March 6, 1934. J. F. WILCOMB 1,949,439

KNITTED NONRAVEL CONTOURED FABRIC

Filed Sept. 10, 1930 4 Sheets-Sheet 1

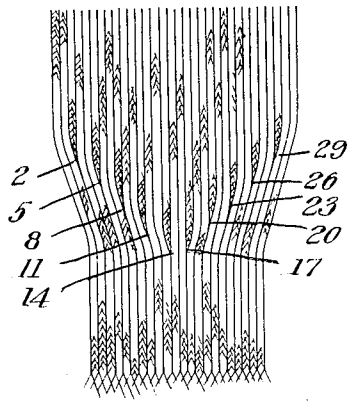


Fig. 2

Fig. 1

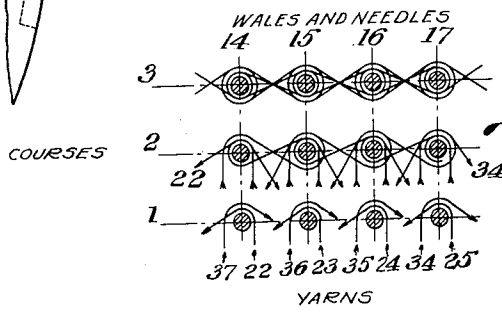


Fig. 10

Inventor:
J. Frank Wilcomb.
By Wm Wallace White
Attorney.

March 6, 1934. J. F. WILCOMB 1,949,439

KNITTED NONRAVEL CONTOURED FABRIC

Filed Sept. 10, 1930 4 Sheets-Sheet 2

Fig. 9

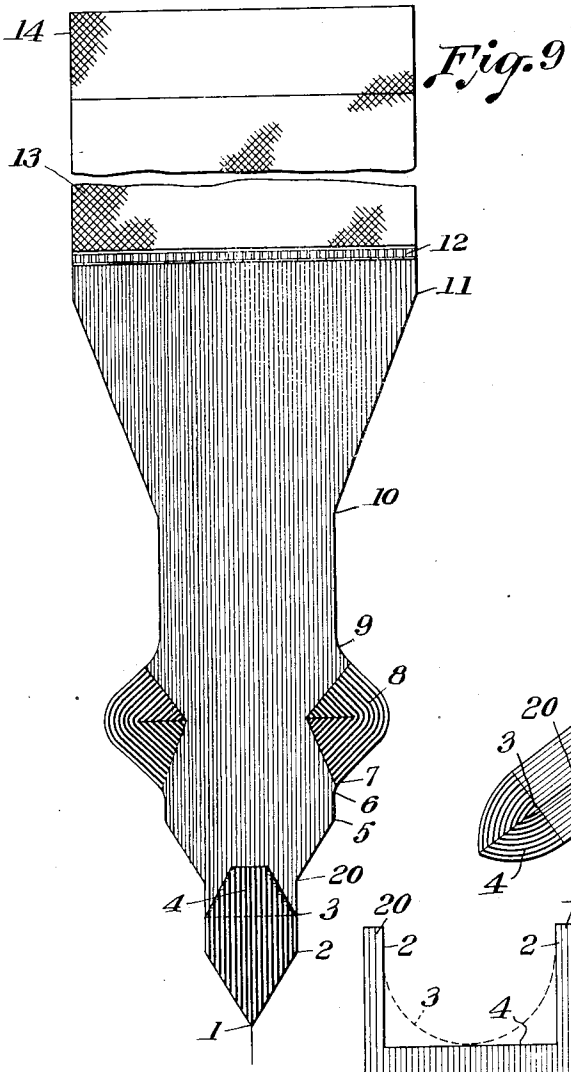


Fig. 4

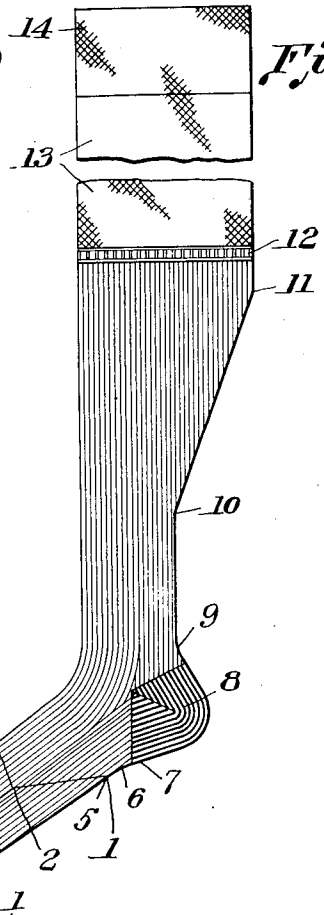
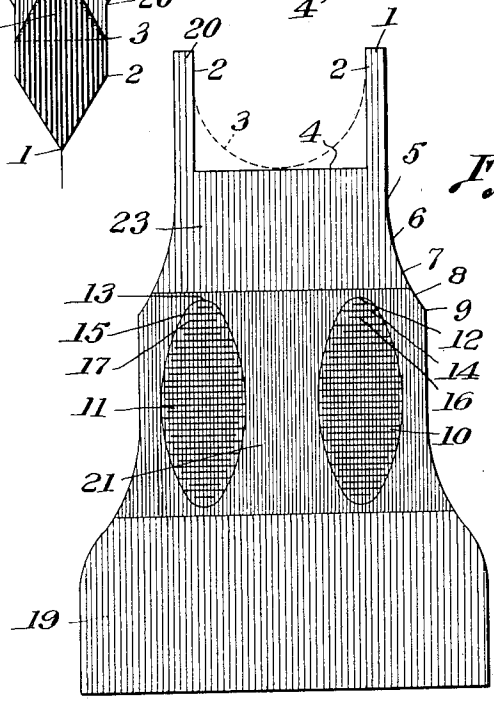


Fig. 3



Inventor:
J. Frank Wilcomb
By
Attorney.

March 6, 1934. J. F. WILCOMB 1,949,439

KNITTED NONRAVEL CONTOURED FABRIC

Filed Sept. 10, 1930 4 Sheets-Sheet 3

Fig. 5

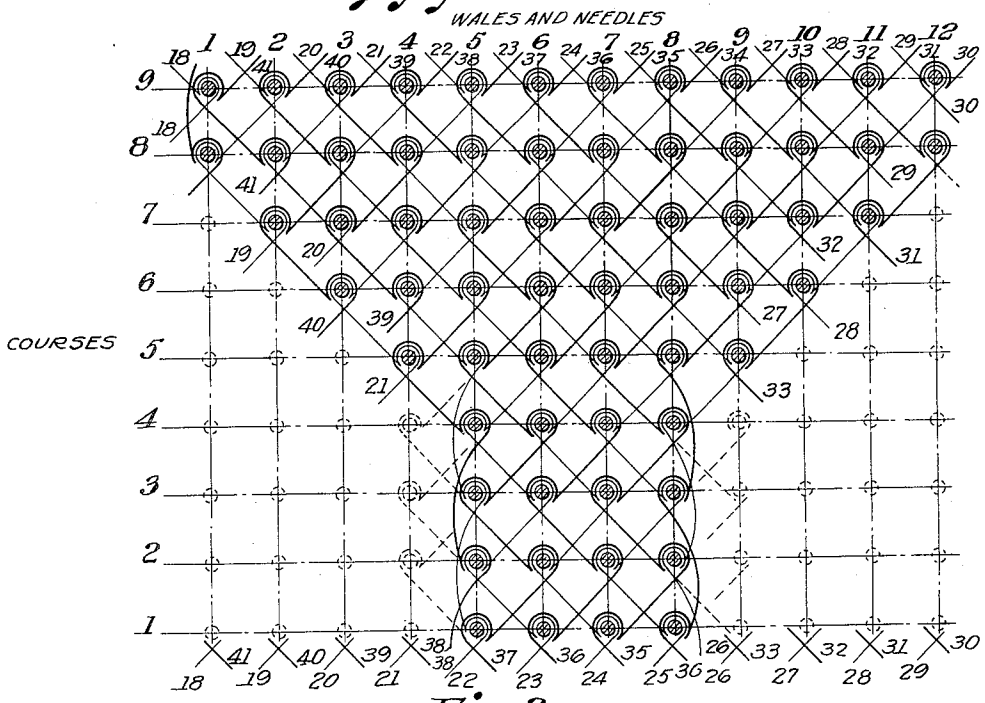
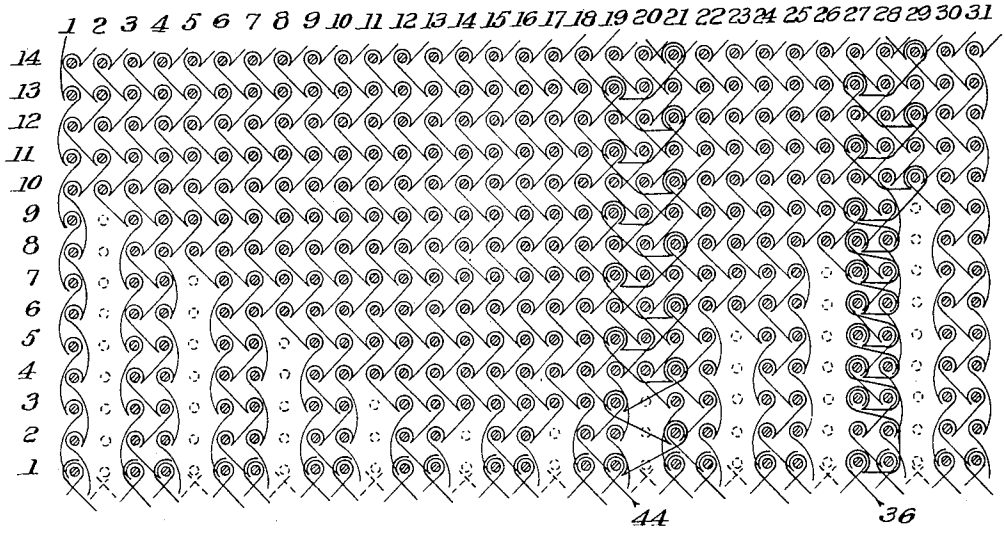


Fig. 8



Inventor:
J. Frank Wilcomb.
By Wallace White
Attorney.

March 6, 1934. J. F. WILCOMB 1,949,439

KNITTED NONRAVEL CONTOURED FABRIC

Filed Sept. 10, 1930 4 Sheets-Sheet 4

Fig. 6

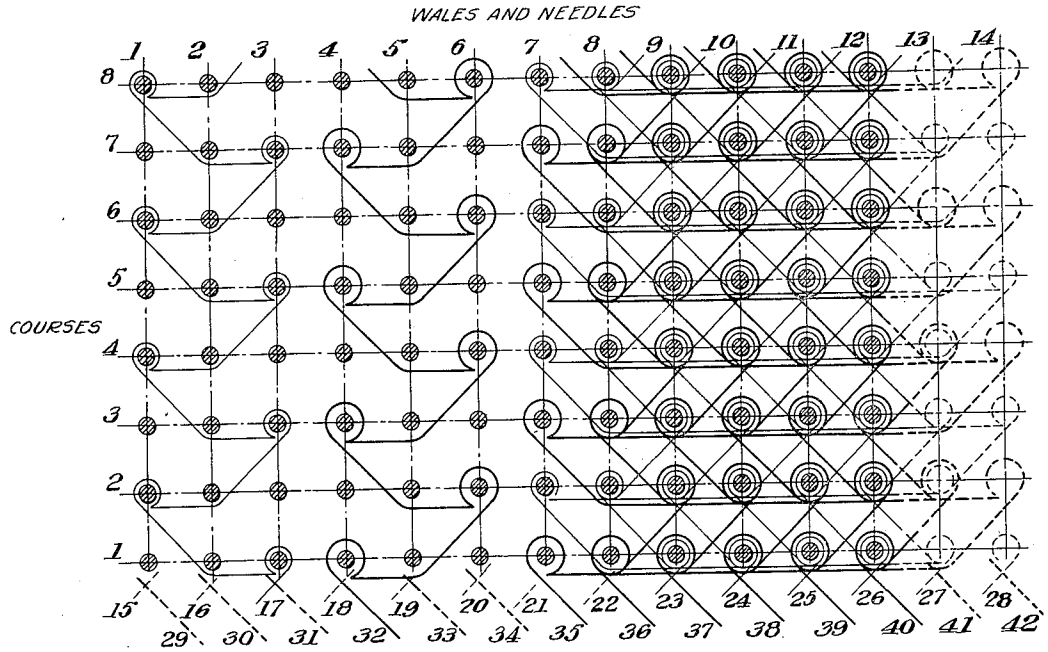
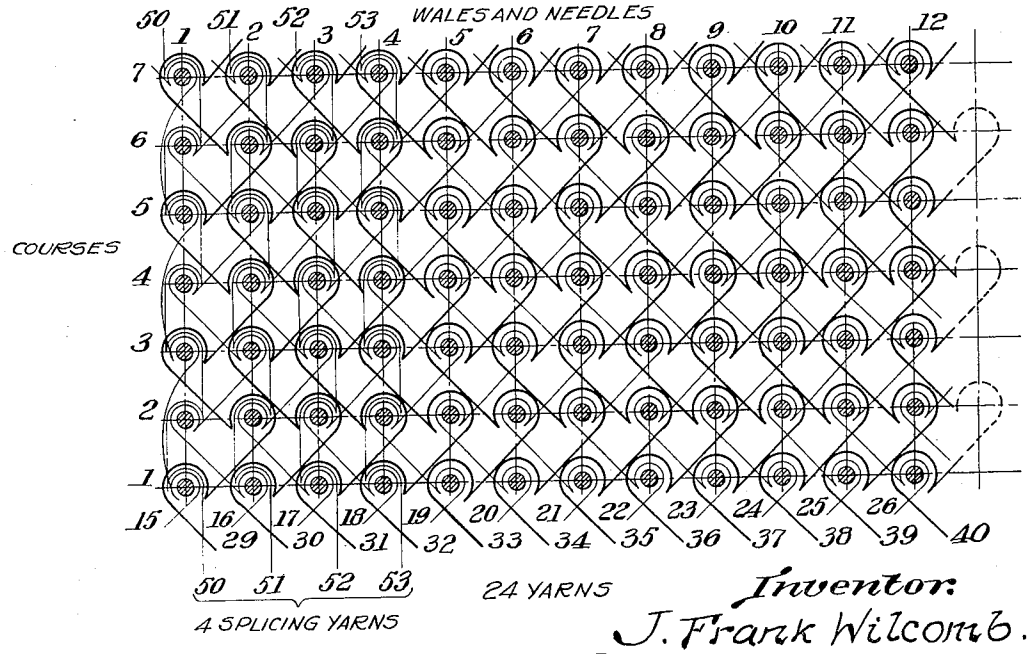


Fig. 7



Inventor:
J. Frank Wilcomb.
By Wm. Wallace White
Attorney.

Patented Mar. 6, 1934 1,949,439

UNITED STATES PATENT OFFICE

1,949,439

KNITTED NONRAVEL CONTOURED FABRIC

John Frank Wilcomb, Philadelphia, Pa.; Maude W. Thompson executrix of said John Frank Wilcomb, deceased

Application September 10, 1930, Serial No. 480,902

17 Claims. (Cl. 66—195)

The invention relates to stockings of the full fashioned class, particularly to the shaping of the leg, making of heels and toes, and reinforcing the selvages.

The invention includes a novel manner of manipulation of threads in stitch structure—a novel method of contouring a knitted fabric—so manipulating the threads that fabrics may be contoured largely by mechanical means independent of the skilled operators usually employed in the production of fashioned knit goods.

The invention is adapted to the production of many kinds of shaped knitted fabrics.

In a broad sense the invention is applicable to stocking manufacture, underwear and other fabrics where elasticity, durability, and contours are factors desired.

By the use of the invention production is increased, quality is improved, the wearing qualities multiplied and the appearance of the face of the fabric greatly enhanced and labor costs greatly reduced.

A leading characteristic feature of the invention is a method of making non-ravel, contoured, knitted fabrics.

A course in the knitting art is the horizontal line of loops made with a single thread feeding the row of needles, each needle of the row successively making a loop. The loops or stitches of the entire row are linked together with the same thread. They are distinguished from vertical stitches called wales. Non-ravel stitches are not literally formed as courses but are so referred to because the loops appear on the face of the fabric in horizontal rows as in a course. Non-ravel stitches are individually made and the yarns of each loop extend into an adjoining wale on another course preceding it and the course succeeding it.

In the method of knitting as hereinafter described, the term "new needle" means a needle that has no stitch on it and that has been idle for a time while other needles are knitting. When brought into action it is called a new needle. A needle that has a stitch on it and is temporarily inactive, as in pocket making, is called an old needle. In the formation of a non-ravel fabric a yarn is fed back and forth from a wale to a stitch in the adjoining wale. In another way of expressing it: Two adjoining needles are companion needles both being fed with the same yarn alternately. The two parallel wales are companion wales to completion. The side of a needle next to its companion is the inside. The side farthest away from the companion needle is the outside. The distinction should be understood and the reason will be apparent in the specification and is important in the stitch and necessary in the contouring, making a leading characteristic feature of my particular non-ravel stitch.

In the accompanying drawings a spring needle knitting machine is disclosed merely to illustrate the non-ravel stitch steps.

In the drawings: Fig. 1 is a vertical cross section of a portion of a knitting machine and shows important units employed in making the contoured non-ravel fabrics. The units and their relative positions are shown with the parts at rest except the needles; they are shown in their highest point, their pressing point, and the lowest or casting off point. The machine shown is of the straight bar type, all the needles being slidable in slots. In this figure a part of a needle controlling wheel is shown in cross section. This pattern wheel provides a means to make needles inoperative; the needles holding their loops during a suspended knitting period; also to leave the needles partly retracted with a loop thereon and at times to leave the needles partly advanced with or without loops thereon.

Fig. 2 is a diagrammatic outline of a widened, flat, contoured fabric, typical of a fabric widened between the wales as distinguished from wales starting from the selvages.

Fig. 3 is a front view of a vest for women's wear having breast pockets integrally knitted in a field of plain non-ravel stitches, the neck and skirt of the vest made up of non-ravel net stitches, the two kinds of stitches and pockets being integrally knitted in a continuous operation.

Fig. 4 is a side elevation of a stocking having a widened, contoured, sole, toe, heel and leg all knitted in one continuous operation.

Fig. 5 is a diagrammatic arrangement of the needles and threads showing two yarns for each needle or stitch and the thread's line of travel from loop to loop and from one course to the next course. In this view are needles in dotted lines showing where the threads would go on the selvage if a needle were there. The widenings due to bringing into action new needles at intervals, thus starting a new wale are shown in this view.

Fig. 6 illustrates the thickening results and the steps to produce thickening without the use of extra yarns.

Fig. 7 is a plan view in the nature of a diagram, showing how the reenforcing yarns are laid on the needles entering into the loops there bound fast with the main yarns that cross each other and become a part of the loop with the splicing yarn.

Fig. 8 is a diagram wherein a method of widening a non-ravel knitted fabric by creating a new wale between two other wales is illustrated. This fabric is distinguished from widened fabrics having the new wales started at intervals along the margins of a knitted fabric by having the short wales beginning between two longer wales.

Fig. 9 is a plan view of a knitted fabric contoured in the knitting operations, showing the heel and toe pockets and the foot part integrally knitted. This fabric represents the stocking illustrated in Fig. 4 but in the form that it has before seaming it up the back.

Fig. 10 is a detail view showing three courses of knitting and the direction the threads take in the operations described in connection with Fig. 5.

The non-ravel contoured fabric herein described is produced on a machine of the spring beard needle type or on a machine of the latch needle type of either the circular or of the straight bar form. In this description I prefer to illustrate the idea with a straight row of needles of the spring beard needle class.

The machine has a row of independently movable sliding needles and two rows of yarn feeders with a yarn for each feeder. The two rows are adapted to move in opposite directions in a horizontal plane, a distance of one or two needles depending upon the kind of non-ravel stitch desired. They are designed to dip between the needles and also to move across the stems of the needles to deliver yarn to the needle hooks. The individual feeders move around the needles in a path or diagram like a horizontal figure 8; each feeder supplying two needles but feeding to only one needle at each course. On one course a feeder wraps the yarn around one needle of two companion needles, another feeder supplying the other needle. On the next course the first mentioned feeder wraps the yarn around the companion needle. All the feeders of the two rows move in unison shogging step by step past and between the needles of the row making a path diagram likened to a horizontal figure 8. Both ends of the figure 8 have the yarn from one feeder but on two different courses. Both ends of the figure 8 have a yarn from another feeder also. The entire course of stitches is a chain of stitches in diagram form of figure 8 linked together. This stitch structure is so important that a fuller understanding should be aimed at in order to make the non-ravel contouring method clear. The difference in the stitch is slight but the importance will be apparent farther on in this specification. The improvement in my non-ravel stitch makes the difference between the ability to contour a non-ravel fabric in a practical way and the inability to do it at all.

The feeders normally move one step to the right or left at each stitch in a course a distance of one needle. One set of feeders generally moves in the opposite direction to the other set a distance of one needle at a step behind a needle.

Sometimes as in making open work like net, the feeders of both sets move in the same direction for one or two courses, then reverse and both move in the opposite direction together. Also, in the case of thickening the two sets move in opposite directions a distance of two needles, both sets of feeders passing and crossing their threads behind a needle and crossing their separate threads in the loops when feeding a needle, after wrapping the yarn around the outer side of the needle.

The two rows of feeders are so arranged relative to each other and relative to the row of needles that any one feeder feeds only one needle at a course; a corresponding feeder in the other row feeding only one needle at a course, meaning to say both feed the same needle of a course, crossing their threads in the loop. When the next stitch is made both feeders have moved in opposite directions and feed adjoining needles in the same way, combining their threads with other threads.

In widening a contoured non-ravel knitted fabric—a stocking leg for illustration—the knitting is started on a small number of needles of the set as in the ankle. There will be many idle needles on each side of the ankle fabric without stitches on them, these needles idle in a retracted position and inactive. The two rows of feeders go through their motions on every course but only the yarns having operating, active needles to feed will engage with anything, as there is no active needle in line with the other yarns. When it is desired to widen the fabric, one new needle on each side of the active needles is brought into action and the yarn of one feeder in each row of feeders lays yarn across the needle stem in opposite directions, crossing the yarns on the needle stem. Should the yarn come to the needle direct from the next needle and be seized by the needle hook, the yarn would be unhooked on the next upward movement of the needle, like dropping a stitch and further knitting could not go on with the new wale. By my system of bringing the yarn to the needle from behind it, around the outer side and then across the needle stem then down between the needles, however, the needle hook is sure to seize the yarn and will retain it on the next upward movement, thus starting a new wale. The succeeding widenings are a repetition of these movements, bringing into action new needles at intervals with a suitable number of courses of knitting between the widenings so as to produce the angle or curvature desired in contouring the fabric.

Pockets, for heels and toes for instance, or pockets like those in a vest for women's wear are produced in a similar way to the seamless pockets usually made on circular machines in spiral knitting; a system which consists of narrowing and widening operations without the transfer of loops, producing gored sections of a fabric in which wales are abruptly diverted from parallel, straight lines into right angled wales in a gore. In this system, the narrowings are the steps where a needle is made inoperative for a time, the inoperative needle holding its loop. At each two courses of knitting, a needle is made inoperative until the desired length of fabric is knitted; then the fabric is widened back to the starting point, by bringing into active operation the needle made inactive in narrowing, one needle at a time, with two courses of knitting between each widening step. The widening needles take new yarn and form loops casting off their retained loops and continuing the wale temporarily suspended in the narrowing operation.

This system of making pockets has been confined heretofore to the making of heels and toes of stockings. By my system of knitting loops of the non-ravel kind where only two needles are fed yarn from a feeder, the yarns extending from wale to wale have a longitudinal trend, while in the spiral knit and the usual flat knit fabrics the yarns are running from side to side if selvaged, and round and round if spiral knit. In other words, a yarn used to make the non-ravel stitch is interknit in two adjoining wales lengthwise of the fabric; other fabrics that ravel have their

yarns each in all the wales and running across the width of the fabric.

Pockets made of non-ravel stitches, two yarns to each loop, besides making a more durable fabric, have gores with yarns crossed covering the eyelet that is ordinarily objectionable in the usual gores. By reason of the thickening threads crossing a wale on the back side of the fabric, the wales are drawn together closely and the eyelet covered even when making three courses between the narrowings and widenings. The usual practice is two courses. With three courses the gored pocket is made into a more acute angle suitable for toes of ladies' hosiery, more nearly the angle of the conventional fashioned toe made by the stitch transferring system.

Pockets may be made in any part of a fabric by my system, not necessarily near the selvage. Long and short wales may be made in any desired part of the width of the fabric to produce contours.

Knitting and widening.—Describing the knitting and widening steps in particular and the formation of the stitches which differ from other kinds of stitches known in the art and that makes the widening operations practicable for fashioning purposes, reference is had to Figs. 5 and 10. These figures show the positioning of the yarns in both the straight-away knitting and the widenings.

Describing first the straight-away knitting and confining the description to two needles and their threads or yarns one should remember that all the other needles and yarns are duplicating the movements since any two needles of the set are operable like any other two needles.

Taking for illustration needles 15, 16 and yarns 23, 24, 35, 36; knitting is started (see Figs. 5, 10) by bringing yarns 23, 24 up between the needles, both yarns having come from the inside of needles of a previous course, moving them across their respective needle stems both yarns in the same direction and the yarns 36, 35 moving simultaneously up between the needles and across the stems of their respective needles in a reverse direction as indicated with arrow points in course 1 Figs. 5, 10. The needles now form loops of two yarns crossed in the loop. The next step, course 2 is to drop the yarns down between the needles; yarn 36 passing behind needle 16 and yarn 24 passing behind needle 15. Both yarns now rise between needles and move across the needle stems in a reverse direction to their first movement. Yarn 24 across needle 15 and yarn 36 across needle 16. Both yarns drop between needles again. Yarns 23 and 35 used in the first loops have moved to adjoining needles 14, 17. Loops are now made on needles 15, 16 and the yarns 24, 36 have moved in a path likened to a figure 8 in a horizontal plane in two courses. The completed courses of loops are shown in course 3 as a chain of figures 8, linked together. Repeating the movements and all the yarns and needles doing the same thing will make a continuous web of similar stitches and courses.

It is important to remember that the yarns coming to a needle for knitting, move partially around a needle; always from the inside of the previous course to the outside of the needle. Outside meaning the outer side of a companion needle. Inside meaning the inner side of the companion needle of a previous course. In the widening operations this is very important as will appear later on in this specification. Two needles operating together on a course are companion needles. On the next course one of the needles joins with another needle and they become companion needles for that course and so on alternating indefinitely. This is clearly shown in Fig. 5.

The foregoing description of the peculiar method of making these non-ravel stitches stresses the importance of the invention as an aid to shaping the fabric. Another equally important advantage is, the stitches are more elastic.

Knitted fabrics are elastic by reason of the allowable expansion of the series of loops laterally. No elasticity is obtained from the threads running from wale to wale. Non-ravel stitches made by other methods where the threads pass from loop to loop in opposite direction—Milanese for example, lack the proper degree of elasticity to be desirable for some uses. By the herein disclosed method each loop is made up of yarns curved around the loop and expansion takes the loop outward on both sides. Other methods tend to contract the loop, to pinch it as the thread pulls from the opposite side and tends to close, rather than open the loop. Elasticity should not be confused with stretch.

Widening is effected in the manner described in Fig. 5. A set of needles may have some inactive needles indicated in dotted circles. The active needles are shown in solid lines cross sectioned in the courses 1 to 9. There are 12 needles shown in the set. It is obvious that more or less needles may be used. There are four needles shown as active needles at the start as in course 1; there are 24 yarns indicated by crossed lines below course 1. One set of yarns are numbered 18 to 29 move in the opposite direction across the needles to the other set numbered 41 to 30. The inactive needles 10, 11, 12, 13 on one side of the active needles and the inactive needles 18, 19, 20, 21 on the other side are called inactive because at the time indicated on the diagram those needles are retracted out of range of the yarns and are empty needles without loops. The active needles have loops and are actively making loops at each course of knitting. Each set of yarns are moved in unison in opposite directions across the row of needles at each course. All the retracted needles fail to contact with the yarns, therefore if the yarns were attached to needles on course 1 and the needles were retired for several courses of knitting the yarns would extend from course 1 to the needle in subsequent courses, forming floating threads, so called. Widening is done by the system herein disclosed. The yarns are not engaged by the inactive needles in the initial course, but they are brought into action at intervals, one needle at a time on each side of the active needles. Therefore the wales are started with a new yarn and with only a short end of yarn protruding from the selvages. Each widening operation is merely making an inoperative needle active and feeding yarn to it. However, if the yarns were to come to the needle from the inside to the outside the needle would engage it with the needle hook and immediately unhook on the next upward movement of the needle. Wrapping the yarn around the needle from outside to inside however insures the beginning of a wale, instead of a series of courses with drop stitches along the selvages. Illustrating the successive widenings in Fig. 5 the new wales are indicated on both sides of the fabric at courses 5, 6, 7, 8, needles 10, 11, 12, 13 on the left and 18, 19, 20, 21 on the right; it being understood that the yarns have not previously been engaged by the needles. When the inactive needles are made active, they

take yarn and the knitting described as straight-away knitting goes on with these needles.

Thickening fabric.—The following is a description of the method employed to produce thickened fabric of non-ravel stitches, without the use of auxiliary yarns, reference being had to drawing Fig. 6. In the drawings are shown a set of needles numbered 1 to 12 shown in solid circles cross-hatched. The courses are indicated by numerals 1 to 8. There are two sets of yarns, two yarns to a needle. The yarns of one set are shown as coming to the needles from the left side, numbered 15 to 27. The yarns of the other set are shown as coming to the needles from the right side and are numbered 29 to 40. In the knitting operations the two sets of yarn move across the needle stems in opposite directions, crossing the yarns on the needle stems and consequently the yarns are crossed in the loops when the stitch is formed. Both sets of yarn are adapted to pass under a needle and to lay the yarns to needles next to the one past, or in another way of saying it, passing a yarn under a needle and across the stem of the second needle. The tortuous path of the several yarns would be confusing in their massed form in a drawing. Therefore a clearer explanation is attempted by showing the direction of travel of two separate yarns, one yarn from each group that travel in opposite directions, thus: Yarn 17 is indicated as coming to a needle 3 in course 1 from the outside of the needle, around the needle and under the next adjoining needle 2 and from behind this needle to the outside of the companion needle 1 of the next course 2 of the knitting. The steps are repeated in all the subsequent courses. The path of the yarn 17 is typical of all the others of the set of yarns 15 to 27.

Describing the path of a single yarn 32 of its set which always moves in the opposite direction to the first set will illustrate how all the yarns of the set 29 to 40 operate. Yarn 32 comes to the needle 4, course 1 from the outside of the needle, passes around it and goes behind needle 5, course 1, then to needle 6 in course 2. The path of this yarn 32 is identical in reverse with the path of needle 17. All the yarns of this second set 29 to 40 perform in the same way simultaneously. Therefore superimposing a series of yarn paths like 17 upon a series of paths of 32 will show the assemblage of the two sets of yarn as indicated on needles 9, 10, 11, 12, courses 1 to 8. The dotted lines indicate yarns and needles that belong to the groups but are not of use in this illustration of the thickening method.

Fig. 7 shows a straight-away knitted fabric made according to the diagram Fig. 5 having the selvage and several wales adjoining it, reenforced or "spliced" meaning the same thing. Illustrating the method of splicing: The yarns 50, 51, 52, 53 are auxiliary yarns. At each course of knitting each of the yarns are laid across a needle stem by feeders, one feeder to each needle to have reenforcing yarn applied. When the needles take the yarns of the main feeders and make loops, the auxiliary yarns are also embraced by the main yarns and intermeshed with the main yarns. The feeders move across the needle stems back and forth, in one direction for a course then the opposite direction on the next course. The construction and operation of these splicer feeders or fingers are shown in Fig. 1, machine drawing.

Contoured fabric.—A contoured fabric made up of non-ravel stitches and having the new. short wales started between the long wales and inside the lines of marginal wales as distinguished from shaping that start at the selvages, is shown in Figs. 2 and 8.

Fig. 2 shows a fabric with new wales, shorter wales, interposed between the long wales at graduated intervals in the longitudinal development of the knitted fabric.

Fig. 8 shows in diagrammatic form the direction or path of the yarns in making the straight-away knitting step by step, one needle at a time also the variations of the yarn paths at the points of interposition where the new wales are begun. The diagram also shows the direction of travel of the yarns of the two needle steps, that bind the wales together where needles are inactive and the variations of their path at the places where the needles are inoperative as well as the direction the yarns take where the new needles are introduced to start a new wale.

In the knitting art, it is a well known fact that a stitch dropped and ravelled back produces a wide open space called a "ladder". These ladders are likewise accidentally made while the fabric is being knitted caused by a hook being broken off or a beard being "dead" having become weakened in the bend and no longer opening to receive the yarn. If the defective needles are removed and the knitting continued without a needle to take its place, the space will close up and the ladder is almost indistinguishable from the usual spaces between wales. This is particularly true when using wool or soft cotton yarns. The two wales on either side of the missing needle will be automatically drawn together by the yarns reaching straight from wale to wale and the evidence of a missing wale is hard to find. In the art this phenomena is taken advantage of in the production of golf hose and fabrics of the coarser gauges.

Taking golf stockings for illustration and employing my system of contouring and employing the non-ravel stitch method: the leg portion is made using a row of needles with certain needles omitted at graduated intervals in starting the ankle (see Fig. 8) and as the knitting progresses new needles are introduced at intervals into the spaces and new wales created thereby increasing the width of the fabric at each addition of a wale.

Figs. 2 and 8 are intended to show how this kind of fashioning may be done automatically by my system of contouring and my method of making non-ravel stitches. In the diagram Fig. 8, 31 needles and wales are shown numbered at the top 1 to 31. The courses of knitting are noted at the left ends 1 to 14. The two sets of yarn are indicated by crossed lines at the foot of the diagram. The active needles are represented with circles in solid lines cross-hatched. The inactive needles 2, 5, 8, 11, 14, 17, 20, 23, 26, 29 are shown in dotted circles in the courses 1 to 9. The two sets of yarns are moved across the needle stems in opposite directions. The movements are step by step a distance of one needle. The movements of the other row are steps of two needle distance as described in Fig. 6 for the thickening method. In knitting this fabric both sets of yarns are operating simultaneously but for clearer understanding the set moving two needles at a step will be discussed first. Only two yarns 36, 44 of the set are indicated as to their perigrinations throughout the lengthwise development of the fabric, it being understood that all the other yarns of the set perform in the same manner. In knitting a course with these threads where certain

needles are inactive, the yarns will cross the inactive needle space and being knitted into the wales on both sides of the inactive needles, the wales will be brought together to some extent and the wales are tied together. See Fig. 8, yarn 44.

Following the path of this thread from course to course: in course 1 the yarn is wrapped around the needle 19 from the outside inward and a loop is formed on the needle; then the yarn moves across the inactive needle 20 and wrapped around the needle 21 from outside to inside, a loop is made on the needle and the yarn goes across the inactive needle 20 in course 2 behind and around needle 19 from outside to inside and a loop is made on that needle for course 3. The next step is a repetition of the first described and a loop is formed on needle 21 in course 4. A new needle is now brought into action, the yarn passes behind this new needle 20 and goes to needle 19 in course 5, wrapping around it and making a loop. From this course to the end as at course 14 the yarn path is the same as just described passing behind a needle or wale and knitting only on each alternate needle, thus binding wales together by knitting on the companion needles separated by one needle.

The other set of yarns as already stated move only one needle at a step and the drawing Fig. 8 is made up of these stitches principally. The yarns of the two needle steps being omitted excepting yarns 36, 44 for clearer understanding. With this one step movement set of yarns knitting on companion needles, the inactive needles do not knit and as the yarns only move one needle distance, two companion needles make parallel wales of chain like form as shown in Fig. 8, needles 3, 4 in courses 1 to 8, for illustration. In reality the wales are tied together with the yarns of the other set as already explained. The completed fabric will appear as shown in Fig. 2 which has the right half filled in with loops and massed wales. The other or left half drawn with outlined long wales and the short wales shaded.

Describing a stocking made of non-ravel stitch and contoured

The stocking is shown in Fig. 4 as a completed article, seamed up the back of the leg and on the two sides of the foot, the seam diverging from the long seam in the instep of the foot. Fig. 9 shows the stocking blank as it comes from the machine. The entire stocking is a single unit all made on one machine at one operation. The stocking is started in the instep portion with two needles at 1, shown in Figs. 4 and 9. The fabric is widened at intervals of one, two and three courses, bringing into knitting action one new needle at a time along the edges of the fabric and new wales started. The widening continues to the point 2, then a short length of fabric of unvarying width is made to the point 3. A pocket 4 is then made at this point preferably using the long taper system described elsewhere in this specification. From the beginning up to this point the stitch system used is that described with reference to Fig. 6. When the toe is completed the knitting is continued using the stitch system described with reference to Fig. 5 and a short length of fabric is made of unvarying width from 3 to 20 to correspond to a similar section 2 to 3 previously referred to. At the point 20 the widening starts for the foot. New needles are brought into action, one at a time along the margins and a section is made widened to correspond when reversed to the first widenings 1 to 2. At the point 5 the fabric is wide enough for a stocking foot, to completely encircle the foot. At the point 6, widenings are made for the gusset. At 7 the two half heel pieces are made. These heels 8 are 90° gores made in about the usual way of making pockets. In this instance however, the thickening system shown in Fig. 6 is employed. When the two half heels are made the stitch is changed to that described with reference to Fig. 5 and the ankle is made of unvarying width from point 9 to 10. From 10 to 11 the fabric is widened at frequent intervals with courses of knitting between them to contour the leg as desired. At the point 12 two or three courses of chain knit fabric is introduced. This chain knit is produced by a movement of the feeders varying from the usual straight-away knitting. From 12 to 14 the fabric 13 is of the net stitch system, one of the variations of the yarn feeder movements. The stocking described has reenforced selvages and several wales adjoining the selvage are reenforced from point 1 to 14 by the system described with reference to Fig. 7.

Knitted vest or similar garment contoured.— The following description of a contoured vest for women's wear as shown in Fig. 3 is intended to be general in its application to knitted garments made up of non-ravel stitches and contoured in the knitting operations by making bulges in the field of stitches, the bulges being produced by knitting long and short courses between the wales of the straight-away knitting; adapted to bathing trunks, toques, caps and the like.

Fig. 3 shows the front half of a vest having breast pockets all knit in one piece at one continuous operation with variations of stitches and courses; that the machine drawing Fig. 1 is especially adapted to produce and the garment Fig. 3, stocking Fig. 4 fabric Fig. 2 are each made in accordance with the method making the principal purpose of this patent application, stressing contouring and non-ravel stitches. It being my claim and probably understood in the art that the usual stitch forming steps with one yarn extending from loop to loop for a course does not lend itself to the various kinds of contouring illustrated in this specification.

By my stitch formation and the methods employed the yarns extend longitudinally of the fabric and extend sidewise, normally, into two wales only. For special requirements the yarns extending into two companion wales separated by a wale. The variety of modifications are almost unlimited. Selvages may be made at intervals in the width of the fabric by the simple omission of two needles, leaving two adjoining needles inactive. Knitting can go on using as few as two needles in a row, all the other needles of the row remaining inactive for varying periods of time. By the machine construction shown in Fig. 1 the needles are independently controlled so that one, two, or any large number of needles may be retired or made inactive anywhere in the production of a fabric made of these non-ravel stitches. The vest shown in Fig. 3 is the front half of the garment and is supposed to be seamed to the other half along the sides.

The vest is started in the knitting with, we will say, ten needles for each shoulder strap as at 1, 20. The two straps are made straight with selvages 2 or if desired the straps may be widened to the contour shown by the dotted line 3. All the needles between the straps as at 4 are

brought into action all at one time and a few courses of knitting is made, then one needle on each side of the fabric as at 5 are made active in the knitting increasing the width by two wales. At frequent intervals other needles are brought into action on each side as at 6, 7, 8, 9 until the width desired is obtained. From course 9 to the completion of the fabric, no additional wales are created. The flaring contour of the skirt is produced by using open or net stitches as commonly made in warp knitting, which stretches to a greater degree than straight-away knitting. Pockets 10, 11 are started on course 8 by allowing all the needles of the row to be inoperative excepting three or four needles for the course. These needles make the first course in the pockets at 12, 13. A course of knitting is made on the four needles then all the needles make a course. Next, all the needles are made inactive excepting, say six or ten needles for the pockets as at 14, 15. These six or ten needles make a short course in each pocket. On the next course all the needles operate to make a full course, then only four or five needles in each pocket division are operative, and a short course, shorter than the last is made as indicated 16, 17. The pockets are completed by repeating the steps just described making alternating short courses between the long courses, the short courses of varying length and of varying number between the courses made with all the needles. This system produces bulges in the fabric because there are more courses in the pockets than in the field of fabric made of long courses. The vest shown in Fig. 3 has a field 21 made up of straight-away knitting shown in Fig. 5. The neck 23 and skirt 19 are indicated as composed of ordinary open or net stitches. The pocket 10 and half the waist fabric is shown in the drawings as filled in with the conventional symbols of knitted fabric. The other half and the pocket 11 are indicated in lines only to make the description and drawing clearer.

Describing the machine.—Fig. 1 is a vertical cross section of a machine that produces stitches of the character described in this specification and it is designed to make any of the fabrics illustrated and conforms in character to the requirements of the step by step methods and the movements of the yarns and needles in the production of contoured fabrics in a very general way.

The principles of the machine are broadly old in the art and belong in the class of warp knitting.

In the drawings is shown a needle of the spring beard type; but latch needles might be substituted and the results be within the intended scope of this specification. The needles are shown in three positions. The highest upward position, the pressing position and the lowest or stitch casting off position. The needles 1 are all independently operative and made to slide in grooves; they being engaged by jacks 2 in a manner old in the art. The needle jacks are controlled by levers 3, 4 said levers being designed to be driven up and down at times by the cam bars 5, 6. These cam bars can be moved up to lift the needle jack and down to depress them at each course of knitting and they have no end-wise movement. In their up and down movements they engage all the levers 3, 4 that project into the range of the cam bar movements. The levers contacting the needle jacks carry them along in their swinging path, consequently the needle has up and down travel also. The levers 3, 4 are operable end-wise to be either in or out of the path of the cam bars 5, 6 through their pivotal connections to the slidable pattern fingers 7, 8 that are slidable in grooved beds 12, 13. These fingers 7, 8 are steel forked instruments that may be likened to a hair pin; they each having two prongs and a nose like a finger. One prong is bent so as to give frictional contact on the two side walls of its groove. The other prong has a lug to which a lever is pivoted. One finger 7, has the lug 9 to which the lever 4 is pivoted and the finger 8 has a lug 10 to which is pivoted the lever 3. Each finger is slidable in a grooved bed. These two beds are grooved top and bottom and are fastened together to be operable as one piece. The grooves of one bed are offset in relation to the grooves of the other bed so that the grooves of one bed line up with the walls of the other bed. By this arrangement the fingers of one bed will be in position between the fingers of the other set. The bent forks 43, 44 provide friction to hold the levers 3, 4 in position while the beds 12, 13 move towards or from the pattern drum 11. The pattern drum 11 has a succession of teeth and notches. The pattern fingers are forced towards the drum 11 after each course of knitting by a movement of the beds 12, 13 towards the drum. The friction of the bent finger 43, 44 is sufficient to pull the levers 3, 4 out of the path of the cam bars when the beds 12, 13 move in one direction. In case of a notch being opposite the fingers the levers 3, 4 will be out of the cam bar paths and the needles will not perform on the next course of knitting, while the drum makes a step in its revolution presenting a new notch or tooth according to the prearranged plan. The beds repeat the movement just described for each course of knitting. The peculiar form of the needle jack 2 and the arms 3, 4 makes it possible to leave certain needles down and inactive, and certain other needles partly down, low enough to insure them from contacting yarn as the feeders swing their yarn across the needle row. In making a variety of fabrics, stocking heels and toes for instance, it is necessary that certain needles be made inoperative and the needles retain their loops for a few courses of knitting. It is also important in making a widened fabric that a number of needles on each side of the active needles remain down and inactive without loops on them for a period of time before being called into action. Illustrating the working of the needles, levers and cam bars as in pocket heel and toe practice, we first narrow the pocket by feeding yarn to a row of needles and making one needle at each end of the row inoperative, the needle holding its loop, not casting off. Two courses of knitting are made and the steps just described repeated a series of times. When the fabric is narrowed enough, the widening is effected by bringing into action one needle on each end of the row that has been idle and holding its loop. The needles are called into action, one at a time with two courses of knitting between the entry of each two end needles. The process is repeated until all the needles are in action and a pocket is knitted. This peculiar arrangement of needles, levers and fingers all under control of the pattern drum makes it practical to perform the narrowing and widening operations without the use of "picks" and to make pockets with the warp knitting principles of yarn control, not heretofore done. The peculiar nee-

dle control permits contouring and to use principles of the warp knitting plan of yarn feeding where it is desirable to contour along the selvages corresponding to the fashioning usually done with transfer points.

By my system of needle control any needle having a loop on it may be left inactive in a position higher than its lowest position by pulling its corresponding lever 3 or 4 as the case may be, out of alignment with the cam bar about to contact it. Any needle may be left inactive in approximately its lowest position with a loop on the needle or without a loop as desired, as in widening.

The yarn fingers 17, 18, 19, 20 are clamped rigidly in the grooves of the carriers 21, 22, 23, 24 and each carrier is slidable endwise on its pivot rod a distance of one needle normally, but a distance of two, three or four needles in exceptional cases. The four independently movable carriers have a swinging motion across the needle row all in unison. The carriers 23, 24 swinging to the line 25, the carriers 21, 22 swinging to the line 26. These swinging motions carry the yarn fingers between the needles, and then the carriers shog endwise passing the yarns behind the needles. The carriers swing again in the reverse direction between the needles to the position shown in the drawings, then shog endwise a distance of a needle and swing the other way, the fingers passing between the needles thus laying the yarns across the needle stems and between the needles. The shogging movements of the carriers is in opposite directions, two in one direction and two in the other direction ordinarily. In some cases as in making net stitches the carriers are arranged to move in the same direction for one or two courses, then move in the opposite direction, all the carriers moving together or in any order desired. The movements are common to the so called warp knitting. To explain the four carriers when most of the diagrams in this specification refers to only two it should be understood that in some cases each alternate yarn finger is omitted in two of the carriers, the two carriers then operate as one. The yarn fingers of one carrier alternate with the fingers in the other.

The foregoing description of the movements of the carriers leaves the fingers between the needles with the yarns laid across the needle stems and the needles start downward having seized the yarns with the needle hooks and in the downward movement the beard (hook) is pressed at 27 by the bed 28 moving towards and against the beard until it is sufficiently pressed to pass the hook through the fabric loop. A continued movement of the needle down to the position lowest in the drawing will result in forming a stitch in the well known manner. Sinkers 30 and web holders 29 perform the duties of such instruments in the usual way in knitting. Those movements relative to the needle movements and the yarns are obvious and need no description further than to say: all the sinkers slide in grooves and all move as one unit through the impulse of the bar 31, which pushes and pulls the sinkers in the grooves of the bed 28. The web holders 29 are likewise slidable in grooves in the bed 28, the bar 32 giving them forward and backward movement as indicated in dotted lines.

The splicing or reenforcing yarns referred to in Fig. 7 are or may be carried with a series of fingers 33 that are slidable in grooves in the bed 34 which bed has a step by step movement one step at each course of knitting along the front of the row of needles moved by the screw 35 which is also a guide for the rocker lever 36 that swings to line 37 to force the fingers 33 and their yarns between the needles. The screw 35 moves the bed 34 when the fingers are in the position shown in the drawing. When the fingers are between the needles the yarns are laid across the needle stems and the retraction of the needle will insure the engagement by the needle hook helped by the main yarns that are crossed on the needle stem. For reenforcing the selvage wales one or any number of fingers may be used. The splicing yarns are indicated at 38. The main yarns are shown at 39, 40, 41, 42.

When starting a new fabric all the yarn ends may be held under a weight bar 16. As the fabric is widened or when a new yarn and needle go into action the new needle seizes the yarns intended for it and continued knitting gradually pulls the yarn from under the bar 16 until it is free. When knitting with all the yarns in action there are no extra ends, the yarns then extending from the fabric to the yarn fingers as shown.

I claim:

1. A knitted selvaged non-ravel fabric contoured by widening in the knitting operation and made up of a series of original wales and a series of additional widening wales and each additional wale starting at a selvage of the fabric, all of said wales being tied together by threads crossing between the wales and knitted into the wales, with each loop of each wale made of two threads coming into the loop from opposite directions and both of said threads coming from loops of adjacent wales in a previous course and extending to loops in adjacent wales in a succeeding course.

2. A knitted non-ravel fabric contoured in the knitting operations made up of a series of parallel wales of unequal length, the loops of the wales formed of two threads, the threads coming to the loops from opposite directions, the threads extending from the two sides of the loops merging with previously made loops in a preceding course in the next adjoining wale in the series of long wales, one of the threads of the short wales being unattached to another wale in making the initial stitch of a wale.

3. A knitted selvaged non-ravel contoured fabric having a series of parallel wales of unequal length with all shorter wales starting at the selvage, the loops in all of said wales being made up of two separate threads, with the threads coming to the loops from opposite directions and crossing each other in the loops and also crossing other threads between the wales, the threads also extending into loops of adjacent wales from the inside of the first-mentioned loops to the outside of the subsequent made loop.

4. A knitted, non-ravel contoured fabric, a series of wales of unequal length, the loops of the long wales composed of two separate threads, each thread extending from a loop in one wale to a loop of another course in the adjoining wale, then extending back again to the wale first named, in a subsequent course of knitting, the initial stitch of the short wales having one thread unattached to a previous loop.

5. A knitted, non-ravel fabric made up of parallel wales of unequal length, selvaged, widened and reenforced along the selvages.

6. A knitted, non-ravel fabric made in a sheet with parallel wales of various lengths, the wales tied together with crossed threads between the wales, each loop of a wale being made up of two

threads, the threads of the loops on the long wales extending to them from loops of preceding courses in the adjoining wales on either side, and the loops of the short wales also being made of two threads, one of said threads extending into loops in an adjoining wale, the other thread being a floating thread when the initial loop of the wale is started.

7. A reenforced selvage and margin of a non-ravel knitted fabric having the reenforcing yarns introduced into the marginal loops together with the main yarns, the yarns of the reenforcing being bound against ravelling by the crossed main yarns being wrapped around the stitch.

8. A knitted non-ravel contoured fabric shaped in the knitting operation, having long and short wales and a gore where some of the short wales are diverted from straight parallel lines into right angled wales and a pocket is produced suitable for heels of a stocking.

9. A knitted, non-ravel fabric contoured in the knitting operation having long and short wales and a gore, some of the short wales merging with other wales at the gore and the wales diverted from straight parallel lines into angled lines, the degree of the angles depending upon the number of courses knitted between the narrowings and widenings of the gored section, and the gored section making a pocket of an angle suitable for toes of stockings.

10. A knitted non-ravel fabric contoured in the knitting operations by making long and short wales at predetermined intervals, beginning the short wales at a later period than the long wales thus widening the fabric from a few needle wales to any desired width or number of wales, the new, shorter wales all starting from the selvages of the fabric and terminating in a gored pocket structure making a fabric suitable for a stocking sole terminating in a pocket toe.

11. A knitted non-ravel fabric suitable for an undergarment, shaped, and contoured in the knitting operations by making long and short wales at predetermined intervals in the progress of knitting making gores in the sections where enlargement is desired, and with the short wales beginning and ending in the gores instead of the selvaged margins.

12. In a warp knitted fabric suitable for a stocking blank, the combination of a selvaged, tapered under-foot portion, a toe pocket portion, an upper foot-portion knitted integrally with the toe portion, a pair of selvaged and gored half-heel portions, and a selvaged flat leg portion widened by increasing the number of wales and with each new wale starting at a selvage of the leg portion, said leg portion being integrally joined and knitted onto the heel portions.

13. A warp knitted fabric suitable for a stocking blank, comprising a selvaged and tapered under-foot portion, a toe pocket widened and narrowed to make a gore, a selvaged upper-foot portion, two selvaged gored half-heel pieces, one at each side, widened and narrowed to make gores and knit onto the upper-foot portion, and a contoured selvaged leg portion with additional widening wales each having its beginning at the selvage, the stocking formed from said blank being seamed up the back and along the foot to the toe pocket.

14. A selvaged, warp knitted, non-ravel fabric suitable for a stocking blank, having a leg portion with contours produced in the knitting by creating new wales at intervals, and with each new wale starting from the selvage, a seamless gored and selvaged heel portion on each side of the flat fabric, a selvaged portion of suitable length for a stocking foot, a seamless gored pocket suitable for a stocking toe, and a selvaged tapered toe extension suitable to be joined to the sole, the various parts being integrally made by a continuous warp knitting operation.

15. The method of making a contoured, warp-knitted fabric suitable for a stocking blank which comprises successively and continuously making an under foot portion, a gored toe pocket, a foot portion, a pair of gored selvaged half-heel portions, an ankle portion with selvages, and a selvaged contoured leg portion widened by the introduction of additional wales each starting at one of the selvages.

16. A method of making a warp-knitted non-ravel fabric suitable for a stocking blank which comprises starting to knit with a small number of needles, making a two selvaged, widened tapered flap before making the toe, the flap being widened by increasing the wales along the margins, making integrally therewith a gored pocket toe, continuing the knitting from the toe and widening the fabric on taper corresponding inversely to the taper of the flap, making a foot piece with a widened gusset, making a pair of selvaged, gored half-heel pieces, making an ankle piece, and making a leg piece, widened by wales starting at the selvages and on selvage needles, all of said selvages being seamed together to make the stocking.

17. A method of making a warp-knitted fabric suitable for a selvaged stocking blank which comprises starting to knit the stocking at or near the toe on the sole side of the foot with a small number of needles, knitting a strip of selvaged fabric gradually widened to one-half the width of the stocking foot, making a seamless gored and selvaged pocket toe, continuously knitting the upper foot part and widening the same at the selvages to correspond inversely to the first selvaged strip, continuing the wales throughout the foot of the stocking, making two half-heel portions of selvaged, gored fabric, continuing the wales into the ankle and leg fabric, and contouring the calf portion by increasing the number of wales at intervals and starting each new wale at the selvage.

J. FRANK WILCOMB.