioned. Those which were selected upwardly over cams 96 and 94 will thereafter take the path previously described.

At the second feed all of the needles will ride up clearing cam 18 and thereafter will be lowered by stitch cam 10. The result is that with yarn introduced at both feeds, the yarn at the first feed will be taken by alternate needles while the yarn at the second feed will be taken by all of the needles. This completes the process of starting knitting.

After yarn has been fed as just described at both feeds for one revolution, the dial jacks will be projected during the second revolution over the intermediate needles which are left in low position and are passing under stitch cam 8. As a result alternate needles will draw yarn over the dial jacks forming the loops which will later be transferred to the needles to complete the welt. The dial jacks will be withdrawn just in back of the needles following the knitting at the first feed in order to permit all of the needles to knit at the second feed. During the third revolution, since the dial jacks will be withdrawn, the alternate needles will knit normally at the first feed, i.e., without drawing loops over the dial jacks, and all needles will knit at the second feed. At the start of the fourth revolution the lowermost selecting cam 88 will be withdrawn permitting all of the pattern jacks to ride over the cams 96 and 94 to raise all needles to the cleared path preceding the first feed so that they may knit. The two feed makeup which has just been described is more fully described in McDonough Patent 2,576,962, dated December 4, 1951.

After the lowermost selecting cam 88 has been withdrawn, cam 31 is moved into position close to the cylinder after which the cams 88 at the first selection station may remain inactive until just prior to the transfer at the end of the welt. During the knitting of the welt, the cam 31 in conjunction with cam 8 substitutes for the previously described raising of needles under the action of cams 96 and 94, and plain knitting of the welt proceeds at both feeds.

After the proper amount of fabric has been knit for the welt and the loops held by the dial jacks are to be transferred back to the needles, in conventional fashion, the cams at the first selection station are again rendered active and the lowermost cam 88 is again moved toward the cylinder so that again only alternate needles will be raised to the cleared path for the purpose of transfer. However, since cam 31 is now in its active position, the intermediate needles will be raised so that all needles will follow the path over the stitch cam 8 to knit at the first as well as the second feed. The dial jacks with their loops will be projected out over the intermediate needles which will ride up through them on cam 31 so as to receive the dial loops as the dial jacks are returned inside the dial before the first knitting cams are reached.

It will be here convenient to interrupt the continuity of description of the knitting of a complete stocking to refer to the alternative of knitting a stocking which is to be started with a top other than in inturned welt, for example a rib type. It will then be necessary to modify a selection of needles at the two feeds. In this connection, it may be pointed out that it is possible to knit on certain selected needles only at both feeds merely by selecting the needles through control of the jacks at the second selection station, with the cam 18 withdrawn, while using the first selection station, or it is possible to knit all needles at the first feed and only selected needles at the second feed by either raising all needles by their jacks at the first selection station or by using cam 31 to raise all needles to knit at the first feed while using the second selection station to raise only selected needles at the second feed. The example of knitting selected needles only at the first feed and all needles at the second feed was given in conjunction with the description of the makeup for the inturned welt. The other selections will be more fully described hereafter in discussion of the knitting of a shadow welt.

Following the making of an inturned welt or other top, the yarns may be changed or not at both feeds for the formation of a shadow welt. It may be assumed that in forming this shadow welt patterning is desired by selective production of tuck or float stitches. Such patterns may be produced elsewhere, as in the leg and instep, and, as will be later indicated, what will be now described is also applicable to the formation of shaped high splices, cradle soles, or the like.

As a first example of patterning, there may be considered the tucking of needles at the first feed only. In this case, the cam 18 is left in to raise all the needles at the second feed while at the first feed stitch cam 8 is re-

moved but cam 31 is kept in position close to the cylinder to raise all needles to tuck level. Cam 28 remains inactive. Under these conditions selection by cams 88 at the first station will be effective to secure the rise of needles to cleared height over the cam 94. Thus, certain needles will be cleared before the first feeding position while others will hold the stitches which were taken at the second feed, passing to the first feed at the tuck level provided by cam 31 and there taking the first feed yarn.

If tucking is desired at the second feed only, cams 18, 72 and 111 may be rendered inactive, cams 31 and 8 active, and selection effected at cams 88. Jacks which are pressed inwardly by cams 88 miss cams 96 and 94 and by reason of inactivity of cam 72 also miss cams 100 and 98, thus remaining at the low selection level. Their needles, accordingly, while they rise and clear over cams 31 and 8 and take yarn in passing under stitch cam 6, are raised only to tuck level at the second feed, taking yarn at this feed in moving down stitch cam 10.

On the other hand, a pattern jack which is not pressed inwardly by a cam 88 rises over cams 96 and 94 so that its needle is cleared through the action of its intermediate jack. By the action of cam 40 the intermediate jack is lowered and lowers the pattern jack. Since cam 111 is inactive the butt 62 remains projected so that the pattern jack rises over cams 100 and 98 and then over cam 108 after being depressed by the action of cam 44 on its intermediate jack. Clearing at the second feed is effected by the pattern jack rise over cam 108 and the needle takes yarn at the second feed, being first depressed by the left-hand cam edge of notch 16 and then by stitch cam 10. It may be noted that cams 44 and 48 depress the intermediate jack and pattern jack in advance of downward movement of the needle to minimize wear on the stitch cams. When the intermediate jack butt reaches the level at 45, the pattern jack butt 62 will be immediately above the cam 110 which prevents it from moving downwardly to such extent as to permit entry of its heel 64 into groove 66. Butt 62 is accordingly retained in its projeced position by the cylinder surface between the grooves 66 and 68.

In the foregoing operation, a pattern jack which is preceded by a sufficient number of jacks which are not rising up cam 98 may be acted upon by pick 116 and thrown thereby off the cam 98 at the tuck level 133. In this case its shoulder 64 will enter the groove 68 by which it will be retained until it passes the edge of cam 106. The pattern jack is then free to be depressed by the movement of the intermediate jack down cam 44 and the lower end of the pattern jack will be cammed outwardly by the lower sloping surface of the groove 68. It will rise on cam surface 108 but will be again thrown off that cam by pick 120. The result will be that its needle at the second feed will not be raised to clearing level. Needles subsequent to the one just under discussion, unless they lag the needle whose pattern jack was picked by a substantial distance, will not be subject to the picking action since the picks will ride on the butts of subsequent jacks until a gap is presented enabling the pick to return to its normal position. It will be evident that what has just been described may result in the production of certain tuck stitches which are not dependent solely on the selection afforded by cam 90. However, a pattern layout may take this into account. If desired, however, the situation may be remedied by providing obvious control from the main cam drum which will swing the picks 116 and 120 to an inactive upper position so that the picking action just described cannot occur.

Selective tucking at the second feed may also be produced by selection of jacks by cams 90, but it is generally preferred to restrict selections by cams 90 and 92 to heel and toe formation, as later described.

The two selection actions by cams 88 and 90 cannot, however, be used for arbitrary simultaneous tucking at both feeds, inasmuch as the selection of needles by cams 90 to effect clearing at the second feed necessarily involve clearing at the first feed by the rise over cam 98. However, a needle which has been cleared by selective action of a cam 88 at the first feed may be tucked at the second feed or a single needle in a single round of knitting may tuck at both feeds by having its pattern jack acted upon at both selection stations by cams 88 and 90.

If welt or held stitches are desired at the first feed, cam 31 may be withdrawn, other conditions being the same as they were for making tuck stitches at the first feed, the needles which are not raised to cleared height then missing yarn at the first feed.

Similarly, if welt or held stitches are desired at the second feed, the cam 20 may be withdrawn, other conditions being the same as they were for making tuck stitches at the second feed.

If reinforced stitches are to be made at the first feed, then cam 28 is inserted to clear all of the needles, the fixed cam 30 returning the cleared needles to tuck level. Selected needles raised to a cleared path by the selection of pattern jacks at the first selection station may then take a reinforcing yarn fed high to those needles in the usual manner while a finger feeding yarn adjacent to the rundown side of throat plate 2 would supply all needles with a body yarn. At the second feed needles raised by the selection of pattern jacks at the second station will ride into the notch 16 to take yarn fed at a high level while cam 18 located in active position will raise the remaining needles to a lower and later cleared level to take the regular body yarn fed at a low level from the left-hand corner of throat plate 4 as viewed in Figure 1. It may be noted that, in the case of the selection for the second feed, while the pattern jacks selected to take the reinforcing yarn at the second feed will rise to a cleared level over cam 98 at the first feed, this rise of needles will be too late to cause them to engage the reinforcing yarn at the first feed. Thus the selection of needles to take reinforcing yarns at the two feeds are independent of each other so that different sets of needles can take reinforcing yarns at the two feeds in the same round of knitting. It will be noted that the selections to take reinforcing yarns are quite arbitrary, and thus reinforcing yarns may be taken to provide either straight or tapered high splices and either plain or shaped cradle soles.

After the shadow welt is completed, yarn changes may be effected at both feeds to knit the leg. Obviously, without invoking selections, but proceeding in the fashion described above for the knitting of looper's loose courses, plain fabric may be knit in the leg and foot throughout. On the other hand, by using selections as just described, reinforcing yarns at one or both feeds may be introduced to provide high splices or cradle soles. As another alternative, selections may be carried out in the same fashion as in the knitting described for the shadow welt to provide tuck or float patterns through the leg and foot thereby providing mesh fabric or needle selection may be effected for other well known types of fancy effects.

For an understanding of the formation of heels and toes in accordance with the present invention, reference may first be made to Figure 6 which shows in diagrammatic form the arrangement of butts of both groups 56 and 60 of the pattern jacks. For purposes of description, it will be assumed that there are two-hundred needles involved, though it will be evident that the number of needles is entirely arbitrary. The needles or jacks are numbered in Figure 6, the needles or jacks being numbered from 1 to 100 in the upper portion of Figure 6 and from 101 to 200 in the lower portion. It will be assumed that during rotary knitting the needles pass through the cams in the order of increasing numbers. It will also be assumed that the heel is to be knit on a central group of the sole needles 101 to 200 while the toe is to be knit on the instep needles 1 to 100. As diagrammed, there are thirty levels of butts 60 and ten levels

of butts 56. In Figure 6 the butts which are retained on the jacks are indicated by the *x*'s in the areas corresponding to the needle or jack numbers and to the butt levels. The levels of butts 60 are numbered 1 to 30 beginning with the lowermost butt level. The levels of the butts 56 are designated by the letters *a* to *j*, the letters running consecutively from the lowermost level of these butts. It will be noted that at the lowermost level for butts 60 the butts are present on alternate jacks. These butts serve for the makeup and other operations already described. For heel and toe formation butts are located at the levels 2 to 12, inclusive, in the zig-zag formation illustrated. Other butts 60 involved in the heel and toe formation are located in groups at the levels 13 through 22, inclusive. The remaining levels may be used for butts 60 or other pattern control purposes as above indicated, but these are not illustrated since the arrangement may be quite arbitrary.

For present heel and toe formation, butts 56 are selectively supplied in groups at the levels *a* to *d* and *f* to *i*, though in the heel formation about to be described only those at the levels *g*, *h* and *i* are involved. This, in particular, is because the heel is formed on less than half the needles. The designation used for the butt levels will also be applied to the levels of the corresponding cams use for selection.

During the last circular course going into the heel, cam 28 is removed, if it has been action, at least by the time needles 111 to 190 are passing it. Cam 31 is removed from action while the selecting cams at 88 and 90 are operated so that the needles 111 to 190 will rise due to the actions of cams 94, 98 and 108 on their jacks, these needles thus taking and knitting yarn at both feeds. Cam 31 is removed as the needles pass high over it. Cams 18 and 20 are also removed (if previously active) as the needles 111 to 190 are raised through the action of cam 108. As needles 111 to 190 are passing the cams 88, the cams of this group at the levels 1 to 12 and 19 to 22 are withdrawn from action while cams at the levels 13 through 18 are moved into action. As will be noted from Figure 6, the jacks of the groups 191 to 200 and 1 to 110 have butts at the levels 13 to 18 so that these jacks are caused to miss cam 94 and move at low level beneath the stitch cams. Stitch cam 8 is moved into action if it has been inactive. The cylinder drive is now changed in conventional fashion to produce reciprocation, and the reverse stroke starts while the needles of the group 191 to 200 and 1 to 110 are under the cams 8, 6 and 10. The first selection station is taken out of action before reversal occurs, cam 70 being first moved away from the cylinder and cam 109 moved in. The other two selection stations now become active and control the operation during heel formation.

Some general remarks may now be made concerning the operations during formation of heels and toes. By reason of what has just been described, the needles which do not take part in pocket formation are caused to move at the low welt level beneath the stitch cams as their jacks miss the jack raising cams. In the case of active needles approaching during a reverse stroke the cams 92 and 114, a leading needle (or needles) may be rendered inactive by reason of the action of a cam 92 to rock its jack to miss the cams 104 and 102. Under such action the jack will remain at low level and the needle will be left at low level since it will not rise to take yarn at either feed, the needle holding a stitch last drawn by it. Of the remaining jacks of the active group which will engage the cams 104 and 102, the leading jack will engage the pick 122 and will be moved off the cam 102 leaving its needle at tuck level. This needle as it engages and moves down cam 12 will take yarn at feed 4. At the same time, its jack will be lowered by the action of cam 46 on its intermediate jack. During the lowering action the heel 64 of the jack will be cammed out of the groove 68 with the result that the butt 62 is again projected for engagement with the cam 106. As the jack rides up this cam it will raise its needle and will be removed from the cam by the action of pick 118. The needle at this time will be raised to tuck level and will take yarn at feed 2 as it engages and is moved downwardly by stitch cam 8. The result, then, is that the leading needle takes yarn at both feeds but tucks. The needles following the leading needle rise fully on cams 102 and 106 to take yarns at both feeds and knit.

Corresponding operations occur during forward reciprocatory strokes under the control of cams 90 and 112, the cams 98 and 108 and their corresponding picks effecting tucking or knitting of those needles which are not rendered inoperative. With the foregoing general statements, reference may now be made to the chart constituing Figure 7 with reference to the jack butt diagram, Figure 6.

In Figure 7, the first column gives the numbers of successive strokes during heel formation. The odd numbered strokes are reverse ones and the even numbered strokes forward ones. The stroke designated 1 is the first one which occurs in reverse direction during reciprocatory knitting. The reference to cams in action refer, in the case of reverse reciprocatory strokes to the cams 92 and 114, the designations being of levels and the dashes indicating groups of cams including and between the numbered levels. In the case of forward strokes, the designations apply to the cams of the groups 90 and 112.

In the column designated "tuck" are listed the numbers of the needles which tuck during the strokes, while in the column designated "knit" are indicated the needles which take and knit the yarns at both feeds.

Considering the first stroke, it will be noted that of the cams 92, those at the levels 2 and 13 to 18, inclusive, are in action while of the cams of group 114 those at the levels *g*, *h* and *i* are also in action. Referring to Figure 6, it will be evident that needles 1 to 100 are all rendered inactive by virtue of butts at the levels 13 to 17, inclusive. Note butts at levels *g*, *h* and *i* are not involved in connection with these needles so that the actions of cams 92 are not nullified. Action of cam 92 at level 18 also renders inactive the needles 101 to 110 and 191 to 200. It will be noted that needles 130, 150, 170 and 190 are associated with jacks having butts at level 2. However, jack 130 is provided with a butt at level *g*, jack 150 is provided with a butt at level *i*, and jack 170 is provided with a butt at level *g*. The result is nullification of the action of the cam 92 by reason of cams 114 which, after the lower ends of the jacks are rocked inwardly serve to raise the jacks so that their lower ends are again rocked outwardly as their heels 64 move out of the groove 66. The butts 62 are accordingly presented for engagement by cam 102 so that the jacks and needles are moved in the knitting race. Thus, the needles 130, 150 and 170 are caused to knit. On the other hand, the needle 190 remains inactive because its jack does not have a butt at any of the levels *g*, *h* and *i*. The result of the foregoing is that the needles of the group 189 to 111 are associated with jacks rising on cam 102, the jack 189 leading the group and being acted on by pick 122, and later by pick 118, to tuck, while the remaining needles knit. In the second stroke, which is a forward stroke, cams of the group 90 at levels 2, 3 and 13 to 18, inclusive, are active and cams of the group 112 at levels *g*, *h* and *i* are active. Selection similar to the foregoing then occurs with the result that needle 112 tucks while needles 113 to 188, inclusive, knit. Throughout the remaining strokes to 27, similar actions occur, as will be clear for any stroke by following what is diagrammed in Figure 7. During this group of strokes narrowing takes place, and it will be noted that in every successive stroke there is a reduc-

tion of two needles which knit. During the twenty-seventh, the last involved in narrowing, twenty-six needles knit, these being of the group 162 to 137.

Widening then begins through strokes 28 to 54, inclusive, which are diagrammed in Figure 8 similarly to the strokes diagrammed in Figure 7. In Figure 8, however, it will be noted that there is a difference in that in the first column of cam levels there are two cam levels designated for each stroke. The significance of this is that at the beginning of the stroke the cam levels are as first indicated while at mid stroke the active cam levels are changed to those secondly designated. What occurs will be made clear from considering stroke 28 which is a forward stroke. At the beginning of this stroke cams of the group 90 are active at levels 2 to 9, inclusive, and 13 to 20, inclusive, and cam 112 at level *i* is active. The result, as will be evident from reference to Figure 6, is that needle 138 will tuck and needle 139 will be the first to knit. However, if cams 7 to 9 remained active, needles 163, 164 and 165 would all be rendered inactive. By changing the cams 90 before the jacks of these needles are selected, these needles are rendered active, so that the group which knits includes all of the needles 139 to 165, inclusive. Following the similar situations through Figure 8, it will be noted that on each stroke the new cam selection (at 90 or 92) at mid stroke renders active needles which are trailing the active group and which would be rendered inactive if the initial cam settings were retained throughout the stroke. As will be evident from following Figure 8, each successive stroke involves two more needles in action than were in action during the preceding stroke. Thus, widening is effected.

What is indicated in Figure 8 as stroke 54 is, in fact, continued as a rotation going off the heel, the drive being changed from reciprocation to rotation with reestablishment of the conditions involved in rotary knitting with such patterning as may have been produced during the leg continuing in the instep.

Rotary knitting then continues until the toe is reached. For the formation of the toe there is specifically indicated in Figure 6 the jack butt arrangement for formation of the toe on the instep needle 1 to 100. The narrowing and widening operations involved in the formation of the toe are precisely comparable with those which have been described for heel formation, the cams 90, 92, 112 and 114 being selected to correspond with the instep jack butt setup. In view of the foregoing detailed discussion of the successive steps involved in pocket formation it will be unnecessary to go into the corresponding details for the toe. Following the completion of the toe, loopers' rounds may be produced by two feed rotary knitting as described above.

The arrangement of the sinkers in knitting as described above, with the heel made on less than half the needles on one side of the knitted tube and the toe made on half the needles on the other side of the knitted tube, may be as follows:

Sinkers with long butts 162 and lacking butts at 164 are arranged alongside the needles which knit the heel. Sinkers having short butts 162 and also butts 164 are arranged alongside the needles which knit the toe. The remaining sinkers, associated with the needles of the sole series flanking the needles which knit the toe are preferably only provided with short butts 162.

During circular knitting center cams 168 and 170 must then be in their lowest position. The positions of cams 172 and 174 are immaterial since there are butts 162 on all of the sinkers.

As the change takes place from rotary to reciprocatory knitting to start the heel, cams 172 and 174 must be in upper position out of action while the cams 168 and 170 are allowed to rise to a half-way position where they will miss the short butt sinkers but withdraw the sinkers having long butts at 162 associated with the heel needles. Thus the sinkers between the needles that knit the instep and which are down out of action remain in inner position toward the center of the needle circle so that when a longer stitch is used in making the heel there will be no strain on the tighter stitches that are used for the instep as the instep needles go under the stitch cams, since the stitches will be merely pulled into the notch 160 which is deep enough so that the tighter instep loops will not be strained or broken. The sinkers between the heel needles will be withdrawn by cams 168 and 170 so that the yarn will be drawn over the platforms 158. Needles progressively thrown out of action have stitches on them drawn to the size they were brought to under the stitch cams so there is no particular strain on these stitches even though their sinkers are being withdrawn during operation.

When the heel is completed, cams 168 and 170 will be pushed downwardly into action so as to withdraw all sinkers during knitting of the foot, which knitting is produced by rotary action.

During the course going into the toe, cams 168 and 170 will be completely withdrawn while cams 172 and 174 will be held down in active position throughout the making of the toe so as to withdraw the sinkers between the needles that knit the toe, leaving the remaining sinkers in their innermost position.

Cams 176, 178, 180 and 182 are at all times in position so that they will move the sinkers inwardly as the needles start to rise, pushing the old loops over the top of the needles in the normal manner.

The stitch structure made by the above needle selection is shown diagrammatically in Figure 9. Knitting proceeds from the loops under the title "narrowing" to the suture indicated generally by the dot-dash line marked 184. As needles resume knitting after being put out of action at the suture, they proceed to knit loops toward the title "widening."

The loops made of the thread that is shaded in Figure 9 are made at one feed and loops made of the unshaded thread are made at the other feed. The arrows around the edge of the figure represent the direction of knitting of the loops aligned with the arrows. Certain of the rows of stitches have been numbered to assist in their description. Assuming for descriptive purposes that this suture occurs at the left hand side of a heel of a stocking held at the top with the toe pointing toward the viewer and that said stocking was knit from the top toward the toe, then courses 186 and 188 would be made during a stroke in the direction of circular knitting or from right toward the left as viewed in Figure 1. Course 186 would have been knit at the first feed and course 188 at the second. In both of these courses 186 and 188 loops numbered 194 and 196 would be the last knit. On the reverse stroke making courses 190 and 192, the needle that knit loops 194 and 196 would be left down out of operation so the yarn would go over the top of this needle. However, the needle that knit loops 198 and 200 in courses 186 and 188 would be tucked so the threads from each feed would be taken in the hook of this needle. In Figure 9, the dark thread that knit the last loop 196 in course 188 at the second feed leads back of loop 196, free of the next loop to be drawn through said loop 196, around in front of loop 200 where it is tucked and thus cast off with said loop 200 so as to be tied in with the next loop to be drawn through 200. This dark thread then forms a loop at 202 and continues on forming loops at each wale in a right to left direction as seen in this figure until it reaches the other suture at the end of this course. The white thread from loop 194 follows the same path as the dark till it forms its first loop 204 in course 192 through loop 202. The remaining narrowing courses are made in the same manner as above. The suture on the other side of the heel is a repetition of this one. During widening, the length of the course is increased by three loops at the end of each

course and shortened by one loop at the start of the course, thus lengthening each pair of courses by a total of two loops. Accordingly, in course 206 which is knit in the same direction as circular knitting, the white yarn knitting first at the first feed has the first of its added three loops 214 pulled through loop 216 and the two strands that accompany it because of the fact that the needle which formed loop 216 was tucked as the leading needle in forming the two courses that preceded course 206. The white thread then forms a loop 218 through a terminal narrowed loop corresponding to loop 196 described above. The final added loop 220 of this white thread is pulled through loop 200 and its accompanying loops are made when the needle on which loop 200 was formed took threads from each of the two feeds into its hook when it tucked as a leading needle during a pair of narrowing courses. The dark yarn fed from the second feed has terminal loops 222, 224 and 226 drawn respectively through the terminal white loops 214, 218 and 220 just described.

Upon reversal of the direction of knitting, the needle that formed loop 226 is tucked as the leading needle in the next pair of courses 210 and 212. The tuck loops are numbered 228 and 230. This needle is tucked through action respectively of picks 122 and 118 whose action has previously been described.

It may be noted that if the toe is made on the opposite side of the knitted tube from the heel, the clutch should be shifted as shown in A. E. Page Patents 1,853,519 and 1,853,520.

It will be evident that various alternative types of sutures may be provided in accordance with the invention with the idle needles taking a low path. If a gusset such as shown in Grothey Patent 2,590,008 is desired, then at the completion of narrowing, which is preferably produced in the same manner as described above for the heel, a number of the needles put out of action during narrowing will be reactivated by jacks selection. This action will produce a single-sided suture. During the knitting of the gusset for the desired width, narrowing will be continued in order to obtain the tapered end near the start of the suture as illustrated in said Grothey patent. Upon completion of the gusset, the needles put into action will be removed from action by jack selection at the second and third stations and widening will take place as described above in connection with the heel. The resulting sutures will be single-sides rather than double-sided as shown in Figure 9.

At the completion of a toe, the clutch will again shift to place the machine in rotary motion to make the loopers' loose course followed by the loopers' waste courses. Preferably, the first selection station will be activated to raise all jacks over cam 94 starting with the jack under needle 100, and the second selection station will be removed from action after the cam 18 is moved adjacent to the cylinder. All of the selecting cams at the second and third selection stations will then be removed from the cylinder after about half of the needles making the toe have passed, or when needle 50 is approximately above the second selection station. This will allow all needles to knit. The loose course may be made in the usual way, adjusting one or both stitch cams to make a loose stitch for one revolution after which a normal stitch is resumed for the making of the waste courses. Upon completion of the waste courses as above described the yarns at both feeds may be removed dropping the completed stocking.

What is claimed is:

1. A knitting machine comprising a cylinder carrying slidable needles, at least two yarn feeding stations, means for producing relative rotation and relative repicrocation between said needles and said yarn feeding stations, and means for producing multiple feed reciprocatory knitting of a narrowed and widened pouch, the last mentioned means comprising means separating the needles into initial active and inactive groups with the needles of the inactive group arranged to move at a level at which they will not contact yarns fed at said feeding stations, means for successively removing needles from the active group to the inactive group at said level during said reciprocatory knitting, thereby to effect narrowing, means for preventing clearing of at least one leading needle of the active group during each stroke of said reciprocatory knitting while causing it to receive yarn at at least one of said feeding stations, thereby to produce tucking, means for causing other needles of said active group to take and knit yarns at both of said feeding stations during each stroke of said reciprocatory knitting thereby to provide multiple feed knitting, and means for thereafter successively restoring needles from the inactive group to the active group during said reciprocatory knitting, thereby to effect widening, while continuing the aforesaid tucking and multiple feed knitting.

2. A knitting machine comprising a cylinder carrying slidable needles, at least two yarn feeding stations, means for producing relative rotation and relative reciprocation between said needles and said yarn feeding stations, and means for producing multiple feed reciprocatory knitting of a narrowed and widened pouch, the last mentioned means comprising means separating the needles into initial active and inactive groups with the needles of the inactive group arranged to move at a level at which they will not contact yarns fed at said feeding stations, means for successively removing needles from the active group to the inactive group at said level during said reciprocatory knitting, thereby to effect narrowing, means for preventing clearing of at least one leading needle of the active group during each stroke of said reciprocatory knitting while causing it to receive yarns at both of said feeding stations, thereby to produce tucking, means for causing other needles of said active group to take and knit yarns at both of said feeding stations during each stroke of said reciprocatory knitting thereby to provide multiple feed knitting, and means for thereafter successively restoring needles from the inactive group to the active group during said reciprocatory knitting, thereby to effect widening, while continuing the aforesaid tucking and multiple feed knitting.

3. A knitting machine comprising a cylinder carrying slidable needles, at least two yarn feeding stations, means for producing relative rotation and relative reciprocation between said needles and said yarn feeding stations, and means for producing multiple feed reciprocatory knitting of a narrowed and widened pouch, the last mentioned means comprising means separating the needles into initial active and inactive groups with the needles of the inactive group arranged to move at a level at which they will not contact yarns fed at said feeding stations, means for successively removing needles from the active group to the inactive group at said level during said reciprocatory knitting, thereby to effect narrowing, means for causing needles of said active group to take and knit yarns at both of said feeding stations during each stroke of said reciprocatory knitting thereby to provide multiple feed knitting, and means for thereafter successively restoring needles from the inactive group to the active group during said reciprocatory knitting, thereby to effect widening, while continuing the aforesaid multiple feed knitting.

4. A knitting machine according to claim 1 comprising means for producing similar multiple feed reciprocatory knitting of a second narrowed and widened pouch on needles which were inactive during the knitting of the first mentioned pouch.

5. A knitting machine according to claim 2 comprising means for producing similar multiple feed reciprocatory knitting of a second narrowed and widened pouch on needles which were inactive during the knitting of the first mentioned pouch.

6. A knitting machine according to claim 3 compris-

ing means for producing similar multiple feed reciprocatory knitting of a second narrowed and widened pouch on needles which were inactive during the knitting of the first mentioned pouch.

7. A knitting machine according to claim 1 in which each needle has associated with it in said cylinder a pattern jack and in which said means for successively removing needles comprising means controlling said jacks to effect the successive removal of needles from the active group to the inactive group.

8. A knitting machine according to claim 3 in which each needle has associated with it in said cylinder a pattern jack and in which said means for successively removing needles comprising means controlling said jacks to effect the successive removal of needles from the active group to the inactive group.

9. A knitting machine according to claim 1 in which each needle has associated with it in said cylinder a pattern jack and in which said means for successively removing needles and said means for successively restoring needles comprising means controlling said jacks to effect the successive removal of needles from the active group to the inactive group and successive restoration of needles from the inactive group to the active group.

10. A knitting machine according to claim 3 in which each needle has associated with it in said cylinder a pattern jack and in which said means for successively removing needles and said means for successively restoring needles comprising means controlling said jacks to effect the successive removal of needles from the active group to the inactive group and successive restoration of needles from the inactive group to the active group.

11. A knitting machine according to claim 1 in which a pick prevents said clearing of a leading needle of the active group during each stroke of said reciprocatory knitting.

12. A knitting machine according to claim 7 in which a pick acting on a pattern jack prevents said clearing of a leading needle of the active group during each stroke of said reciprocatory knitting.

13. A knitting machine comprising a cylinder carrying slidable needles, slidable pattern jacks individually associated with said needles, said jacks being provided with butts selectively located at various levels at least two yarn feeding stations, means for producing relative rotation and relative reciprocation between said needles and said yarn feeding stations, and means for producing multiple feed reciprocatory knitting of a narrowed and widened pouch, the last mentioned means comprising selecting devices at said various levels selectively operating on the butts of said jacks to control active and non-active conditions of needles.

14. A knitting machine comprising slidable needles, pattern jacks individually associated with said needles, a carrier mounting said needles and pattern jacks, each of at least some of said jacks being provided with butts of two different groups, there being in each of said groups butts at a plurality of levels, a selection station having two groups of selecting means, each of the last mentioned groups comprising a plurality of selecting means at different levels, the means of one group cooperating with butts of one of said groups and the means of the other group cooperating with butts of the other of said groups with said means of one group arranged to act on butts prior to said means of the other group, so that action of means of one group nullifies the preceding action of means of the other group, and means for moving the jacks following actions of the means of said groups in accordance with said actions.

15. A knitting machine comprising slidable needles, pattern jacks individually associated with said needles, a carrier mounting said needles and pattern jacks, each of at least some of said jacks being provided with butts of two different groups, a selection station having two groups of selecting means, the means of one group acting upon butts of one of said groups and the means of the other group acting upon butts of the other of said groups, means for effecting movements of jacks the butts of the first group of which are not acted upon by the means of the first group, and for effecting similar movements of jacks the butts of the first group of which are acted upon by the means of the first group only if the butts of the second group of such jacks are acted upon by the means of the second group subsequently to the last mentioned action by the means of the first group.

16. A knitting machine comprising a cylinder carrying slidable needles, a pair of yarn feeding stations, means for producing relative rotation and relative reciprocation between said needles and said yarn feeding stations, a forward stitch cam and a reverse stitch cam at each of said feeding stations, means effective to clear needles selectively during rotary knitting prior to engagement with the forward stitch cam first reached during rotary knitting, and means for effecting by two feed knitting the formation of a pair of concatenated courses during each stroke of reciprocatory knitting, said last means comprising means effective to clear needles selectively during reciprocatory strokes in a forward direction between the forward stitch cams, and means effective to clear needles selectively during reciprocatory strokes in a reverse direction between the reverse stitch cams.

17. A knitting machine comprising a cylinder carrying slidable needles, a pair of yarn feeding stations, means for producing relative rotation and relative reciprocation between said needles and said yarn feeding stations, a forward stitch cam and a reverse stitch cam at each of said feeding stations, means effective to clear needles selectively during rotary knitting prior to engagement with the forward stitch cam first reached during rotary knitting, and means for effecting by two feed knitting the formation of a pair of concatenated courses during each stroke of reciprocatory knitting, said last means comprising means effective to clear needles selectively during reciprocatory strokes in a forward direction both in advance of and between the forward stitch cams, and means effective to clear needles selectively during reciprocatory strokes in a reverse direction both in advance of and between the reverse stitch cams.

18. A knitting method for producing multiple feed reciprocatory knitting of a narrowed and widened pouch on a circular knitting machine comprising producing during each reciprocation of an active group of needles tucking by at least one leading needle of said active group without clearing said leading needle during said reciprocation, and causing the taking and knitting of a plurality of yarns by following needles of said active group during said reciprocation.

19. A knitting method for producing multiple feed reciprocatory knitting of a narrowed and widened pouch on a circular knitting machine comprising producing during each reciprocation of an active group of needles tucking by at least one leading needle of said active group without clearing said leading needle during said reciprocation, and causing the taking and knitting of a plurality of yarns by following needles of said active group during said reciprocation, the number of active needles being successively reduced from stroke to stroke to produce narrowing.

20. A knitting method for producing multiple feed reciprocatory knitting of a narrowed and widened pouch on a circular knitting machine comprising producing during each reciprocation of an active group of needles tucking by at least one leading needle of said active group with taking by said needle of a plurality of yarns without clearing said leading needle during said reciprocation, and causing the taking and knitting of a plurality of yarns by following needles of said active group during said reciprocation.

21. A knitting method for producing multiple feed reciprocatory knitting of a narrowed and widened pouch

on a circular knitting machine comprising producing during each reciprocation of an active group of needles tucking by at least one leading needle of said active group with taking by said needle of a plurality of yarns without clearing said leading needle during said reciprocation, and causing the taking and knitting of a plurality of yarns by following needles of said active group during said reciprocation, the number of active needles being successively reduced from stroke to stroke to produce narrowing.

22. A knitting method for producing multiple feed reciprocatory knitting of a narrowed and widened pouch on a circular knitting machine comprising producing during each reciprocation of an active group of needles tucking by at least one leading needle of said active group without clearing said leading needle during said reciprocation, and causing the taking and knitting of a plurality of yarns by following needles of said active group during said reciprocation, the number of active needles being successively reduced from stroke to stroke to produce narrowing, and thereafter producing during each reciprocation of an active group of needles tucking by at least one leading needle of said active group without clearing the last mentioned leading needle during said reciprocation, and causing the taking and knitting of a plurality of yarns by following needles of said active group during the last mentioned reciprocation, the number of active needles being successively increased from stroke to stroke by adding trailing needles to said active group to produce widening.

23. A knitting method for producing multiple feed reciprocatory knitting of a narrowed and widened pouch on a circular knitting machine comprising producing during each reciprocation of an active group of needles tucking by at least one leading needle of said active group with taking by said needle of a plurality of yarns without clearing said leading needle during said reciprocation, and causing the taking and knitting of a plurality of yarns by following needles of said active group during said reciprocation, the number of active needles being successively reduced from stroke to stroke to produce narrowing, and thereafter producing during each reciprocation of an active group of needles tucking by at least one leading needle of said active group with taking by said needle of a plurality of yarns without clearing the last mentioned leading needle during said reciprocation, and causing the taking and knitting of a plurality of yarns by following needles of said active group during the last mentioned reciprocation, the number of active needles being successively increased from stroke to stroke by adding trailing needles to said active group to produce widening.

24. A knitting machine comprising slidable needles, pattern jacks individually associated with said needles, a carrier mounting said needles and pattern jacks, each of at least some of said jacks being provided with butts of two different groups, a selection station having two groups of selecting means, the means of one group cooperating with butts of one of said groups and the means of the other group cooperating with butts of the other of said groups so that action of means of one group nullifies the action of means of the othe rgroup, and means for moving the jacks following actions of the means of said groups in accordance with said actions, said machine including means for effecting reciprocatory knitting by said needles during which reciprocatory knitting individual selections of needles for the formation of narrowed and widened pouches are controlled by the coaction of means of said groups with said pattern jacks.

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