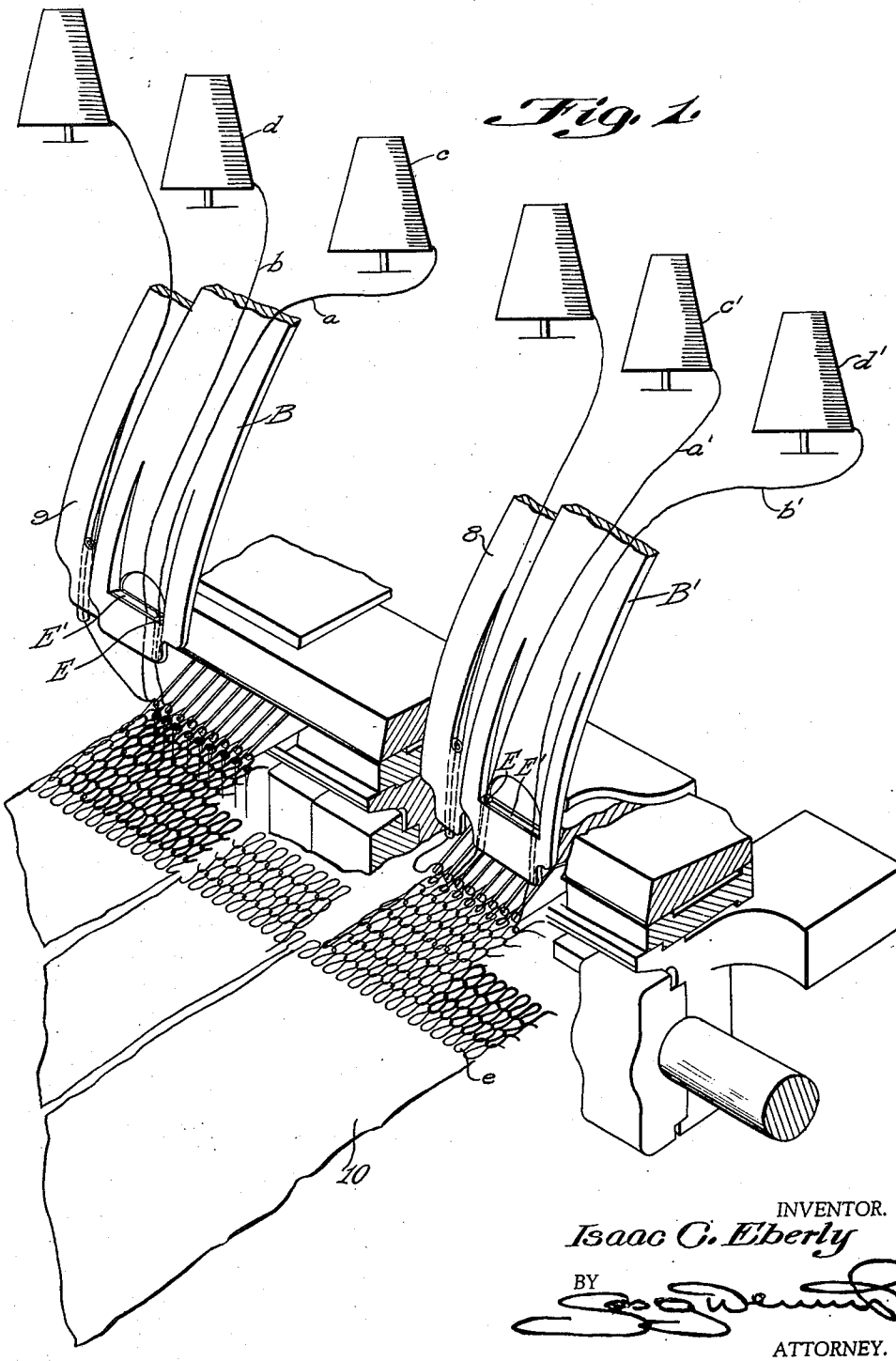
Aug. 20, 1935. I. C. EBERLY 2,011,758

ART OF KNITTING

Filed April 17, 1934 3 Sheets-Sheet 1

Fig. 1.



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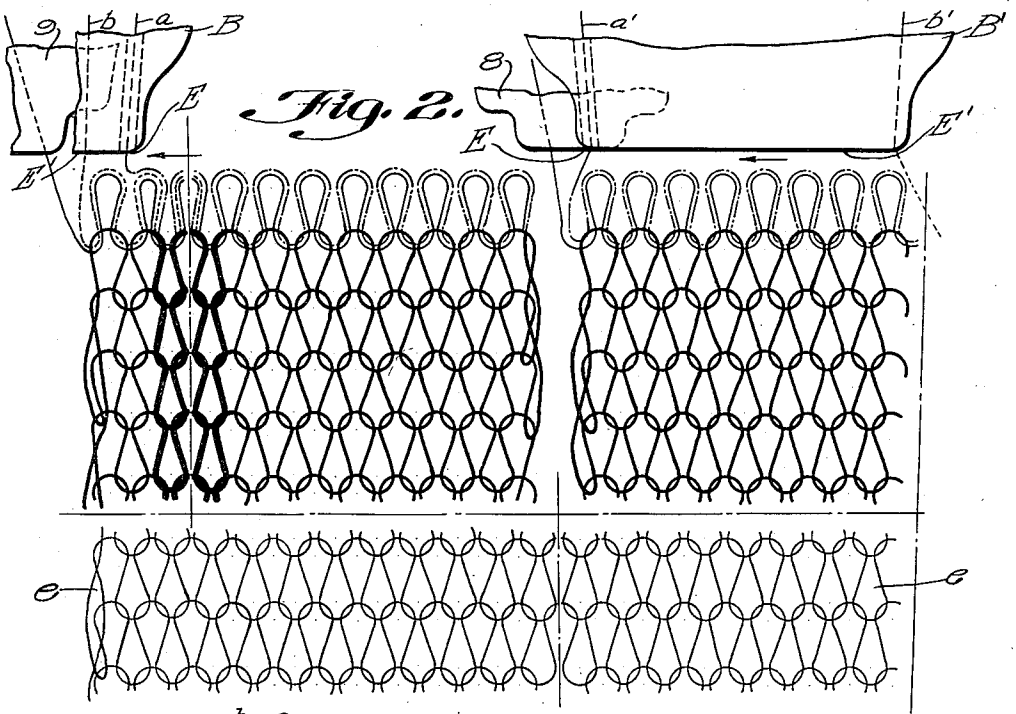
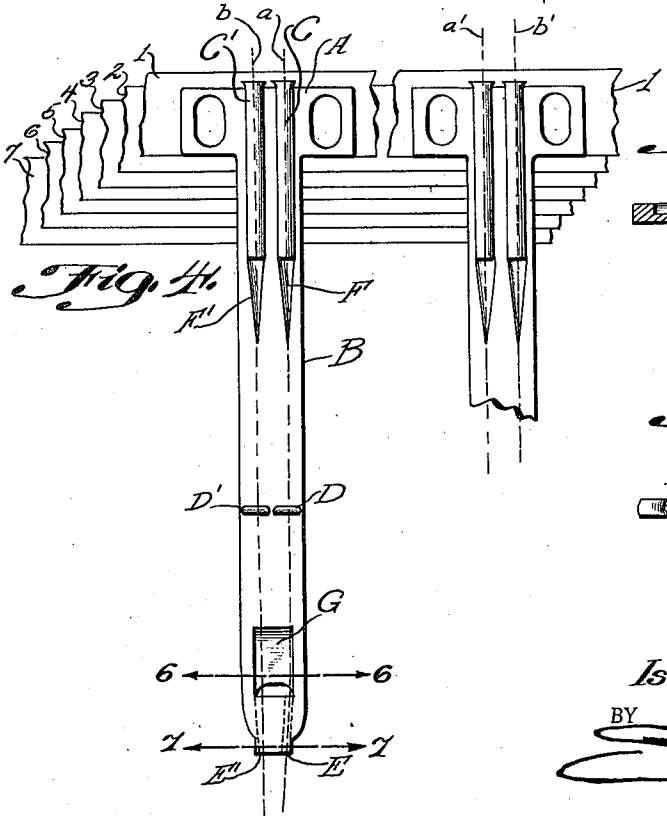
ART OF KNITTING

Filed April 17, 1934 3 Sheets-Sheet 2





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Filed April 17, 1934 3 Sheets-Sheet 3

Fig. 3.

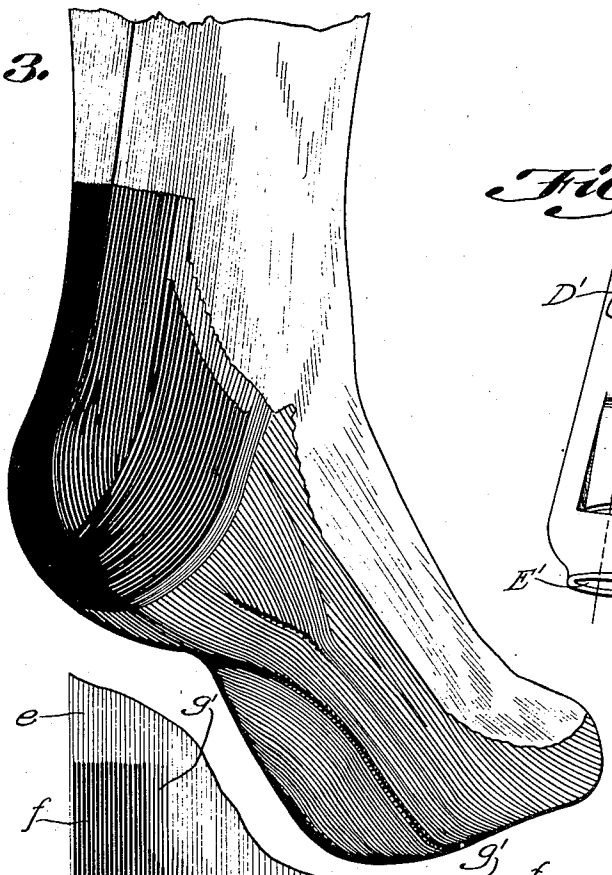
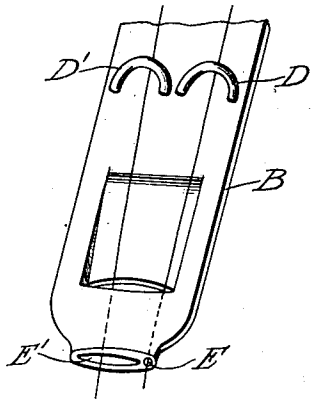


Fig. 3a.

Fig. 5.



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Patented Aug. 20, 1935 2,011,758

UNITED STATES PATENT OFFICE

2,011,758

ART OF KNITTING

Isaac C. Eberly, Reading, Pa.

Application April 17, 1934, Serial No. 721,010

11 Claims. (Cl. 66—129)

My invention is an improvement in the art of knitting involving an improved apparatus for and method of producing a fabric having adjacent groups of wales unequally reenforced during the knitting thereof by utilizing a single carrier to lay a plurality of overlapped reenforcing yarns along a portion of a course and laying single reenforcing yarn in the course beyond at least one and preferably beyond both ends of the doubly reenforced section without leaving a wide band of unreenforced or lightly reenforced wales adjacent to the stocking back seam.

My invention is primarily designed for use with a full-fashioned knitting machine of the so-called "Cotton" type having a bank of bearded needles disposed between sinkers and dividers by which courses of yarn, laid in sequence upon the sinkers by carriers, are bent around the needle shanks and knitted by the downward movement of the needles into fabric having loops arranged in courses and wales. Each carrier used to lay a course of yarn for forming or reenforcing different portions of the fabric is ordinarily attached to a separate carrier rod, of which there are usually seven. These carrier rods are selectively reciprocable individually or in groups by a friction box and coulier motion. Such machines are well known in the art and need no further description to those familiar therewith. Certain principles and features of my invention are, however, applicable to other types of knitting machines and methods.

A leading object of my invention is to minimize the movements of carriers past one another, and to minimize the number of carrier rods in action, in forming a so-called "heel-within-a-heel" in full-fashioned hosiery, or in unequally reenforcing adjacent groups of wales in other knitted fabric or portions thereof so as to provide a relatively large number of lightly reenforced wales at one side only of a group of heavily reenforced wales and few or no lightly reenforced wales at the other side of the heavily reenforced group.

In accordance with my invention, a single carrier rod may be utilized for laying reenforcing yarns in knitting high heel splicings and heel tabs to heavily reenforce them from a wale adjacent to the fabric selvage across a desired number of wales and to lightly reenforce the fabric for a desired number of wales beyond the heavily reenforced portion thereof. This greatly improves the appearance and wear of the stocking by permitting the gradual gradation of the fabric from a heavily reenforced high heel splicing through a lightly reenforced group of wales to a sheer or diaphanous portion of the fabric forming the ankle and instep of a stocking. It also provides a group of lightly reenforced wales between the heavily reenforced portion of the heel tabs and the seam by which each heel tab is connected with the lightly reenforced or sheer fabric forming the foot. The breakage of transfer needles which normally results when the heel tabs are heavily reenforced to the transfer edges thereof is thereby eliminated or minimized.

In the preferred practice of my invention, the heel splicings and tabs are heavily reenforced up to the wale next to the outer selvage wale so as to permit the seaming of the fabric along the outer selvage wales without the formation of a bulky roll at the seam or any perceptible variation in the reenforcement at the back of the heel.

In the knitting of hosiery having a "heel-within-a-heel," in accordance with my invention, the yarn forming the main body of the fabric may be laid in any usual or desired manner, and the high spliced sections on opposite sides of the fabric each comprises wales reenforced by a plurality of reenforcing yarns laid by a single reenforcing carrier.

The plurality of reenforcing yarns laid by each carrier are preferably so controlled that, on movement of the carrier across the needle bed in one direction, the reenforcing yarns are fed in closely juxtaposed relation to one another, so that both reenforcing yarns are laid by the carrier substantially to the selvage of the fabric. But on the movement of the carrier across the needle bed in the opposite direction, the reenforcing yarns are spaced relatively widely from one another, so that one of the reenforcing yarns is laid in the path of a substantially greater number of needles than the other reenforcing yarn. When the sinkers, dividers and needles are operated, the loops of the wales which include both reenforcing yarns as well as the main yarn, are heavily reenforced, whereas the loops of wales which include but a single reenforcing yarn and the main yarn are lightly reenforced, and the loops of the wales which include only the main yarn are unreenforced and sheer.

The control of the feeding positions of the reenforcing yarns, in the opposite movements of the carrier, is preferably effected by providing each reenforcing carrier with a plurality of yarn guides comprising feeding apertures or tubes at the end thereof. One of the guide tubes is spread laterally so as to permit the reenforcing yarn

passing therethrough to move from one side to the other side thereof, a distance preferably equal to the width of six or eight wales. The other reenforcing yarn is fed through a guide tube or constricted aperture permitting substantially no lateral travel of the yarn with respect thereto. When the carrier is moved in one direction, the tension on the reenforcing yarn passing through the laterally spread guide tube causes the yarn to shift laterally until it is in juxtaposition with the wall of the other guide tube or aperture and close to the reenforcing yarn being fed from the latter. On the movement of the carrier in the reverse direction, viz., toward the side on which the constricted tube lies, the tension on the yarn passing through the laterally spread guide tube causes the yarn to shift to the side of such tube remote from the constricted guide tube, and consequently the yarn passing through the laterally spaced tube lags behind the yarn passing through the constricted tube and does not pass across the stems of the same number of needles as the yarn passing through the constricted tube before the reversal of the carrier.

The characteristic features and advantages of my improvements will further appear from the following description and the accompanying drawings in illustration thereof.

In the drawings, Fig. 1 is a fragmentary perspective view illustrating diagrammatically a knitting head of a typical full-fashioned hosiery knitting machine to which my invention is applied; Fig. 2 is a fragmentary diagrammatic view illustrating the laying of yarns by main carriers and reenforcing carrers in accordance with my invention; Fig. 3 is a perspective view of a stocking foot knitted in accordance with my invention; Fig. 3*a* is a diagrammatic view of a section of the leg fabric comprised in the stocking section shown in Fig. 3 before the application of the foot to the heel tabs and leg section and the seaming thereof; Fig. 4 is a broken front elevation of carriers comprised in my invention and a group of carrier rods; Fig. 5 is an enlarged perspective view of the feeding end of the carrier illustrated in Fig. 4; Fig. 6 is a transverse sectional view of the carrier taken on the line 6—6 of Fig. 4; and Fig. 7 is an enlarged transverse section of the carrier taken on the line 7—7 of Fig. 4.

In the practice of my invention, I preferably utilize a complementary pair of reenforcing or auxiliary carriers each comprising an apertured head A for attachment to a carrier rod and a stem or shank B or B' having attached thereto a pair of parallel guide tubes C and C', a pair of guide eyes D and D' in alignment with the axes of the tubes C and C', and a pair of terminal feeding tubes E and E' set in the nose or free end of the carrier. Each carrier shank contains the inclined tapering grooves F and F' adjacent to the exit orifices of the tubes C and C' and the inclined recess G adjacent to the openings of the tubes E and E' so that yarn passing from the tube C to the tube E and from the tube C' to the tube E' make close sliding contact with the surface of the intermediate portion of the shanks. Each tube E is preferably cylindrical in form and its bore has a cross section but slightly greater than the cross section of yarn to be fed therethrough. Each tube E' is preferably elliptical in form so that the bore thereof has the characteristics of a lateral slot having a height substantially equal to the diameter of the bore of a tube E and a width substantially greater than its height, and preferably equal to the width of six to ten wales of the fabric to be knitted. The width of the bore of a feed tube E' permits yarn fed therethrough to shift laterally toward and from yarn passing through the bore of the adjacent tube E a distance greater than the width of a needle, or of a wale formed by such needle from yarn supplied by the carrier.

The carrier shanks B and B' have the feed tubes E and E' transposed as compared with one another, as illustrated by the auxiliary carriers shown at the left and right hand sides of Fig. 1, for in the knitting of the high heel splices and heel tabs of a stocking blank, one carrier is required having its tube E to the right of its tube E' and another carrier is required having its tube E to the left of its tube E', so that the carrier for supplying reenforcing yarn for each high heel splicing will have its wider bore E' on the side of the carrier toward the selvage of the splicing.

In the utilization of a pair of such carriers for reenforcing the high heel splicings of a stocking leg fabric, they may both be connected with a usual carrier rod 1 of a usual type of full-fashioned knitting machine having additional carrier rods 2, 3, 4, 5, 6 and 7, to each of which may be connected a yarn carrier of ordinary type such as illustrated by the yarn carriers 8 and 9. The yarn carriers are selectively operable individually or in groups by connecting the respective rods 1, 2, 3, 4, 5, 6 and 7 with a usual friction box (not shown).

The welt, main leg portion and main yarn of the high heel splicing and heel tabs of a stocking leg fabric 10 may be knitted by laying courses of yarns from carriers operated by the carrier rods 2, 3, 4, 5, 6 and 7, or any of them, in any manner desired.

In accordance with my invention, when the knitting of the blank 10 has progressed far enough to require the reenforcement of the high heel splicing, the carrier 1 is connected with the friction box so as to operate in synchronism with the carrier or carriers laying the main yarn for the high heel splicings, ankle and instep.

The auxiliary or reenforcing carrier B for reenforcing the high heel splicing and heel tab at the left of the fabric, shown in Figs. 1 and 2, is supplied with two separate yarn ends *a* and *b* from the cones *c* and *d*, the yarn ends being fed under separate tensions of the usual type (not shown). The carrier B' for laying yarns for reenforcing the high heel splicing and heel tab at the right hand of the fabric, shown in Figs. 1 and 2, is supplied with yarn ends *a'* and *b'* from the separate cones *c'* and *d'*, these yarn ends being likewise subjected to the action of usual tension devices between the cones and carriers in the usual manner. As illustrated in Figs. 1 and 2, the sheer or diaphanous section *e* of the leg above the high heel splicings is knitted from a silk yarn, which may be of any desired number of threads, but preferably no coarser than four thread silk, and such silk is laid by any desired number of the usual carriers, such as 8 and 9.

When the high heel splicing is begun and the carrier rod 1 is connected with the friction box, each carrier B and B' begin to lay reenforcing yarns to form the high heel splicings.

If it be assumed that the friction box and carrier bars are moved from right to left in laying the initial course for the high heel splicings, the tube E of the carrier B' will start to move the yarn *a'* from the wale next to the right hand selvage wale of the fabric before the tube E' of the carrier B' starts to move the yarn *b'* from the wale forming the right hand selvage of the

fabric. After the lagging yarn *b'* has started to move, the yarns *a'* and *b'* will be laid in overlapping relation in the initial course of the right hand high heel splicing until the carrier rod has reached its extreme left hand position. At this time the yarn *a'* will be projected toward the center of the fabric a distance of approximately eight wales beyond the wales in which the yarn *b'* is laid. Consequently, the selvage wale of the initial course of the right hand high heel splicing will be reenforced by but a single reenforcing yarn *b'*; the next succeeding wales, of any desired number, of such initial course will be individually reenforced by both the reenforcing yarns *a'* and *b'*; and the last eight wales of such initial course will be reenforced only by the reenforcing yarn *a'*.

Simultaneously with the laying of the reenforcing yarn in the initial course of the right hand high heel splicing, the carrier B will lay reenforcing yarns in the initial course of the left hand high heel splicing. In starting the laying of the yarns *a* and *b* from the inner portion of the fabric, the yarn *a* will be started from eight wales to the right of the starting point of the yarn *b*. The yarn *b* will not start to move toward the left hand until the carrier B has moved the yarn *a* a distance sufficient to cause the wall of the tube E' adjacent to the tube E to engage the yarn *b*. The yarns *a* and *b* will then move toward the left in substantially juxtaposed relation in the initial course of the left hand high heel splice. When the carrier rod has reached its extreme left hand position, the yarn *b* will be in position to be knitted into the left hand selvage wale of the fabric while the yarn *a* will be in position to be knitted into the wale next to the left hand selvage wale of the fabric. Consequently, when the yarns laid for the initial course of the left hand high heel splice are knitted in by the needles, the selvage wale will be reenforced only by the yarn *b*, the adjacent wales of desired number in such course will be reenforced by the knitting in of both the reenforcing yarns *a*, *b* and the eight wales to the right of the doubly reenforced wales will be reenforced only by the reenforcing yarn *a*.

It will, of course, be understood that the main yarn of the initial course of the right hand high heel splice, the left hand high heel splice and the intervening sheer or diaphanous portion of the fabric is laid by a suitable carrier in the usual manner.

When the friction box and carrier rods are moved from left to right to lay the second course of the high heel splicings, the tube E of the carrier B starts to move the yarn *a* from the second wale of the fabric toward the right before the tube E' of the carrier B starts to move the yarn *b* from the selvage wale of the fabric, since the tension on the yarn *b* holds it while the carrier B is moved a distance equal to the width of the bore of the tube E'. When the carrier has moved such distance, say eight wales, the yarns *a* and *b* are laid by the movement of the carrier B in overlapping relation with each other and with the main yarn until the carrier rod has reached its extreme right hand position. In such position of the carrier rod the yarn *a* will be some eight wales to the right of the stopping point of the yarn *b*.

As the yarn *a'* was stopped in the initial course of the right hand high heel splicing some eight courses to the left of the stopping point of the yarn *b'* in such course, the yarn *b'* will be caused by the tension thereon to lag, on the right hand movement of the carrier B' in laying the second course, until the yarn *b'* is engaged by the wall of the slot E' adjacent to the tube E. Thereafter the further right hand movement of the carrier B' will feed the yarns *a'* and *b'* in juxtaposed position to one another and lay them in the second course in overlapped relation with one another and with the main yarn until the carrier B' has reached the extreme limit of its movement to the right. In such position of the carrier B', the yarn *b'* will be in position to be knitted into the right hand selvage wale of the fabric and the yarn *a'* will be in position to be knitted into the second wale. Consequently the second course and all succeeding courses of both the right hand high heel splicing and the left hand high heel splicing will be heavily reenforced or lightly renforced as was the initial course of such high heel splicing.

When a desired number of courses have been laid and reenforced as described to form high heel splicings of desired height and contour, the operations of the main yarn carrier or carriers will be so changed as to lay main yarn courses for spaced heel tabs on opposite sides of the fabric; such main yarn courses for the heel tabs being laid and regulated in any usual or desired manner.

The reenforcement of the respective heel tabs will, however, be effected, in accordance with my invention, by the laying of yarns by the carriers B and B' in the same manner as described in connection with the reenforcement of the high heel splicings.

As illustrated in Fig. 2, the heel tab knitted at the left of the stocking fabric is composed of any desired number of courses, in each of which there is an outer selvage wale loop composed of a main yarn and a single reenforcing yarn *b*, an adjacent group of wale loops of desired number having the main yarn doubly reenforced by both the yarns *b* and *a* and a group of wale loops toward the inner selvage of the tab having the main yarn reenforced only by the reenforcing yarn *a*. Similarly the heel tab formed on the right hand side of the fabric is composed of a desired number of courses each comprising a group of wale loops, say eight in width, adjacent to the inner selvage of the tab and composed of the main yarn and reenforcing yarn *a'*. Adjoining this group of lightly reenforced loops there is a group, as shown in Fig. 3*a*, of wale loops composed of the main yarn and both of the reenforcing yarns *a'* and *b'*, and next to this group is a selvage wale loop composed of the main yarn and the reenforcing yarn *b'*.

As diagrammatically illustrated in Fig. 3*a*, the resulting stocking leg blank consists of a sheer or diaphanous leg portion *e* formed from the main yarn or yarns or fine silk, such for instance as two thread silk. At the lower end of this section *e* there are formed the high heel splicings *f*. The high heel splicings are each composed of a continuation of the fine silk from which the portion *e* is knitted, and in addition has its outer selvage wale reenforced by the yarn *b* or *b'* respectively, which may be of say three thread silk. The group of wales *g* adjoining the outer selvages are reenforced by the yarns *a*, *b*, or *a'*, *b'* respectively, and adjoining each such heavily reenforced section there is a group or band of wales *g*, in which the loops formed of the fine silk of the main courses are reenforced by the yarn *a* or *a'* respectively, which may be of say four and a half thread silk.

The heel tabs *h* and *i* are each similarly formed of an outer selvage wale composed of loops containing a main yarn and reenforcing yarn *b* or *b'*, a heavily reenforced group of wales *g* comprising loops containing the main yarn and the reenforcing yarn *a*, *b* or *a'*, *b'*, respectively, and the lightly reenforced group of wales *g'* adjacent to the inner selvages of the tabs and comprising loops containing the main yarns and reenforcing yarn *a* or *a'* respectively.

A foot blank composed of either sheer knitted fabric or lightly reenforced knitted fabric may be readily attached by means of transfer needles to the inner selvage edges of the heel tabs as shown in Fig. 3. When the outer selvage edges of the high heel splicings and the heel tabs are seamed up, the lightly reenforced selvage loops are concealed in the seam, minimize the size of the roll along the seam, and the back heel is of uniform and attractive appearance.

Having described my invention, I claim:

1. In a knitting machine, the combination with a bank of knitting needles and a pair of carriers movable to and fro across different groups of needles of said bank, each of said carriers having a plurality of yarn guides, and the yarn guides of said carriers which are remote from one another having wider yarn spaces than the yarn guides of said carriers which are nearer to one another.

2. In a knitting machine,. the combination with a bank of knitting needles, of a main yarn carrier movable to and fro across needles of said bank and a reenforcing yarn carrier having a plurality of yarn guides of different widths, the reenforcing yarn laid by the wider guide lagging behind the reenforcing yarn laid by the narrower guide upon movement of the reenforcing carrier in one direction and the yarn laid by the narrower guide lagging a lesser distance behind the yarn laid by the wider guide upon the movement of the reenforcement carrier in the opposite direction.

3. In a knitting machine, the combination with a bank of knitting needles, of a yarn carrier movable back and forth across needles of said bank and simultaneously feeding a plurality of yarns to needles of said bank sufficient in number to form a substantial heel area of triple yarn thickness, said carrier having means permitting the lagging of one of the yarns fed thereby a distance behind the other yarn fed thereby equal to the width of a heel-border area of double yarn thickness on movement of the carrier in one direction and for feeding a continuation of such lagging yarn and a continuation of the other yarn in substantially juxtaposed relation on the movement of the carrier in the opposite direction.

4. In a knitting machine, the combination with a bank of knitting needles, of a yarn carrier having guides for a plurality of yarns, the yarns fed by said carrier being fed in closely juxtaposed relation on movement of the carrier in one direction and in more widely spaced relation to one another on movement of the carrier in the opposite direction.

5. In a knitting machine, the combination with a bank of needles, of means comprising a single carrier rod for laying a plurality of yarns in the path of said needles, said means laying one of said yarns a plurality of wales beyond the other of said yarns on the movement of said carrier rod in one direction and said yarns overlapping one another over a plurality of wales to substantially the selvage of the fabric on movement of the carrier rod in the opposite direction.

6. In a knitting machine, the combination with a bank of needles, of means comprising a single carrier rod for laying a plurality of yarns in the path of said needles, said means laying one of said yarns a plurality of wales beyond the other of said yarns on the movement of said carrier rod in one direction and said means laying one of said yarns a lesser number of wales beyond the other on the movement of said carrier rod in the opposite direction, said yarns overlapping one another over a plurality of wales.

7. In the knitting of fabric so as to form wales and courses providing a main heel area of triple yarn thickness and a heel-border area of double yarn thickness, the steps whch consist in laying in a course a main yarn and a plurality of reenforcing yarns with all of said yarns in overlapping relation, projecting one of said reenforcing yarns a number of wales beyond the other reenforcing yarn at one end of a course and projecting a continuation of the last named reenforcing yarn a lesser number of wales beyond the first named reenforcing yarn at the opposite end of a succeeding course.

8. In a knitting machine having a bank of needles for knitting yarns to form wales and courses, means for laying a course comprising a main yarn beginning at a selvage edge of a fabric, means for laying in said course a reenforcing yarn beginning at a selvage edge of said fabric, means for laying in said course a further reenforcing yarn beginning at a wale removed from the selvage edge of said fabric, said means laying said yarns in overlapping relation over a number of wales, means for stopping the laying of said first reenforcing yarn in said course while continuing the laying of said main yarn and said second reenforcing yarn in said course a distance greater than the starting point of the latter from the selvage edge.

9. In the knitting of fabric so as to form wales and courses providing a main heel area of triple yarn thickness and a heel border area of double yarn thickness, the steps which consist in laying a course including a main yarn and at least two reenforcing yarns, beginning the laying of one of said reenforcing yarns at one wale of said fabric, beginning the laying of the other reenforcing yarn at a different wale of said fabric, laying the reenforcing yarns in overlapping relation over a number of wales of the fabric sufficient to form a heel area of triple yarn thickness, stopping the laying of one of the reenforcing yarns in said course and continuing the laying of the other of the reenforcing yarns in said course a number of wales past such point of stoppage greater than the distance between their starting points so as to form a heel-border area of double thread thickness.

10. In the kniting of fabrics to form courses and wales, the steps which consist in laying a course including a main yarn and at least two reenforcing yarns in overlapped relation to form a heel area of triple yarn thickness, and shifting the reinforcing yarns toward one another in the laying of one course and shifting the reenforcing yarns away from one another in the laying of another course.

11. In the knitting of a stocking blank reenforced to form a "heel within a heel" with a heel main area of triple yarn thickness and a heel-border area of double yarn thickness, the steps which consist in laying a yarn course including a main

yarn and at least two reenforcing yarns, all of said yarns being laid concurrently and in overlapping relation coextensively with a heel area of triple yarn thickness and with one of the reenforcing yarns trailing the other reenforcing yarn a distance equal to the width of the heel-border area; concurrently knitting all of said yarns into a course of loops; laying a second yarn course including a main yarn and said two reenforcing yarns, all of said yarns being laid concurrently and in overlapping relation coextensively with said heel area of triple yarn thickness with the two reenforcing yarns in close juxtaposition to one another; and concurrently knitting all the yarns of the second course into loops interlacing with the loops of the first course of loops.

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