April 5, 1932. E. O. NEBEL 1,852,936

METHOD AND APPARATUS FOR PRODUCING FANCY KNIT FABRIC

Filed May 11, 1931 5 Sheets-Sheet 1

Fig. 1.

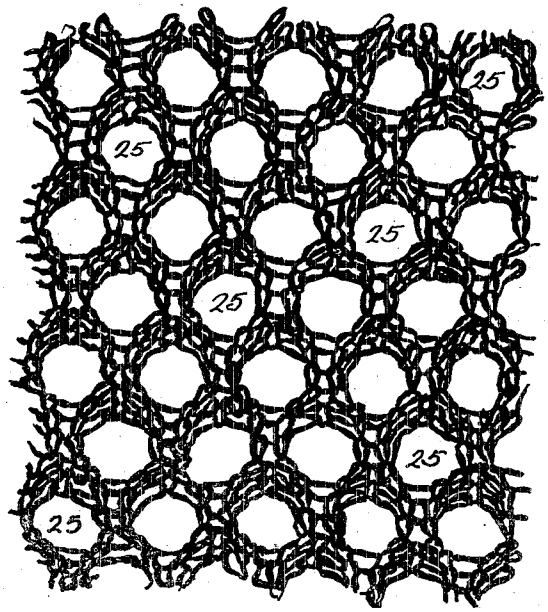
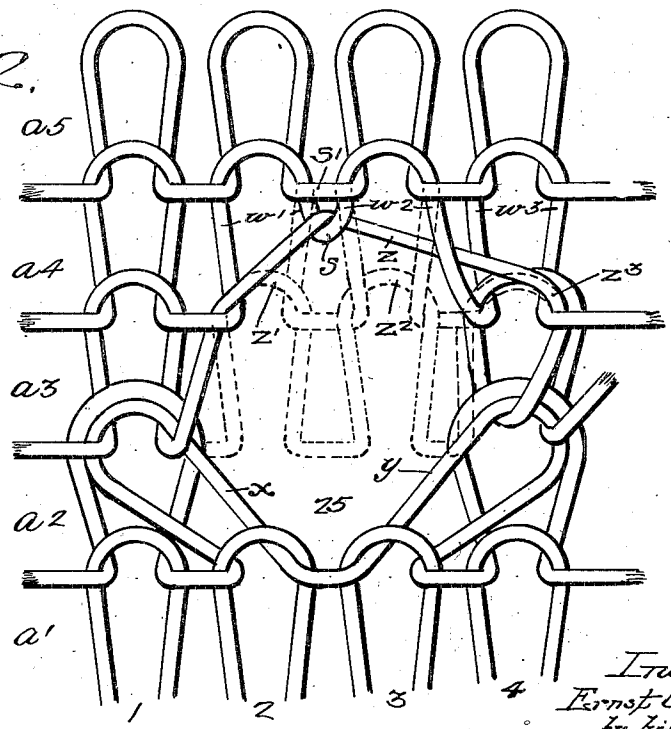


Fig. 2.



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Filed May 11, 1931 5 Sheets-Sheet 2

Fig. 3.

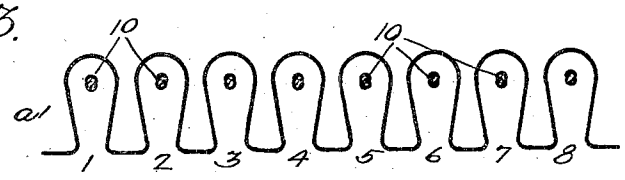


Fig. 4.

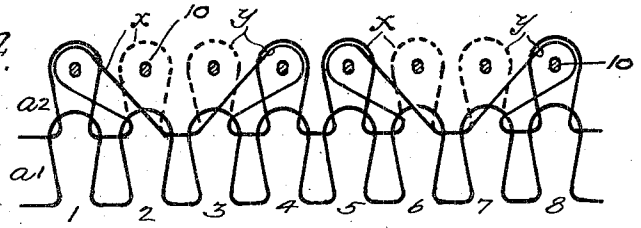


Fig. 5.

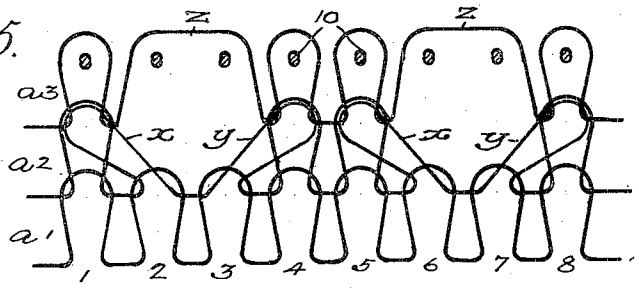
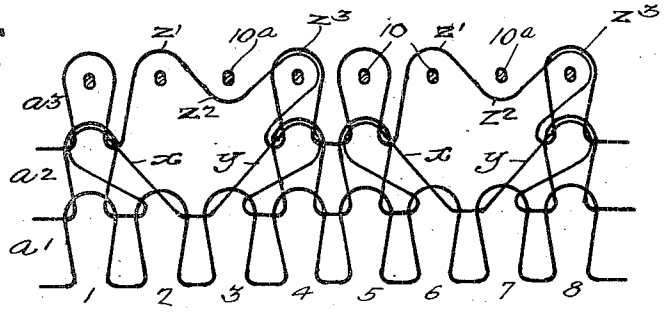


Fig. 6.



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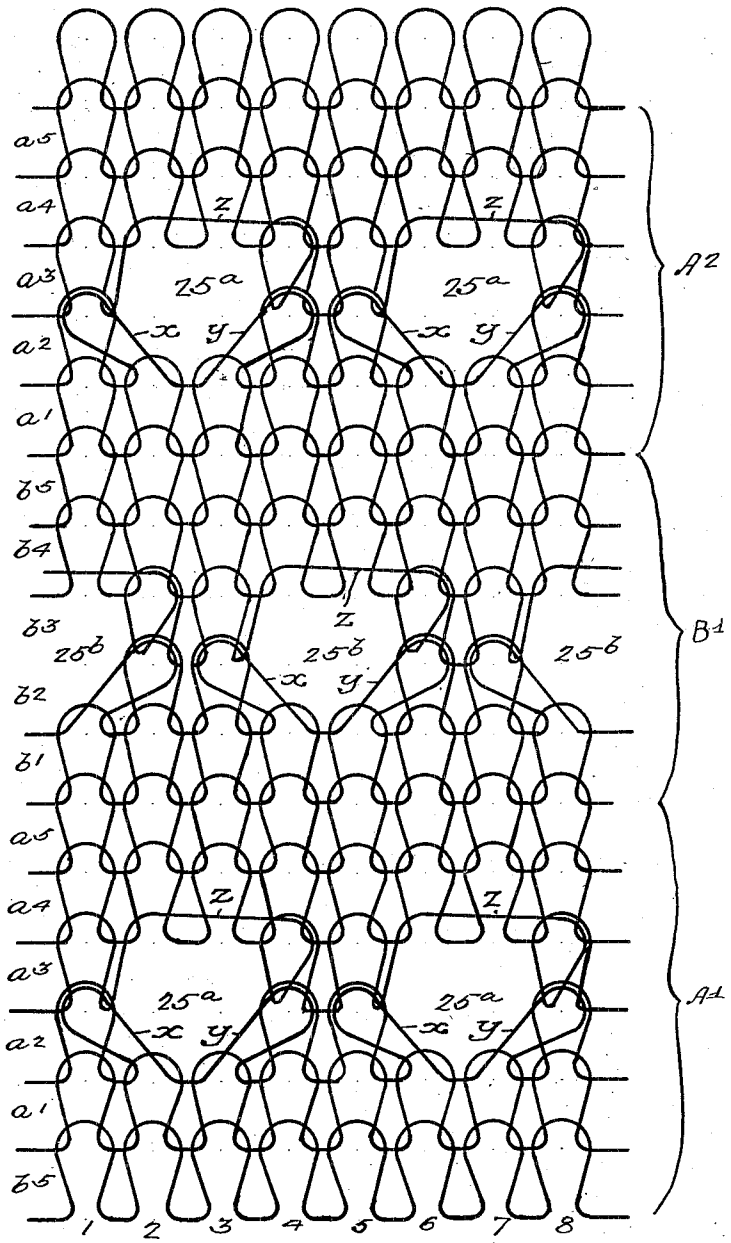
METHOD AND APPARATUS FOR PRODUCING FANCY KNIT FABRIC

Filed May 11, 1931 5 Sheets-Sheet 3

Fig. 9.



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METHOD AND APPARATUS FOR PRODUCING FANCY KNIT FABRIC

Filed May 11, 1931 5 Sheets-Sheet 4

Fig. 7.

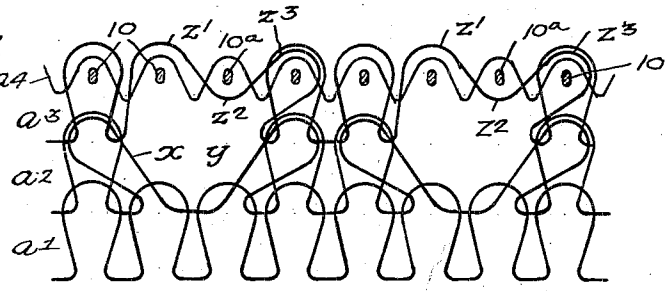


Fig. 8.

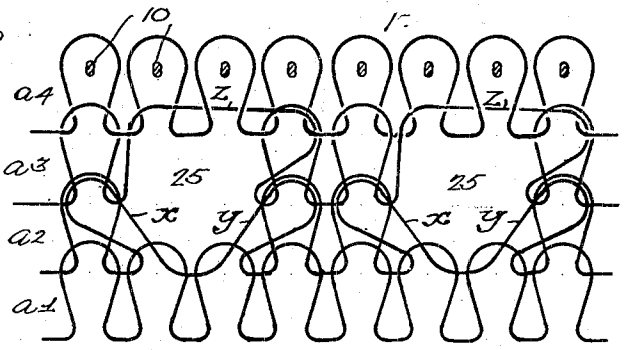
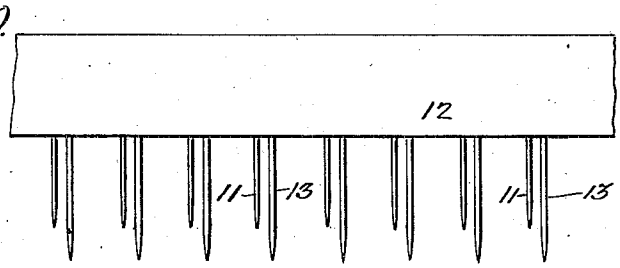


Fig. 10.



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Filed May 11, 1931 5 Sheets-Sheet 5

Fig. 11.

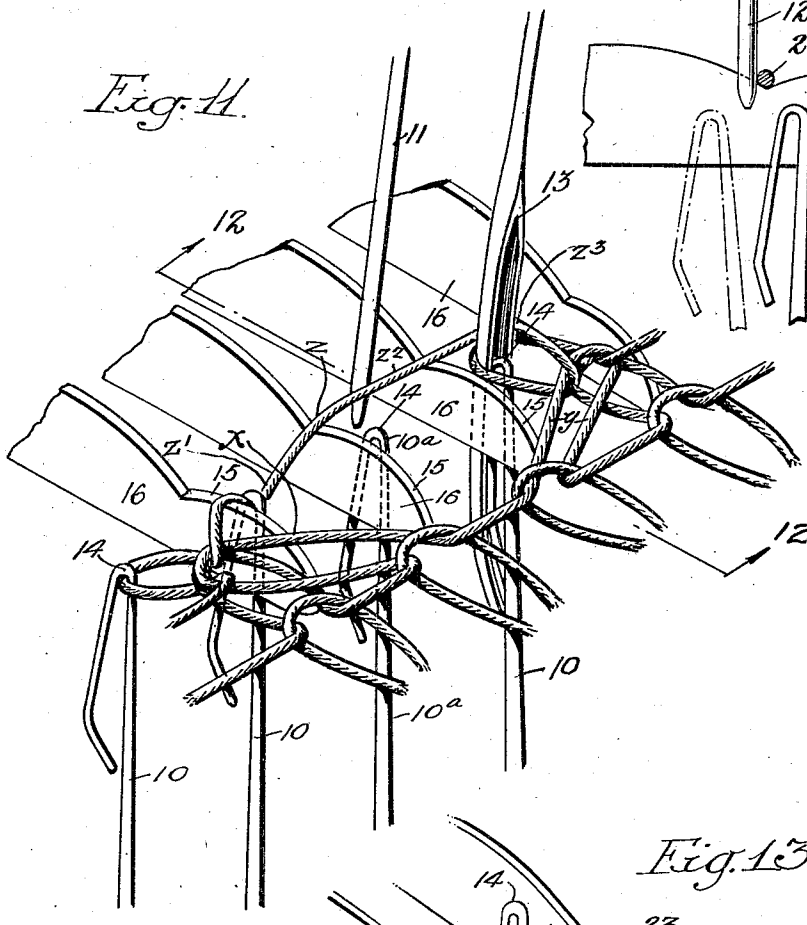


Fig. 12.

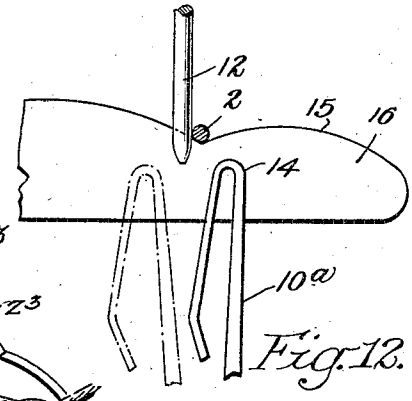
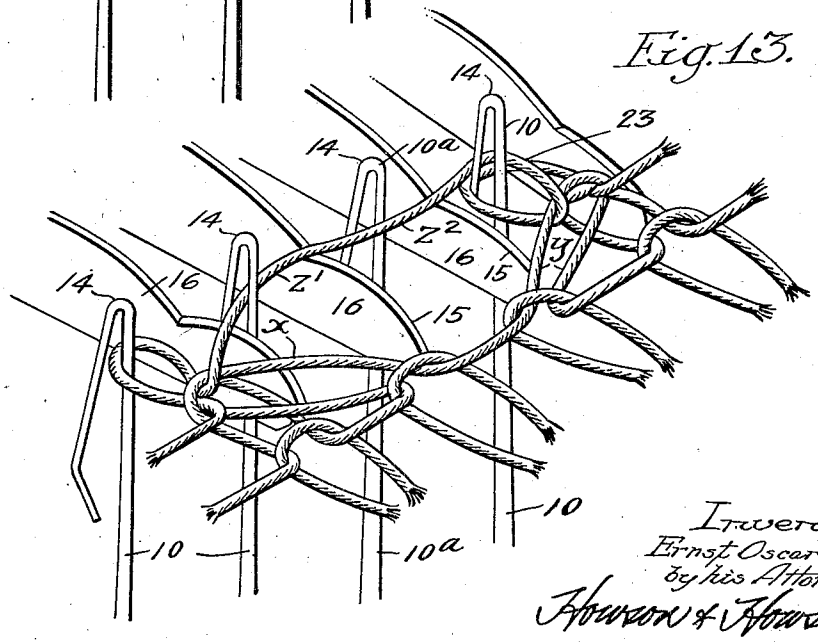


Fig. 13.



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR PRODUCING FANCY KNIT FABRIC

Application filed May 11, 1931. Serial No. 536,585.

This invention relates to a method and an apparatus for producing fancy knitted fabric, and particularly to the production of openwork or lace effects in hosiery, known to the art as "net" hose.

The principal object of the invention is to produce net hose having substantially circular openings devoid of all undesirable floating threads crossing the openings, which detract from the appearance of the fabric and which are apt to catch on protruding objects and become broken, thereby destroying the stockings for future dress wear.

One feature of the invention resides in the use of an ordinary stitch transfer bar, equipped with thread-holding elements disposed adjacent relatively spaced regular transfer points respectively for preventing the formation of floats across the openings in the fabric.

Another feature of the invention resides in the method of knitting the fabric which involves the use of the thread-holding elements at a particular stage in each knitting cycle, embracing a plurality of successively knit courses, throughout the production of the fabric.

Other objects, features, advantages, a description of the method, and the construction and operation of the elements involved will be fully disclosed hereinafter, reference being had to the accompanying drawings, of which:

Fig. 1 is an enlarged plan view of a piece of fabric under tension between the needles and the take-up rolls of a conventional type of full-fashioned flat hosiery knitting machine;

Fig. 2 is a stitch diagram of a portion of the fabric surrounding one of the openings in the fabric as shown in Fig. 1;

Figs. 3 to 9 inclusive illustrate course-by-course knitting of a plurality of courses constituting a complete knitting cycle in producing one row of openings in the fabric shown in Figs. 1 and 2, Fig. 9 illustrating three successive cycles in producing the staggered relationship of the openings in alternate rows thereof;

Fig. 10 diagrammatically illustrates a face view of the transfer bar of the knitting machine, such as is used in the production of "Picot" edges on ordinary full-fashioned turned welt hosiery, but modified in accordance with the principles of this invention;

Fig. 11 is a diagrammatic perspective view of a number of the knocking-over bits and needles of the knitting machine and showing one of the transfer points and an adjacently positioned holding element in one phase of the knitting operation;

Fig. 12 is a sectional elevation taken on the line 12—12, Fig. 11; and

Fig. 13 is a view similar to Fig. 11, but showing the needles partly raised and the transfer point and holding element removed.

As shown in Fig. 3, a course of stitches a^1 is shown as having been formed on the needles 10 of an ordinary full-fashioned hosiery knitting machine, the course of stitches constituting the beginning of wales 1 to 8 inclusive. In Fig. 4, a second course of stitches a^2 is shown as having been knit onto the stitches of course a^1 respectively.

Every fourth stitch x in the second course a^2, for example the stitches of wales 2, 6, etc., are then transferred from the needles on which they were formed onto the needles next adjacent thereto, in a direction to the left, a distance of but one needle.

The adjacently disposed stitches y, lying to the right of the stitches x, are then transferred one needle to the right, for example from wales 3, 7, etc., to wales 4, 8, etc., respectively, as clearly shown in Fig. 4.

A third course of stitches a^3 is then knit onto the stitches of course a^2, as shown in Fig. 5, and due to the transfer of the stitches x and y, as above noted, a long loop z is formed around the two needles, in each case, from which the stitches x and y had been transferred.

The next step involves the use of the holding elements or pins 11 which are secured in the transfer bar 12, see Fig. 10, immediately adjacent the transfer points 13, which in order to transfer the stitches x and y, as above noted, are spaced apart the distance of four needles, the elements 11 being spaced from the transfer points 13 the distance of one needle, to the left, in the present instance.

The elements 11, as shown in Figs. 10, 11 and 13, are relatively shorter than the transfer points for reasons that will be obvious as the description of the process progresses.

The sides of the long loops z, z, which are aligned with the wales 3, 7, etc., are then transferred to the right the distance of one needle, or onto the needles forming the stitches of wales 4, 8, etc., respectively, as shown in Figs. 6 and 11.

During this transfer of the long loops z, z, the needles 10, as usual in transferring stitches, descend until their upper ends 14 lie below the upper edges 15 of the knocking-over bits 16, as shown in Figs. 11 and 12. The transfer points 13, in transferring the stitches, move downwardly between the bits into contact with and overlapping the needles as shown in Fig. 11. At the same time the holding elements 11, being shorter than the transfer points 13, but moving downwardly with the transfer points, enter into the spaces between the knocking-over bits, immediately along side of the spaces entered by the transfer points 13. The holding elements 11, as shown in Figs. 11 and 12, lie behind the thread of the long loops z, or at the opposite side of the thread from that on which the transfer points 13 lie.

In making the transfer from the points 13 to the needles 10, the needles are pressed rearwardly or the transfer bar may be moved forwardly as desired, to effect firm contact between the transfer points and the needles. In so doing all the needles, except the needles 10^a from which the long loops z have been transferred, are flexed slightly, but the needles 10^a in not being restrained by loops or transfer points, remain straight, and as the needles and transfer points are relatively moved toward each other in obtaining firm contact therebetween the free needles 10^a move from the full line position, Fig. 12, to the broken line position shown in said figure, which brings the upper ends 14 of the needles 10^a into position behind the thread of the long loops z, or at the same side of the thread as that occupied by the holding elements 11 which remain stationary and hold the thread z from moving rearwardly such as may be caused by the needles lying at the opposite sides of the needles 10^a being pressed rearwardly and pulling the thread with them should a flexure of the transfer points 13 occur.

The needles and transfer points are then raised, the sinkers (not shown) moving out in the usual manner over the stitches and long loops resting on top of the knocking-over bits 16. The needles continue to rise and in so doing the needles 10^a come up behind the long loops z, as shown in Fig. 13, the transfer points 13 and holding elements 11 continuing to rise after the needles are brought to rest, thereby effecting the transfer of the stitches from the transfer points 13 to the respectively aligned needles 10, leaving the stitches of course a^3 disposed as shown in Figs. 6, 11 and 13.

Looping of the thread of the long loops z around and to the fronts of the needles 10^a breaks up each of these long loops into three small loops z^1, z^2 and z^3, as shown in Fig. 6, thereby preparing for the formation of regular stitches on all needles in the next course to be formed.

Fig. 7 illustrates a thread sunk around all the needles 10 and 10^a for the formation of the next successive course a^4, and Fig. 8 shows the course a^4 as having been completed, thereby completing the formation of one horizontally aligned row of openings 25 in the fabric.

Another course of stitches a^5 is then knit onto the course a^4, as shown at the bottom of Fig. 9, thus completing one knitting cycle in the production of the fabric shown in Fig. 1.

In Fig. 9, three complete knitting cycles are shown at A^1, B^1 and A^2, respectively, the opening 25^a, 25^a formed by the cycles A^1 and A^2, respectively, being vertically aligned, while the openings 25^b formed by the cycle B^1 are positioned in staggered relation to those of the cycles A^1 and A^2.

The staggering of the openings in the cycle B^1 is effected by merely moving the transfer bar 12 to the right, for example, until the transfer points 13 thereof are brought into alignment with the needles on which the stitches of wales 4 have been formed, after which the formation of the courses b^1, b^2, b^3, b^4 and b^5, of the cycle B^1 are carried out in precisely the same manner as above described relative to the formation of the courses a^1, a^2, a^3, a^4 and a^5, respectively, of cycle A^1.

The dividing of the long loop z into three small loops z^1, z^2 and z^3, as shown in Fig. 6, throws the center small loops z^2 in front of the needle 10^a while the loops z^1 and z^3 remain in normal position behind the needles next adjacent to and on opposite sides respectively of the needle 10^a, consequently when the stitches w^1, w^2 and w^3 of the course a^4 are pulled through the loops z^1, z^2 and z^3 respectively of course a^3, the stitches w^1 and w^3 will pass normally down through the loops z^1 and z^3 respectively while the center stitch w^2 will pass upwardly through the center loop z^2, as shown in dotted lines in Fig. 2.

Due to the tension of the knitting thread and the tension under which the fabric is normally held between the needles and take-up rolls of the machine the loops z^1, z^2 and z^3 instead of remaining full and lying in the positions shown in dotted lines in Fig. 2 will be drawn out again into one single long loop z as shown in full lines in Fig. 2, and the sinker loop s between the stitches w^1 and w^2 will be foreshortened and thereby take up

the slack in the thread of the long loop z, thus instead of the long loop z appearing as a float across the opening 25 it will be pulled up close to the sinker loop s^1 of course c^5, thus adding to the symmetry of the hole 25.

The staggering of the openings 25 throughout the fabric and the tension under which the fabric is produced causes the courses of stitches throughout the fabric to give and take and thereby become distorted to assume the appearance illustrated in Fig. 1, wherein the holes 25 become substantially circular in form.

While the sequence of operations has been specific as to the direction and order of the transfer of the stitches x and y and the long loop z has been described as being transferred to the right, obviously this order may be varied to suit the wishes of the operator, for example the long loop z may be transferred to the left and at such time the thread-holding element will be positioned to the right of the transfer point in accordance therewith.

Obviously, the holding elements may be carried by an element independent of the transfer bar and brought into the described relationship with respect to the transfer points at the desired moment without departing from the essential feature of the invention, which resides principally in the holding of the thread of the long loop z so that the needle 10^a will come up behind this thread instead of in front of the thread as would normally occur if such a holding element were not provided; or the holding element 11 may be given a slight forward movement with respect to the transfer point to carry the thread z forward of the needle 10^a if desired; however, the preferred and most simple form of the invention has been illustrated and described above as being the more desirable due to its relative simplicity.

I claim:

1. The process of forming an opening in a knitted fabric during the knitting thereof, said process comprising the formation of stitches of a course on a plurality of needles respectively, transferring a pair of adjacent stitches of said course in opposite directions respectively onto needles adjacent those on which the said transferred stitches were formed, knitting a second course of stitches onto the stitches of the first said course, whereby a long loop is formed across the needles from which said transferred stitches were taken, transferring one side of said long loop to an adjacent needle to increase the length of the loop, transposing the central part of said long loop from the back side of a needle intermediate the ends of the elongated loop across which the said elongated loop passes to the front side of said needle, and knitting a third course of stitches onto said second course thereof.

2. The process of forming an opening in a knitted fabric during the knitting thereof, said process comprising the formation of stitches of a course on a plurality of needles respectively, transferring a pair of adjacent stitches of said course in opposite directions respectively onto needles adjacent those on which the said transferred stitches were formed, knitting a second course of stitches onto the stitches of the first said course, whereby a long loop is formed across the needles from which said transferred stitches were taken, transferring one side of said long loop to an adjacent needle to increase the length of the loop, transposing the central part of said long loop from the back side of a needle intermediate the ends of the elongated loop across which the said elongated loop passes to the front side of said needle, whereby single stitches are started on each of the needles previously included in the elongated loop, and knitting a third course of stitches onto the full complement of needles to complete the opening in the fabric and thereby draw the said long loop to and tie said long loop in at one side of the opening.

3. The process of forming an opening in a knitted fabric during the knitting thereof, said process comprising the formation of stitches of a course on a plurality of needles respectively, transferring a pair of adjacent stitches of said course in opposite directions respectively onto needles adjacent those on which the said transferred stitches were formed, knitting a second course of stitches onto the stitches of the first said course, whereby a long loop is formed across the needles from which said transferred stitches were taken, transferring one side of said long loop to an adjacent needle to increase the length of the loop, transposing the central part of said long loop from the back side of a needle intermediate the ends of the elongated loop across which the said elongated loop passes to the front side of said needle, whereby single stitches are started on each of the needles previously included in the elongated loop, knitting a third course of stitches onto the full complement of needles to complete the opening in the fabric and thereby draw the said long loop to and tie said long loop in at one side of the opening, knitting a predetermined number of additional courses on said full complement of needles, and then repeating the said transfer operations of the next series of successive courses to form a second opening in line with the first said opening walewise of the fabric.

4. The process of forming openwork in knitted fabric comprising the formation of stitches of a course on a plurality of needles respectively, transferring at relatively spaced intervals across said course adjacent pairs of stitches in opposite directions respectively onto needles adjacent those on which said pairs of stitches were formed, knitting a sec-

ond course of stitches onto the stitches of the first said course, whereby a long loop is formed across each of the said pairs of needles from which said transferred stitches were taken, transferring one side of each of said long loops to an adjacent needle to increase the lengths of the long loops respectively, transposing the central portion of each of the said elongated loops from the back side of a needle intermediate the ends of the loop across which the loop passes to the front side of said needle, whereby single stitches are started on each of the needles from which the said transfers have been made, and knitting a third course of stitches on the full complement of needles to complete a series of openings in the fabric in a line coursewise of the fabric.

5. The process of forming openwork in knitted fabric comprising the formation of stitches of a course on a plurality of needles respectively, transferring at relatively spaced intervals across said course adjacent pairs of stitches in opposite directions respectively onto needles adjacent those on which said pairs of stitches were formed, knitting a second course of stitches onto the stitches of the first said course, whereby a long loop is formed across each of the said pairs of needles from which said transferred stitches were taken, transferring one side of each of said long loops to an adjacent needle to increase the lengths of the long loops respectively, transposing the central portion of each of the said elongated loops from the back side of a needle intermediate the ends of the loop across which the loop passes to the front side of said needle, whereby single stitches are started on each of the needles from which the said transfers have been made, knitting a third course of stitches on the full complement of needles to complete a series of openings in the fabric in a line coursewise of the fabric, knitting a predetermined number of courses onto the said third course, repeating the transferring and transposing operations during the knitting of the next three courses with the transferring of adjacent pairs of stitches being performed at needles lying intermediate those at which the first said transfers were made, whereby a second series of openings is formed on a line coursewise of the fabric and spaced coursewise and walewise with respect to the openings of the first series thereof.

6. The process of forming openwork in knitted fabric comprising the formation of stitches of a course on a plurality of needles respectively, transferring at relatively spaced intervals across said course adjacent pairs of stitches in opposite directions respectively onto needles adjacent those on which said pairs of stitches were formed, knitting a second course of stitches onto the stitches of the first said course, whereby a long loop is formed across each of the said pairs of needles from which said transferred stitches were taken, transferring one side of each of said long loops to an adjacent needle to increase the lengths of the long loops respectively, transposing the central portion of each of the said elongated loops from the back side of a needle intermediate the ends of the loop across which the loop passes to the front side of said needle, whereby single stitches are started on each of the needles from which the said transfers have been made, knitting a third course of stitches on the full complement of needles to complete a series of openings in the fabric in a line coursewise of the fabric, knitting a predetermined number of courses onto the said third course, repeating the transferring and transposing operations during the knitting of the next three courses with the transferring of adjacent pairs of stitches being performed at needles lying intermediate those at which the first said transfers were made, whereby a second series of openings is formed on a line coursewise of the fabric and spaced coursewise and walewise with respect to the openings of the first series thereof, said operations being effected on the same needles as the corresponding operations during the formation of the first said series of openings to form a third series of openings in line walewise of the fabric with the first said series of openings, forming a fourth series of openings in line walewise of the fabric with the second said series of openings, and continuing the formation of openings alternately in line with the first and second series of openings walewise of and throughout the knitting of the fabric.

7. The combination with the needles of a flat knitting machine on which a long stitch loop has been formed across a plurality of adjacent needles, of a transfer point adapted to transfer one end of the said long loop from the needle around which the said end passes to a needle adjacent thereto to increase the number of needles included in the long loop, and means adjacent the transfer point for transposing a portion of said long loop from a position behind to a position in front of one of the needles across which the long loop passes, for starting single stitches on the needles previously included in the said long loop.

8. The combination with the knocking-over bits and the needles of a flat knitting machine on which a long stitch loop has been formed across a plurality of adjacent needles, of a transfer point adapted to transfer one end of the long loop from the needle around which the said end passes to a needle

adjacent thereto to increase the number of needles included in the long loop, and means co-operating with the said knocking-over bits to hold a portion of the long loop in a relatively fixed position during the said transfer operation, to permit one of the needles included in said long loop to descend at one side of the held portion of the loop and to rise at the opposite side of the said portion of the long loop during the said transfer operation, to start single stitches on the needles previously included in the long loop.

9. The combination with the knocking-over bits and needles of a flat knitting machine, a plurality of transfer points adapted to co-operate with predetermined and relatively spaced needles, and a plurality of stitch-holding elements disposed adjacent the said transfer points respectively and co-operating with the knocking-over bits for holding portions of the transferred stitches in relatively fixed position during the transfer operation.

10. The combination with the knocking-over bits and needles of a flat knitting machine, of a transfer bar, a plurality of transfer points carried in spaced relation on said bar for transferring stitches from predetermined and relatively spaced needles, and a plurality of holding elements carried by said transfer bar and positioned adjacent the said transfer points respectively and co-operating with said knocking-over bits to hold portions of the transferred stitches in relatively fixed positions during the transfer operation.

11. The combination with the knocking-over bits and needles of a flat knitting machine, of a transfer bar, a plurality of transfer points carried in spaced relation on said bar for transferring stitches from predetermined and relatively spaced needles, and a plurality of holding elements carried by said transfer bar and positioned adjacent the said transfer points respectively and co-operating with said knocking-over bits to hold portions of the transferred stitches in relatively fixed positions during the transfer operation, said holding elements being of a shorter length than said transfer points to protrude a lesser distance below the top edges of said bits than do said transfer points during said transfer operation.

12. In a flat knitting machine, the combination of a transfer bar, a plurality of transfer points carried in spaced relation on said bar, and a plurality of relatively short holding elements disposed on the bar adjacent the transfer points respectively, as and for the purposes set forth.

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