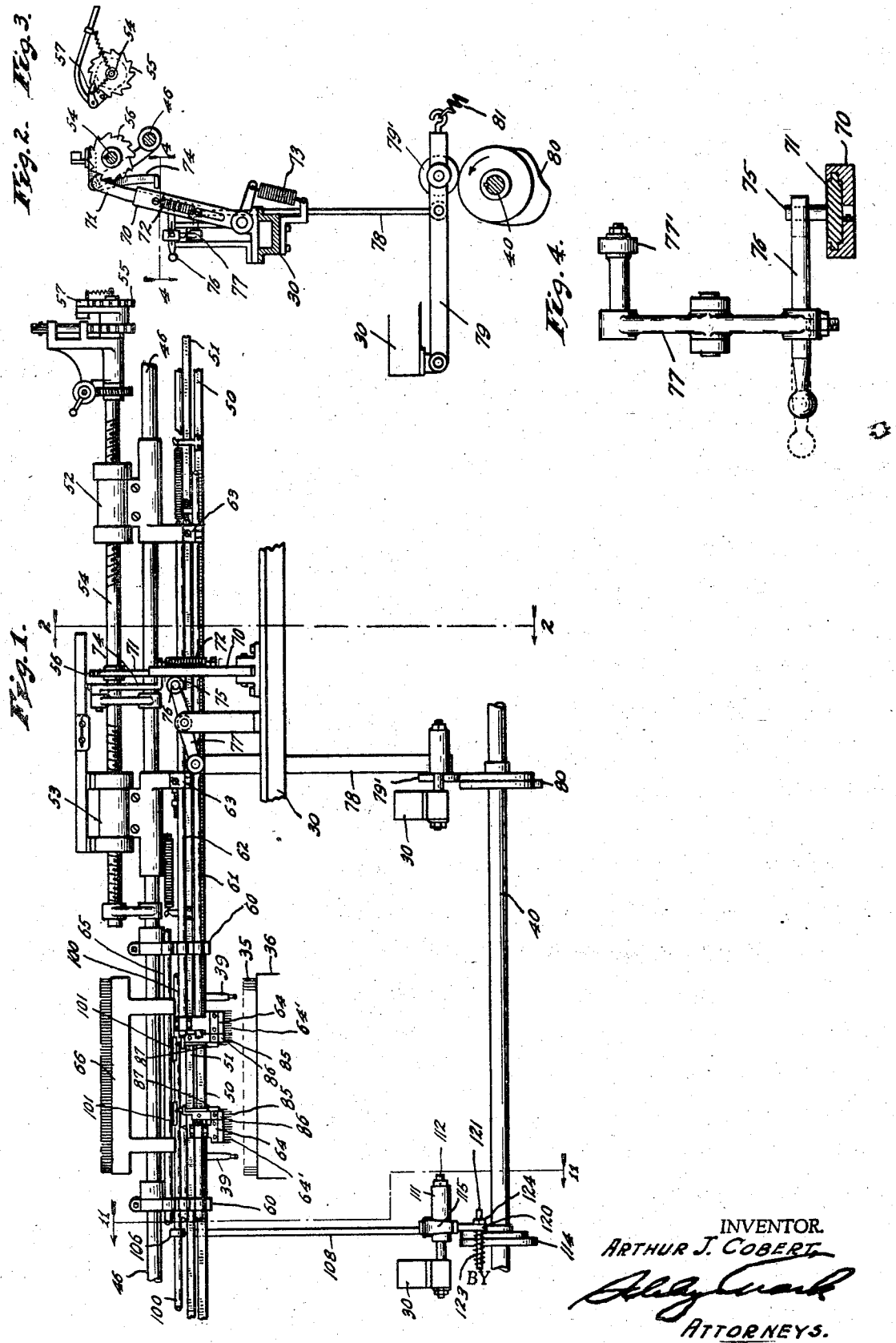
Sept. 28, 1943. A. J. COBERT 2,330,681

MACHINE AND PROCESS FOR KNITTING HOSIERY BLANKS

Filed Feb. 24, 1941 4 Sheets-Sheet 1



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Filed Feb. 24, 1941 4 Sheets-Sheet 2

Fig. 5.

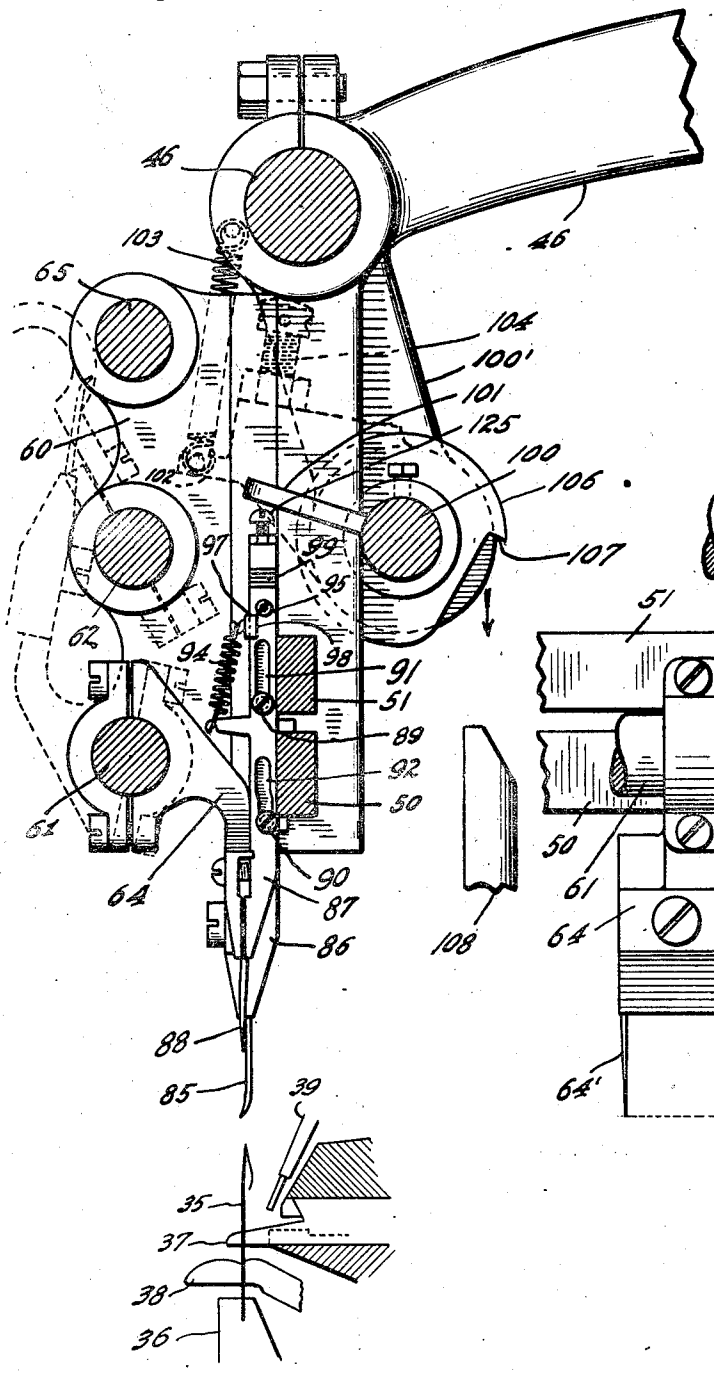
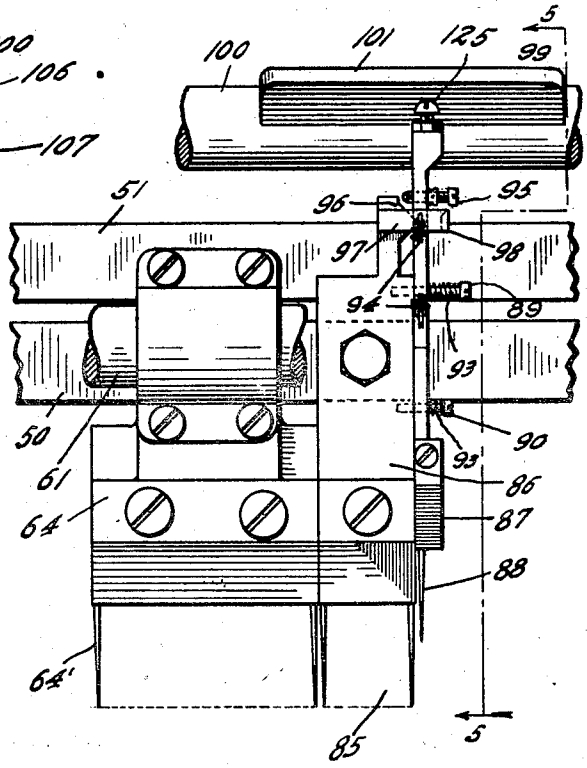


Fig. 6.



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Filed Feb. 24, 1941 4 Sheets-Sheet 3

Fig. 7.

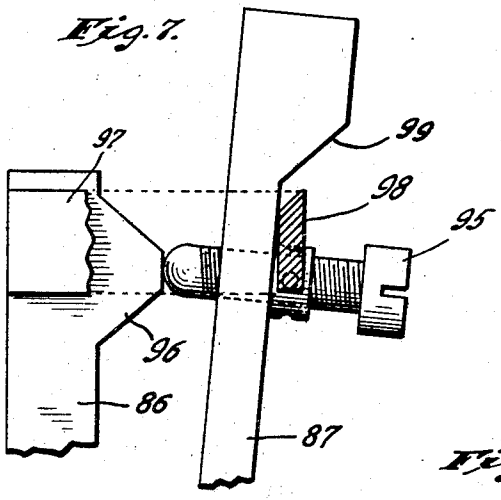


Fig. 9.

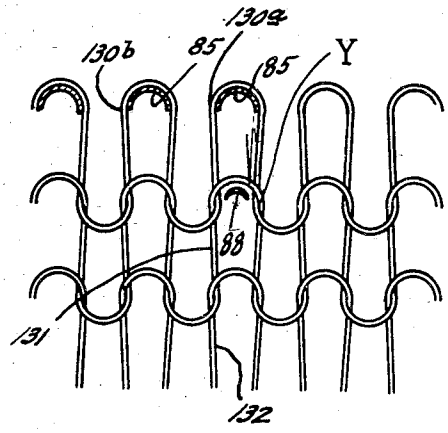


Fig. 8.

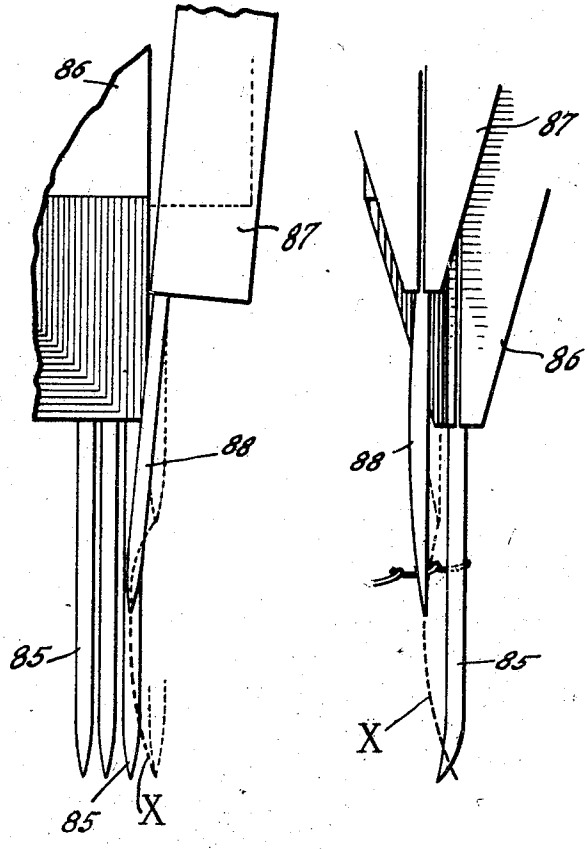
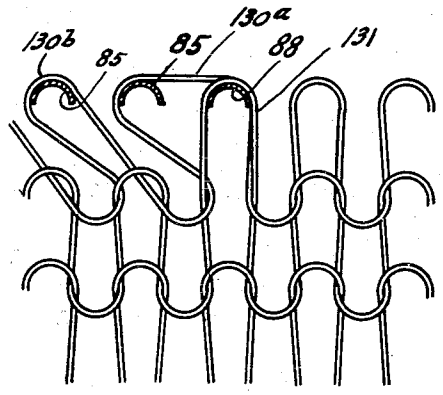


Fig. 10.



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Sept. 28, 1943. A. J. COBERT 2,330,681

MACHINE AND PROCESS FOR KNITTING HOSIERY BLANKS

Filed Feb. 24, 1941 4 Sheets-Sheet 4

Fig. 13.

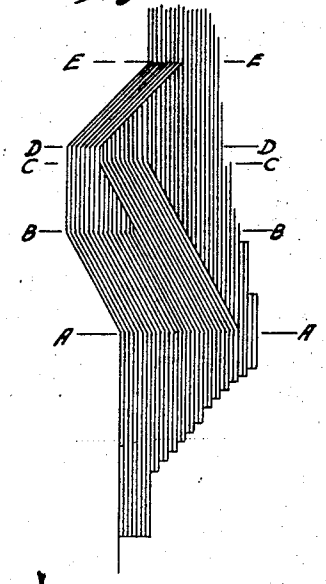


Fig. 11.

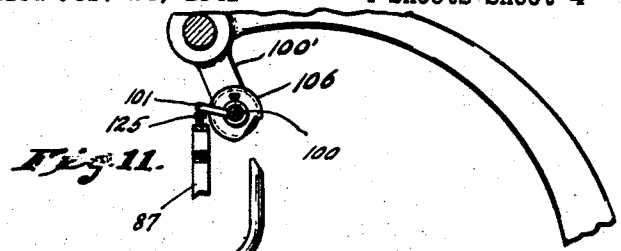


Fig. 12.

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UNITED STATES PATENT OFFICE

2,330,681

MACHINE AND PROCESS FOR KNITTING HOSIERY BLANKS

Arthur J. Cobert, Indianapolis, Ind., assignor to Real Silk Hosiery Mills, Inc., Indianapolis, Ind., a corporation of Illinois

Application February 24, 1941, Serial No. 380,181

16 Claims. (Cl. 66—89)

In my co-pending application Serial No. 438,711, filed April 13, 1942, I have disclosed a flat-knit, single-unit hosiery blank in which the heel-forming portion is widened by the outward transfer of stitches, such blank being characterized by the fact that the outward transfer of stitches in marginal wales to effect the widening for the heel does not leave an oblique row of openings in the fabric. The present invention relates to a machine and process for forming such a stocking blank.

It is the object of my invention to produce a machine capable of forming a complete stocking blank in a single operation. More specifically, it is my object to produce a machine which will widen the blank in the vicinity of the heel by the outward transfer of stitches in a manner which will not leave in the fabric an oblique row of openings adjacent the innermost transferred stitches in the several courses over which widening is effected. A further object of my invention is to construct such a machine by modifying a flat-knitting machine of standard form in such a manner that the modifications introduced will not interfere with ordinary knitting operations which the machine is capable of performing.

The conventional flat knitting machine embodies, in addition to the knitting mechanism proper, so called narrowing mechanism by means of which stitches near the margins of the fabric are transferred inwardly from the needles on which they are respectively formed to other needles. Such narrowing mechanism includes a narrowing frame, an intermittently rotatable narrowing spindle, narrowing slides, and transfer points carried by said narrowing slides, the narrowing slides being operatively connected to the narrowing spindle so that rotational movement of the spindle will move the slides in opposite directions and cause sets of transfer points at the margins of the fabric to be moved inwardly toward each other. In carrying out my invention, I add to such a flat knitting machine means for rotating the narrowing spindle in a direction opposite to that in which it is normally rotated to effect narrowing operations. Through the operation of this mechanism, the ordinary transfer points are made capable of transferring stitches outwardly. To prevent the formation of openings in the fabric which would otherwise result from the outward transfer of stitches, I employ in association with each set of transfer points a longitudinal-transfer point and means for operating it so that, during the transferring operation, it will enter the stitch immediately ahead of that upon the innermost of the regular transfer points and transfer such stitch longitudinally of the blank to apply it, at the conclusion of the transfer operation, to the needle which would otherwise be left vacant as the result of the lateral transfer operation. In the preferred form of stocking set forth and described in my co-pending application above referred to, outward transfer of stitches in the upper portion of the heel is effected in a relatively large number of marginal wales and is continued through a lower portion of the heel only in a group of wales spaced inwardly from the margin of the blank; and to adapt the machine for the formation of this preferred form of stocking, I employ the regular transfer points on such inwardly spaced group of wales and provide each section of the machine with two sets of auxiliary lateral transfer points which can be moved between inoperative and operative positions and which, when in operative position, extend outwardly from the regular points at least to the margin of the blank to effect the transfer of stitches in marginal wales.

The accompanying drawings illustrate my invention: Fig. 1 is a fragmental front elevation of the center portion and one section of a knitting machine to which my invention has been applied; Fig. 2 is a vertical section on the line 2—2 of Fig. 1; Fig. 3 is an end elevation of the narrowing spindle showing the means normally employed to operate it; Fig. 4 is a horizontal section on the line 4—4 of Fig. 2; Fig. 5 is a vertical section on the line 5—5 of Fig. 6 through the front portion of the narrowing frame and showing the main and auxiliary transfer slides, the narrowing fingers carried thereby, the longitudinal transfer point, and the means for operating it; Fig. 6 is a fragmental front elevation of the machine showing a set of transfer points operating at the left-hand side of the blank in one section of the machine; Fig. 7 is a front elevation and Fig. 8 a side elevation, both on an enlarged scale, showing the path of travel of the longitudinal-transfer point in relation to the regular lateral-transfer points; Fig. 9 is an idealized fragmental plan view of a portion of the fabric knit on my machine showing the longitudinal-transfer point just piercing the fabric; Fig. 10 is a view similar to Fig. 9 showing the stitches transferred and ready to be reapplied to the needles; Fig. 11 is a vertical section on the line 11—11 of Fig. 1 showing the mechanism by which operation of the longitudinal-transfer points is effected; Fig. 12 is a section on the line

12—12 of Fig. 11 showing most of the mechanism thereof in plan; and Fig. 13 is a fragmental plan view of the heel-forming portion of a hosiery blank such as can be knit on my machine.

The machine illustrated in the drawings, except for the incorporation of the instrumentalities characterizing my invention, is the well known Schubert & Salzer flat knitting machine, model HSL. It comprises an elongated main frame 30 supporting a plurality of knitting mechanisms each of which is capable of knitting a stocking blank, or at least the leg portion thereof. Each knitting mechanism includes a row of bearded needles 35 mounted in a needle bar 36, a set of sinkers and dividers 37, a set of knock-over bits 38, and a set of thread carriers 39, all operated in known manner by means including a cam shaft 40 which extends for the length of the machine.

Pivoted on an axis extending longitudinally of the main frame 30 near the rear thereof is the usual narrowing frame 46. This frame carries a pair of longitudinally slidable narrowing slides 50 and 51 operatively connected respectively to two nuts 52 and 53 mounted on oppositely threaded portions of a narrowing spindle 54 which is rotatably mounted on the narrowing frame near the longitudinal center thereof. The spindle 54 has rigid with it two ratchet wheels 55 and 56 of opposite hand and disposed respectively near one end and near the middle of the spindle. In conventional narrowing operations, the ratchet wheel 55 (and with it the narrowing spindle) is rotated by a co-operating pawl 57 which, as is well understood, is reciprocated by suitable mechanism (not shown) to produce inward movement of transfer points carried by the slides 50 and 51. The ratchet wheel 56 is ordinarily used only when it is desired to move the transfer points outwardly to or toward a normal position after they have been moved inwardly in a narrowing operation; but, as will be brought out in detail below, I employ the ratchet wheel 56 for an additional and somewhat different purpose.

The machine as so far described is well known. In modifying it to make a stocking blank having the characteristic features shown in Fig. 13, I add to it the following instrumentalities:

A. Two sets of auxiliary narrowing points for each section of the machine, and a pair of auxiliary narrowing slides on which such points are mounted.

B. Means for rotating the spindle 54 through the medium of the ratchet wheel 56 to effect an outward transfer of stitches.

C. A pair of special transfer points at each section of the machine for effecting the transfer of stitches longitudinally of the blank.

D. Means for operating such special transfer points.

Auxiliary narrowing points and slides

At spaced intervals along the front of the narrowing frame I provide guides 60 adapted to slidably support vertically spaced auxiliary narrowing slides 61 and 62 which run for the full length of the narrowing frame. These slides 61 and 62 are adapted to be operatively connected to the two narrowing nuts 52 and 53 respectively, as by means of releasable clamps 63. At each section of the machine, there is mounted upon each of the slides 61 and 62 an auxiliary narrowing finger 64 which carries a series of transfer points 64' and which is arranged to be moved to and from an operative position. Desirably, to effect this movement of the auxiliary fingers 64, they are rigidly secured to the respective slides and the latter are circular in cross-section so as to be rotatable as well as slidable in the guides 60.

The guides 60, in addition to supporting the slides 61 and 62, may also support a slide 65 for the conventional picot bar 66, with which my invention is not concerned.

Widening mechanism

In the conventional knitting machine, the ratchet wheel 56 is rotated by a pawl mounted on the main frame 30 in position to engage such a ratchet wheel and rotate it through a limited angular extent in a reverse direction as the narrowing frame moves upwardly after having effected an inward transfer of stitches. In the practice of my invention, it is necessary that the narrowing spindle be rotated in such reverse direction during the transfer operation. Accordingly, there is pivotally mounted on the main frame 30 a generally vertical arm 70 (Figs. 1 and 2) carrying a pawl 71 adapted to co-operate with the ratchet wheel 56, the pawl being mounted for radial sliding movement in the arm 70. A spring 72 acting on the pawl 71 urges it upwardly, while a second spring 73 acts on the arm 70 to urge it rearwardly or toward the ratchet wheel 56. A conventional throw-out lever 74, modified as may be necessary to engage the arm 70 rather than the ordinary one-piece pawl, may be employed whenever it is desired to hold the arm 70 outwardly out of association with the ratchet wheel 56 in opposition to the force exerted upon it by the spring 73.

The pawl 71 carries an outwardly projecting abutment 75 disposed beneath a pin 76 slidably mounted in one end of an intermediately pivoted lever 77. The opposite end of the lever 77 is provided with a roller 77' overlying an actuating rod 78 which extends downwardly through the frame of the machine and is connected at its lower end to an oscillatable arm 79 actuated by a cam 80 on the main cam-shaft 40, desirably through the medium of a cam-following roller 79'. The cam 80, like many of the cams on the cam-shaft of the standard machine, has two axially separated portions the right-hand one of which is circular and lies beneath the cam-following roller 79' during straight knitting operations and the other of which is contoured or lobed and is moved beneath the cam-following roller when the cam shaft is shogged for a transferring operation. A spring 81 may be employed to urge the arm 79 downwardly into association with the cam 80.

When the pin 76 is advanced to overlie the abutment 75, oscillation of the lever 77 caused by the cam 80 will move the pawl 71 downwardly in the arm 70 to rotate the ratchet wheel 56 and the narrowing spindle. If the pin 76 is retracted, however, oscillation of the lever 77 will not produce movement of the pawl 71. Under these circumstances, the pawl 71 is held in its uppermost position by the spring 72 and may be employed under the control of the throw-out arm 74 to produce reverse rotation of the narrowing spindle in the conventional manner.

Longitudinal stitch-transfer mechanism

Associated with each section of the machine are two sets of main transfer points 85 carried respectively by the main narrowing slides 50 and 51. The two sets of points 85 at each section, their

manner of mounting, and the longitudinal-transfer point associated with each set are the same except for the obvious differences arising from the fact that they operate on different sides of the blank and are attached to narrowing slides of different height. Accordingly, I shall describe in detail only one set of lateral-transfer points 85 and its associated longitudinal-transfer point, selecting for this purpose the set at the left of the blank.

The transfer points 85 of each set are clamped in a narrowing finger 86 (Figs. 5 to 8) in conventional manner, and the narrowing finger is secured to the associated slide 50 or 51 in the usual way. On the inner face of each narrowing finger 86 there is mounted for vertical movement a slide 87 carrying a single transfer point 88. The slide 87 is supported for generally vertical movement relative to the finger 86 as by two screws 89 and 90 which project outwardly from the finger 86 through vertically elongated slots 91 and 92 in the slide 87. Springs 93 acting between the heads of the screws 89 and 90 and the slide 87 tend to hold the latter against the side face of the finger 86. A third spring 94 acting between the slide and the finger tends to draw the former upwardly to the limit of movement provided by the slots 91 and 92.

Near its upper end, the slide 87 is screw-threaded for the reception of a screw 95 which projects outwardly through the slide in position to engage an inwardly projecting cam 96 on the upper end of the finger 86. An arm 97 projects laterally from the finger 86 near the upper end thereof and is provided at its end with a rearwardly extending lip 98 overlying the inner surface of the slide 87 in position to be engaged by an inclined cam 99 at the upper end of the slide.

As will be obvious, the course traveled by the lower end of the transfer point 88 as the slide moves downwardly will depend upon the respective shapes of the slots 91 and 92, which determine the position of the point longitudinally of the blank, and upon the cams 96 and 99 which determine the position of the point laterally of the blank. Figs. 7 and 8, which are enlarged views, illustrate the character of the movement imparted to the lower end of the transfer point 88 as the slide 87 is forced downwardly. In those figures, the slide 87 and point 88 are shown in full lines at an intermediate point in downward movement of the slide, and the path traveled by the lower end of the point 88 is indicated by the heavy dotted line X.

As will be clear from Figs. 5 to 8, when the slide 87 is in its uppermost position the transfer point 88 is well above the points 85 in a position where it will not pierce any fabric thereon and so interfere with ordinary transferring operations performed by the points 85. Laterally of the blank, the transfer point 88 in its raised position may be spaced from the adjacent point 85 by a distance substantially corresponding to the spacing of the points 85 from each other; while longitudinally of the blank, the point 88 may be slightly ahead of the plane of the points 85.

As the slide 87 moves downwardly from its uppermost position, the screw 95 engages the cam 96 to throw the upper end of the slide inwardly of the blank, or to the right in Figs. 6 and 7. Since the springs 93 tend to hold the slide against the side of the finger 86, the slide pivots about the point of engagement between its lower end and the side face of the finger 86 and carries the lower end of the transfer point 88 laterally in front of the adjacent transfer point 85 in order to enter the stitch immediately ahead of that upon such point 85. As downward movement of the slide 87 continues, the screw 95 moves past the cam 96, the cam 99 engages the lip on the arm 98 to move the upper end of the slide outwardly of the blank, and the point 88 is restored to its normal lateral distance from the adjacent point 85. The upper portion of the slot 92 is offset forwardly of the machine relatively to the lower portion, and when this forwardly offset portion of the slot comes into association with the screw 90, the lower end of the slide is moved rearwardly to bring the transfer point 88 into co-planar relationship with the transfer points 85. The inner lower corner of the cover plate by which the points 85 are secured to the finger 86 may be relieved as indicated so as not to interfere with movement of the transfer point 88 as it swings over in front of the adjacent point 85.

The position of the point 88 when the slide 87 is raised is relatively unimportant, so long as it lies above the fabric during normal transferring operations and does not interfere with other parts of the machine, such as the sinkers and dividers. It is, however, important that the point 88 pierce the fabric at the desired place therein, and also important that in the lower position of the slide 87 the point 88 occupy a position beside the innermost main point 85. Adjustment of the screw 95 permits control of the lateral position of the lower end of the point 88 at the time it pierces the fabric.

Mechanism for operating transfer points 88

For the purpose of operating the several slides 87 I mount in the narrowing frame a longitudinally extending rock shaft 100 (Figs. 1, 5, and 6) which is provided at intervals with outwardly extending plates 101 each of which is adapted to overlie the upper end of one of the slides 87. The longitudinal extent of each of the plates 101 should be sufficient so that the associated slide will not move out of operative relation to it during any of the ordinary widening operations of the machine. The shaft 100 may be mounted in bearings 100' clamped to the front member of the narrowing frame.

Rigid with the rock shaft 100 I provide an arm 102 (Fig. 5) between which and the narrowing frame 46 there acts a spring 103 tending to rock the shaft 100 in a direction which will elevate the plates 101. Movement of the rock shaft under the influence of the spring 103 is limited, as by providing the arm 102 with a stop-screw 104 positioned to engage one of the bearings 100' or some other convenient point of the narrowing frame.

To the rock shaft 100 there is secured a collar 106 having in its periphery a notch 107 adapted to be engaged by the upper end of a push rod 108 to rotate the rock shaft and depress the plates 101. Near its lower end, the push rod 108 is operatively connected to the rear end of a lever 111 which is pivoted near the front of the frame 30 on a pivot bolt 112 and which carries a laterally projecting pin 110. Slidably mounted on the pin 110 between a stop washer 109 and the lever 111 is a cam-following roller 113 adapted to engage a cam 114 on the cam shaft 40. For the purpose of rendering the lever 111 operative and inoperative as desired, the roller 113 is slidable on the pin 110 under the control of a lever 115 having a bifurcated end straddling the roller 113. The roller-shifting lever 115 is pivoted on

an approximately vertical axis to the hub of the lever 111 and continues forwardly beyond such pivot.

The cam 114 may, like the cam 80, have a right-hand circular portion and a left-hand lobed portion. Except when the widened portion of the blank is being knit, the roller-shifting lever 115 holds the roller 113 far enough to the right on the pin 110 so that it will not be engaged by the lobed portion of the cam 114 even when the cam shaft 40 is shogged to the right to effect a transferring operation. By moving the lever 115, however, the roller 113 can be so placed on the pin 110 that it will lie above the lobed portion of the cam 114 when the cam shaft is shogged. Even if the cam 114 has a right-hand circular portion wide enough to support the roller 113 at all times except when such roller is on the lobed portion of the cam, I prefer to provide an independent means for supporting the lever 111 when it is inoperative. To this end, the lever 111 may continue rearwardly past the pin 110 to engage a screw 116 projecting upwardly from a bracket 117 secured to the main frame 30 of the machine. A spring 118 urges the rear end of the lever 111 downwardly, while the screw 116 supports the lever and holds it in such a position that the periphery of the roller 113 will not drop below the top of the circular portion of the cam 114. The expedient of supporting the lever 111 independently of the roller 113 relieves such roller of load and greatly reduces the effort which would otherwise be required to shift it on the pin 110.

If desired, the roller-shifting lever 115 can be automatically controlled by the conventional pattern chain (not shown). If this is to be done, there may be attached to the front end of the lever a block 120 which slidably receives a rod 121 operatively connected to one of the control rods 122 with which the regular knitting machine is equipped. A compression spring 123 acting between the rod 121 and the block 120 urges the latter toward the right, and movement of the block relative to the rod under the influence of the spring is limited by a collar 124 clamped to the rod. Except when the widened portion of the blank is being knit, the control rod 122 is in its leftwardmost position; but when knitting of the widened portion of the blank is begun the control rod is moved to the right by the pattern chain, thus causing the roller-shifting lever 115 to move the roller 113 to the left on the pin 110 into operative association with the cam 114. With the roller 113 in such position, the lobed portion of the cam 114 is moved beneath the roller when the cam shaft 40 is shogged, thus making it possible for the cam to elevate the rod 108 to rock the shaft 100 and cause the plates 101 to depress all the slides 87. Desirably, the plates 101 do not engage the respective slides 87 directly, but instead bear upon thrust screws 125 mounted in the upper ends of the slides. By adjustment of each thrust screw 125, the lowermost position of the longitudinal transfer point 88 can be controlled.

The upper end of the rod 108 co-operates with parts carried by the narrowing frame while the lower end co-operates with parts supported from the main frame. As will become more apparent hereinafter, the rod 108 must remain in engagement with the collar 106 during a portion of the movement of the narrowing frame, and it is necessary to take account of this fact in the design of the means by which the rod 108 is supported and actuated. Accommodation for vertical components of movement of the shaft 100 as the narrowing frame is raised and lowered may be made by properly shaping the cam 114. To accommodate for horizontal components of movement of the shaft 100 the upper end of the rod 108 is given some freedom of movement fore and aft of the machine, conveniently by associating with it a spring 127, which urges the upper end of the rod forwardly, and a guide 128, which is supported from the main frame of the machine and which limits forward movement of the upper end of the rod under the influence of the spring 127. The guide 128 is so positioned that when the upper end of the rod 108 enters into operative association with the notch 107 immediately prior to rocking the shaft 100 such upper rod-end will be cammed rearwardly by the surface of the collar 106 to move the rod rearwardly away from the guide and leave its upper end free to follow horizontal displacements of the shaft 100. Obviously, the rod 108 in its normal position must be so positioned vertically that its upper end will not strike the wall of the notch 107 and rock the shaft 100 when the narrowing frame is making its initial dip to pick the stitches off the needles.

Stocking produced

I have illustrated in Fig. 13 the heel-forming portion of the preferred type of stocking-blank which my machine is capable of knitting. This stocking blank is knit in any desired manner down to the course A—A, at which widening for the heel is to commence. From course A—A to course B—B, where the heel-forming portion of the blank attains its greatest width, the stitches in a relatively large number of marginal wales at each side of the blank are transferred outwardly, desirably at the rate of one needle for every two courses of knitting, while travel of the thread carriers is increased at the same rate. Between courses B—B and C—C the outward transfer of stitches is continued in a group of wales spaced inwardly from the margin of the blank, but transfer of stitches in marginal wales is discontinued and the travel of the thread carriers is not increased. Between courses C—C and D—D a few plain-knit courses may be produced, and from course D—D to course E—E the blank is narrowed by the inward transfer of stitches in marginal wales. Beyond course E—E knitting is continued to form the foot in any desired way.

Along the oblique line of the innermost laterally transferred stitches other stitches are transferred longitudinally of the blank, as will be more apparent hereinafter, to prevent the formation of openings in the fabric which would otherwise result from the fact that the outward transfer of stitches at each side of the blank leaves one needle with no stitch upon it.

While the form of stocking blank just described is the preferred one, it is to be understood that my invention may be employed in any other form of blank in which widening is produced by an outward transfer of stitches.

Operation

During knitting of the leg portion of the blank down to the course A—A where heel-widening is to begin, the auxiliary transfer points 64' are in the inoperative position illustrated in dotted lines in Fig. 5, the pin 76 in the lever 77 is retracted into the dotted-line position shown in Fig. 4 so that the pawl 71 remains at all times in its uppermost

position in the arm 70, and the cam-following roller 113 is held by the lever 115 out of association with the cam 114. As a result, none of the instrumentalities which I have added to the machine operate, and the knitting of the leg proceeds in the usual manner. The narrowing at the calf or at other points in the leg portion of the blank is effected by operation of the transfer points 85 in the customary way and is not interfered with by the several longitudinal transfer points 88, which are in their upper position and above the fabric at all times. The axial shift of the cam shaft 40, which is incident to each such narrowing operation, is without effect on the instrumentalities I have added to the machine; for the cam-following roller 113 is too far to the right to be engaged by the contoured portion of the cam 114, and the lever 77, although rocked by the contoured portion of the cam 79 at each narrowing operation, transmits no motion to the pawl 71 because the pin 76 is retracted and in a position where it does not engage the abutment 75.

When the course A—A is reached, the auxiliary transfer slides 61 and 62 are rotated to bring the transfer points 64' into their operative position shown in full lines in Fig. 5, and the auxiliary slides are moved longitudinally of the machine until the fingers 64 lie against and immediately outside of the main narrowing fingers 86 so that each set of transfer points 64' and the adjacent set of transfer points 85 will form a continuous series as shown in Fig. 6. The clamps 63 are tightened to secure the slides 61 and 62 to the nuts 52 and 53 respectively. The pawl 57 is disengaged from the ratchet wheel 55, to remain disengaged therefrom until widening of the blank has been completed, and the spindle 54 is rotated manually to bring each set of transfer points 64'—85 into proper position laterally of the associated blank. The pin 76 is advanced into the full-line position shown in Fig. 4 where it overlies the abutment 75 on the slide 71, and the roller 113 is moved by the lever 115 into operative position adjacent the cam 114.

The standard knitting machine to which my invention is shown as applied is capable of adjustment to vary the number of plain-knit courses, if any, which intervene between successive transferred courses. In making the form of stocking which I prefer, the widening over the heel-forming portion of the stocking is at the rate of one needle for every two courses of knitting; and I therefore adjust the machine so that one plain-knit course will intervene between successive transferred courses. As will be readily understood, during the knitting of a plain course, the narrowing frame remains elevated, the cam shaft 40 is in its leftwardmost position, and the cam-following rollers 79' and 113 are in association with the circular portions of the respectively associated cams. As a result, none of the instrumentalities which I have applied to the machine operate during the knitting of a plain course. When a transferring operation is to be performed, however, the cam shaft 40 is shogged to the right, thus bringing the lobed portions of the cams 80 and 114 beneath the rollers 79' and 113 respectively to produce the series of operations necessary in carrying out my invention.

The stitches in each course of knitting where a transfer operation is to take place are formed in the usual way, and after the preceding course has been cast off and the needles have arisen, the narrowing frame 46 is lowered, the transfer points 64' and 85 pick the stitches off the needles with which they are respectively associated, and the narrowing frame rises slightly to move the transfer points clear of the knock-over bits, exactly as in any ordinary transferring operation. When the transfer points are clear of the needles, the lobe of the cam 80 raises the roller 79' to elevate the push rod 78 and swing the lever 77 in a clockwise direction (Fig. 1) about its axis of mounting on the main frame. The resultant depression of the pin 76 moves the pawl 71 downwardly and rotates the narrowing spindle 54 in a reverse direction to move the slides 60, 61, and 62 for a distance equal to the spacing between adjacent needles. This movement of the slides carries each set of transfer points 64'—85 outwardly of the blank. Before the narrowing frame is lowered to bring the shifted transfer points into association with the needles, and preferably while the outward movement of the points 64'—85 is being effected, the lobe of the cam 114 acts on the roller 113 and raises the rod 108. The upper end of this rod then engages the collar 106 to rock the rock shaft 100 and depress the plates 101, thus lowering all the slides 87 on the main transfer fingers 86. The heads of the thrust screws 125 are freely slidable along the under surfaces of the plates 101, so that lateral movement of the fingers 64 and 86 relative to the plates 101 does not interfere with depression of the slides 87.

As the slides 87 are depressed, the lower end of each of the longitudinal transfer points 88 swings outwardly of the blank as indicated by the upper portion of the dotted-line X in Figs. 7 and 8; and, as depression of the slide continues, the lower end of the point 88 pierces the fabric, entering the stitch which is immediately ahead of the stitch on the innermost transfer point 85. Fig. 9, which is a diagrammatic, idealized plan view of a portion of the fabric shows stitches 130*a* and 130*b* supported on the two innermost of the main transfer points 85 and shows the longitudinal-transfer point 88 just entering the stitch 131 which lies in the precedingly knit course immediately ahead of the stitch 130*a* on the innermost main transfer point 85.

As downward movement of the slide 87 continues, the lower end of the transfer point 88 moves inwardly of the blank (relative to the finger 86) and rearwardly of the machine along the dotted-line X in Figs. 7 and 8 until, at the lower limit of movement of the slide 87, the points 85 and 88 occupy the relative positions illustrated in Fig. 10. Since, as the slide 87 moves downwardly to carry the lower end of the transfer point 88 inwardly of the blank relatively to the finger 86, the finger 86 is being transferred outwardly, the result is that the stitch 131 is transferred longitudinally of the blank in position to be restored to the needle upon which it was originally formed when the transferred stitches are replaced on the needles. In entering the stitch 131, the point 88 also enters the stitch 130*a* which is supported on the innermost of the main transfer points 85; and as a result, when the longitudinal-transfer point 88 reaches the completion of its movement, the stitch 130*a* is spread across two wales of the fabric, as will be clear from Fig. 10. As will also be clear from Fig. 10, the outward movement of the finger 86 transfers the spread stitch 130*a* and the stitches lying outwardly beyond it for a distance one needle outwardly of the blank.

After the lateral movement of the finger 86 and the downward movement of the slide 87 which have just been described is completed, the narrowing frame again drops to apply the transferred stitches to the needles in the usual way, and the narrowing frame and cam-shaft 40 then return to their normal positions to condition the machine for the knitting of a new course. After the transferred stitches have been deposited upon the needles, every needle throughout the extent of the widened course has a stitch upon it with the result that when the next course is knit no hole will be left in the fabric adjacent the innermost of the outwardly transferred stitches.

It is of course necessary that the longitudinal-transfer point 88 be held in alinement with the points 85 as the narrowing frame dips to apply the transferred stitches to the needles. This is accomplished by so shaping the trailing portion of the lobe on the cam 114 that the rod 108 will move downwardly with the narrowing frame and thus not disturb the shaft 100.

Like the cam 114, the cam 80 must be designed with regard to movements of the narrowing frame—that is, it should be so shaped as to cause the pawl 71 to follow movements of the narrowing frame except as may be necessary to produce rotation of the narrowing spindle 54 at the time when outward transfer is to be effected.

The travel of the thread carriers 39 is coordinated with the outward transfer of stitches. As it is inconvenient to increase thread-carrier travel by a distance of one needle only, the traverse of the thread carriers, instead of being increased one needle for each alternate course, is increased for two needles every fourth course. Means for increasing in increments the travel of the reinforcing-thread carriers are a feature of the standard Schubert & Salzer model HSL machine; and many of such machines have been modified by extending that expedient to the control of the main-thread carriers. I accordingly deem it unnecessary to describe in detail the means by which the extent of thread-carrier travel is controlled. Desirably, as in a conventional narrowing operation, the thread carriers and their associated stops are moved simultaneously with the lateral movement of the transfer points.

It will be noted from Fig. 10 that the innermost transferred stitch 130*a* embraces both the longitudinal transfer point 88 and the innermost of the lateral transfer points 85 at the conclusion of the transferring operation. As a result, this stitch will be placed around two needles before the next course is knit. This fact, however, will not result in the starting of a run or ladder, because the stitch 131 will be around only one of the needles to which the stitch 130*a* is applied and its outer stretch will separate the two loops of the next-knit course.

If desired, the screw 95 may be adjusted to reduce the extent to which the longitudinal transfer point 88 swings across in front of the innermost point 85, and the transfer point 88 can thereby be caused to enter the fabric between the threads of the stitches 130*a* and 131 at the point marked Y in Fig. 9. If this is done, only the stitch 131 will embrace the transfer point 88, and the innermost transferred stitch 130*a* will embrace only the innermost lateral transfer point 85. I prefer, however, to introduce the point 88 into the center of the stitch 131 as shown in Fig. 9 and thereby to cause the stitch 130*a* to embrace two transfer points.

It sometimes happens, especially if not enough longitudinal tension is being applied to the fabric, that the longitudinal transfer point 88, instead of entering the stitch 131 immediately ahead of the stitch 130*a*, will enter the stitch 132 immediately ahead of the stitch 131. If this occurs, not only the stitches 130*a* and 131, but also the stitch 132, will embrace the transfer point 88 when it reaches the lower limit of its movement. This, however, will not be objectionable.

Knitting of the blank in the manner above indicated, with the cam shaft 40 being shogged at every other course to effect an outward transfer of stitches in marginal wales, continues from course A—A to course B—B. At course B—B, the clamps 63 are loosened and the slides 61 and 62 rotated about their respective axes to bring the auxiliary narrowing fingers 64 into inoperative position, and the mechanism which has been operating between courses A—A and B—B to produce increased travel of the thread carriers is thrown out of operation, conveniently under control of the pattern chain. The pin 76, however, remains advanced and the pawl 57 remains disengaged from the ratchet 55. As a result, when the cam shaft is shogged at the conclusion of the knitting of every other course, each set of main transfer points 85 transfers outwardly of the blank the stitches in a group of wales spaced inwardly from the adjacent blank-margin. The roller 113 remains in association with the cam 114, so that the longitudinal-transfer points 88 will be depressed at every transfer operation. The machine operates in this manner until course C—C is reached, at which point plain knitting may be resumed through course D—D.

During the knitting of the blank between courses C—C and D—D, the pin 76 may be retracted, the pawl 57 reengaged with the ratchet 55, the lever 115 operated to move the roller 113 out of association with the cam 114, and the transfer points 85 adjusted laterally of the machine in position to begin the inward transfer of stitches in marginal wales which, with concomitant narrowing, characterizes that portion of the blank lying between the courses D—D and E—E. As previously pointed out, the longitudinal-transfer point 88 remains above the fabric during narrowing operations, because the roller 113 is out of association with the cam 114.

As will be apparent, the number of main transfer points 85 on each narrowing finger 86 will correspond to the number of wales in which stitches are transferred outwardly between courses B—B and C—C. The number of auxiliary transfer points 64′ on each of the auxiliary fingers 64 should be at least sufficient to extend from the outermost main transfer point 85 to the margin of the blank. Any auxiliary transfer points 64′ which lie beyond the margin of the blank cause no disadvantage, as no stitches are formed on the needles with which they co-operate.

In accordance with established practice, the lower ends of the main and auxiliary transfer points 85 and 64′ are bent slightly in a forward direction. Such a bending is not desirable, however, in the case of the longitudinal-transfer point 88, and I therefore prefer to make this point substantially straight as indicated in the drawings.

I claim as my invention:

1. In a flat knitting machine for knitting flat

hosiery blanks, a narrowing frame, means for moving said narrowing frame, a pair of narrowing slides mounted in said narrowing frame, narrowing fingers carried respectively by said slides, each of said narrowing fingers being provided with a series of main transfer points, mechanism operating in timed relation with said frame-moving means for shifting said narrowing slides outwardly to increase the distance between said fingers, a longitudinal transfer point associated with each of said fingers and normally disposed above said main transfer points, and means operative as said narrowing slides move outwardly to cause said longitudinal transfer point to move downwardly through fabric supported on said main transfer points in front of the innermost thereof, to enter a stitch immediately in front of the stitch carried by such innermost main transfer point, and thence to move inwardly and rearwardly to a position in line with said main transfer points and adjacent the innermost thereof.

2. In a flat knitting machine for knitting flat hosiery blanks, a narrowing frame, means for moving said narrowing frame, a pair of narrowing slides mounted in said narrowing frame, narrowing fingers carried respectively by said slides, each of said narrowing fingers being provided with a series of main transfer points, mechanism operating in timed relation with said frame-moving means for shifting said narrowing slides outwardly to increase the distance between said fingers, a longitudinal transfer point associated with each of said fingers and normally disposed above said main transfer points, and means operative to cause said longitudinal transfer point to move downwardly through fabric supported on said main transfer points in front of the innermost thereof, to enter a stitch immediately in front of the stitch carried by such innermost main transfer point, and thence to move inwardly and rearwardly to a position in line with said main transfer points and adjacent the innermost thereof.

3. In a flat knitting machine for knitting flat hosiery blanks, a narrowing frame, means for moving said narrowing frame, a pair of narrowing slides mounted in said narrowing frame, narrowing fingers carried respectively by said slides, each of said narrowing fingers being provided with a series of main transfer points, mechanism operating in timed relation with said frame-moving means for shifting said narrowing slides outwardly to increase the distance between said fingers, a longitudinal transfer point associated with each of said fingers and normally disposed above said main transfer points, and means operative to cause said longitudinal transfer point to move downwardly through fabric supported on said main transfer points in front of the innermost thereof, to enter a stitch in front of the stitch carried by such innermost main transfer point, and thence to move inwardly and rearwardly to a position in line with said main transfer points and adjacent the innermost thereof.

4. In a flat knitting machine for knitting flat hosiery blanks, a narrowing frame, means for moving said narrowing frame, a pair of narrowing slides mounted in said narrowing frame, narrowing fingers carried respectively by said slides, each of said narrowing fingers being provided with a series of main transfer points, mechanism operating in timed relation with said frame-moving means for shifting said narrowing slides outwardly to increase the distance between said fingers, a member supported for generally vertical sliding movement from each of said fingers and adjacent the inner side thereof, a longitudinal transfer point carried by said member, spring means acting upwardly on said member to hold said longitudinal transfer point above said main transfer points, means operative as said narrowing slides moved outwardly to depress said member relative to the associated finger, and means for guiding said member as it is depressed to cause said longitudinal transfer point to move downwardly through fabric supported on said main transfer points in front of the innermost thereof, to enter a stitch immediately in front of the stitch carried by such innermost main transfer point, and thence to move inwardly and rearwardly to a position in line with said main transfer points and adjacent the innermost thereof.

5. In a flat knitting machine for knitting flat hosiery blanks, a narrowing frame, means for moving said narrowing frame, a pair of narrowing slides mounted in said narrowing frame, narrowing fingers carried respectively by said slides, each of said narrowing fingers being provided with a series of main transfer points, mechanism operating in timed relation with said frame-moving means for shifting said narrowing slides outwardly to increase the distance between said fingers, a member supported for generally vertical sliding movement from each of said fingers and adjacent the inner side thereof, a longitudinal transfer point carried by said member, spring means acting upwardly on said member to hold said longitudinal transfer point above said main transfer points, means operative to depress said member relative to the associated finger, and means for guiding said member as it is depressed to cause said longitudinal transfer point to move downwardly through fabric supported on said main transfer points in front of the innermost thereof, to enter a stitch immediately in front of the stitch carried by such innermost main transfer point, and thence to move inwardly and rearwardly to a position in line with said main transfer points and adjacent the innermost thereof.

6. In a flat knitting machine for knitting flat hosiery blanks, a narrowing frame, means for moving said narrowing frame, a pair of narrowing slides mounted in said narrowing frame, narrowing fingers carried respectively by said slides, each of said narrowing fingers being provided with a series of main transfer points, mechanism operating in timed relation with said frame-moving means for shifting said narrowing slides outwardly to increase the distance between said fingers, a member supported for generally vertical sliding movement from each of said fingers and adjacent the inner side thereof, a longitudinal transfer point carried by said member, spring means acting upwardly on said member to hold said longitudinal transfer point above said main transfer points, means operative to depress said member relative to the associated finger, and means for guiding said member as it is depressed to cause said longitudinal transfer point to move downwardly through fabric supported on said main transfer points in front of the innermost thereof, to enter a stitch in front of the stitch carried by such innermost main transfer point, and thence to move inwardly and rearwardly to a position in line with said main transfer points and adjacent the innermost thereof.

7. The invention set forth in claim 6 with the

addition that said member-guiding means is adjustable to vary laterally of the hosiery blank the point at which said longitudinal transfer point pierces the fabric.

8. The invention set forth in claim 6 with the addition that said member-depressing means comprises a shaft mounted in and extending longitudinally of said narrowing frame, said shaft being provided above each of said members with an outwardly projecting plate, and mechanism operative in timed relation with said slide-shifting mechanism for rocking said shaft to cause said plates to depress said members.

9. In a flat knitting machine for knitting flat hosiery blanks, a row of needles upon which courses of stitches are successively formed, lateral transfer mechanism including a series of transfer points disposed in a plane parallel to said row of needles for transferring a plurality of stitches at each end of a course outwardly from the needles upon which they were respectively formed to adjacent needles, and longitudinal transfer mechanism including independent transfer points relatively movable with respect to said series of points in a path intersecting the plane of said series of points for transferring to needles which would otherwise be left vacant by such outward transfer stitches from the immediately adjacent previously-knit course.

10. In a flat knitting machine for knitting flat hosiery blanks, a row of needles upon which courses of stitches are successively formed, lateral transfer mechanism including a series of transfer points disposed in a plane parallel to said row of needles for transferring a plurality of stitches at each end of a course outwardly from the needles upon which they were respectively formed to adjacent needles, and longitudinal transfer mechanism including independent transfer points relatively movable with respect to said series of points in a path intersecting the plane of said series of points for transferring to needles which would otherwise be left vacant by such outward transfer stitches from a previously-knit course.

11. In a flat knitting machine for knitting flat hosiery blanks, a row of needles upon which courses of stitches are successively formed, lateral transfer mechanism including a series of transfer points disposed in a plane parallel to said row of needles for transferring stitches in each of certain courses outwardly from the needles upon which they were respectively formed to adjacent needles, and longitudinal transfer mechanism including independent transfer points relatively movable with respect to said series of points in a path intersecting the plane of said series of points for transferring to needles which would otherwise be left vacant by such outward transfer stitches from a previously-knit course.

12. The invention set forth in claim 11, with the addition that the respective stitch-transferring operations of the relatively movable points of said two transfer mechanisms occur simultaneously.

13. The invention set forth in claim 10 with the addition that said lateral transfer mechanism includes a set of main transfer points and a set of auxiliary transfer points at each edge of the blank, each set of main points being located inwardly of the margin of the blank, with each set of auxiliary points when in operative position extending outwardly from the outermost of the associated main points at least to the margin of the blank and being movable from operative position to an inoperative position, and with the points of the longitudinal transfer mechanism permanently associated with the points of said main sets and movable between positions in front of the plane of said main sets and positions in said plane laterally adjacent the innermost points of said main sets.

14. In a flat knitting machine for knitting flat hosiery blanks, a row of needles upon which courses of stitches are successively formed, a main frame, a narrowing frame movably mounted thereon, and lateral transfer mechanism for transferring a plurality of stitches at each end of a course outwardly from the needles upon which they were respectively formed to adjacent needles, said lateral transfer mechanism including narrowing slides slidably mounted in said narrowing frame, narrowing fingers respectively carried by said slides, a narrowing spindle rotatably mounted in said narrowing frame and having threaded portions of opposite hand, nuts on said threaded portions, said slides being operatively connected to said nuts respectively, a ratchet on said spindle, an arm pivotally mounted on said main frame, a pawl slidably mounted in said arm in position to engage and rotate said ratchet, yielding means acting on said arm to hold said pawl in operatve association with said ratchet, and means for reciprocating said pawl in said arm in timed relation with movements of said narrowing frame.

15. In a process for forming a flat-knit hosiery blank, the steps of knitting successive courses of stitches, interrupting the knitting at the completion of the formation of an intermediate course of stitches, removing a group of adjacent stitches at each end of said intermediate course from the needles upon which they were respectively formed for transferring them outwardly of the blank onto respectively adjacent needles, picking up stitches from previously knit courses for transference longitudinally of the blank onto the needles from which the innermost of said outwardly transferring stitches were removed, aligning the longitudinally transferred stitches with the laterally transferred stitches, simultaneously applying all outwardly and longitudinally transferred stitches to needles, and resuming knitting.

16. The invention set forth in claim 15 with the addition that in effecting the longitudinal transfer and before the laterally transferred stitches are applied to needles each innermost of the outwardly transferred stitches is caught with the stitch being longitudinally transferred and distorted inwardly for application to the needle upon which it was originally formed simultaneously with the application of the longitudinally transferred stitch to said needle.

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